

REINHOLD ENVIRONMENTAL Ltd.

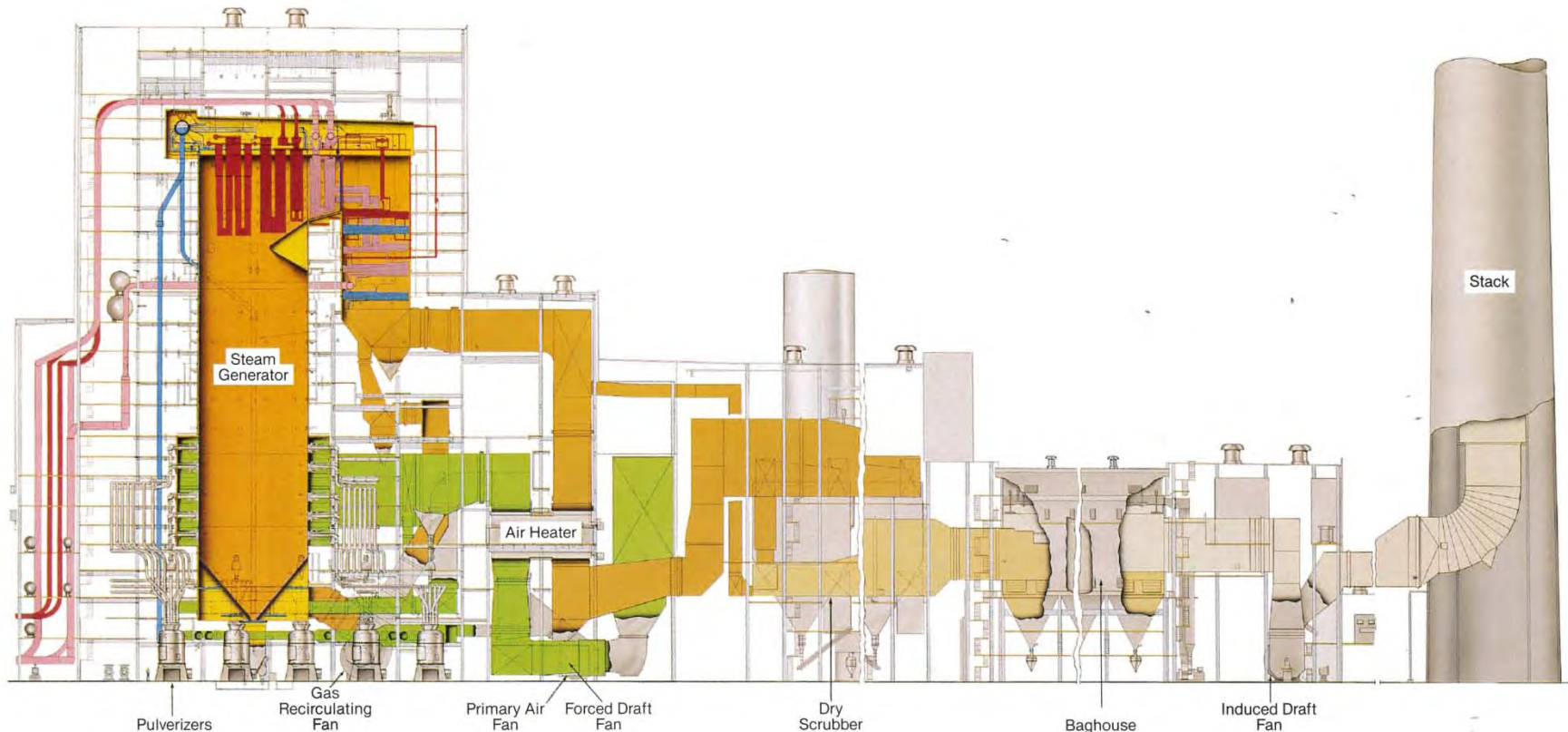


2016 NO_x-Combustion-CCR Round Table Presentation

February 1 & 2, 2016, in Orlando, FL / Hosted by OUC

All presentations posted on this website are copyrighted by Reinhold Environmental, Ltd (RE). Any unauthorized downloading, attempts to modify or to incorporate into other presentations, link to other websites, or obtain copies for any other uses than the training of attendees to RE's Conferences is expressly prohibited, unless approved in writing by RE or the original presenter. RE does not assume any liability for the accuracy or contents of any materials contained in this library which were presented and/or created by persons who were not employees of RE.

Controlling the Cost of MATS Compliance via Air In-Leakage Reduction

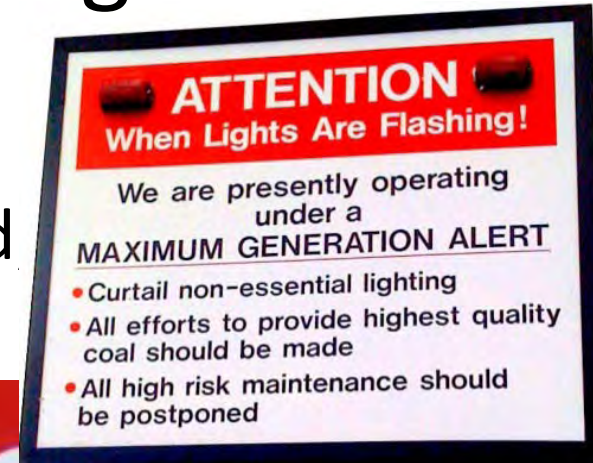


Babcock & Wilcox

Image Courtesy of B&W

Cycling, Fractures, Air In-Leakage: Heat Rate & Compliance

- The impact of cycling is well understood
 - Mechanical damage
 - stress fractures
 - weld cracking
 - refractory failure
 - and other failures
 - Air in-leakage
 - Increased heat rate
 - Reduced reliability
 - Reduced availability
 - Capacity reduction
 - Increased emissions



Increased Compliance, Increased Challenges



- Current MATS Rules
 - Added equipment
 - Added heat rate
- Proposed 111(d), the Clean Power Plan regulating Carbon Emissions
 - Unrealistic expectations
 - Front loaded requirements
 - Currently the only way to minimize GHG is by reducing throughput via efficiencies

Air In-Leakage & Efficiency & Emissions

Inaccurate O₂ readings contribute to:

- Increased fuel consumption & emissions,
- High desuperheating spray water flows that are significant steam turbine cycle heat-rate penalties.
- Elevated furnace exit gas temperatures,
- Overheated metals,
- Decreased tube reliability
- Higher LOI's,
- Production of popcorn ash,
- Fouling/Slagging,
- Excessive sootblower operation

Boiler Excess Air reduces combustion efficiency & increases NO_x Emissions

Increased mass flow, and variations in temperature, moisture and velocity through the precipitator and baghouse decreases collection performance.

Reduced Lower Furnace Heat Absorption

High primary airflows contribute to:

- Poor fuel distribution
- Poor coal fineness
- Decreased load control
- High dry gas losses
- Excessive NO_x levels

Bottom ash carbon content

APH & SCR fouling, & fly ash carbon losses

Increased Back-end Ductwork Corrosion

Scrubber Performance: Lengthens & complicates scrubber tuning, and impacts capacity

ID Fan Capacity Limitations

Image Courtesy of STORM ENGINEERING

Low Hanging Fruit Opportunities for Heat Rate Improvement

- Boiler & ductwork air in-leakage
- High exit temperature
- Dry gas loss
- Primary airflow optimization
- Steam temperature
- De superheater spray water flow
- LOI (flyash & bottom ash)
- Slagging & fouling
- Aux power consumption
 - fans, sootblowers, etc.

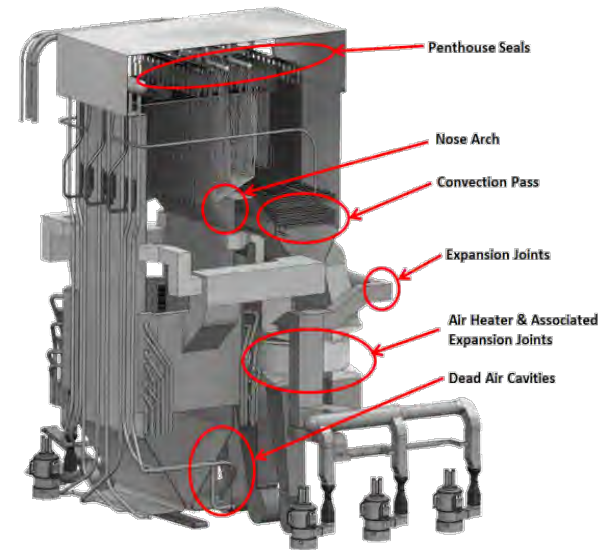


Image Courtesy of STORM ENGINEERING



Air In-Leakage, the Flue Gas Path & Emissions

- Excess Air
 - Excessive NO_x emissions
 - Reduced combustion efficiency
- Inaccurate O₂ Readings
 - Higher fuel consumption = more throughput per BTU
- Increased Gas Volume
 - Can exceed the capacity of the APC equipment
- Increased Gas Velocity
 - Insufficient residence time
 - Poor gas flow distribution
- Decreased Flue Gas Temperatures
 - Reduces sorbent effectiveness
- Increased Moisture
 - Increases ash resistivity
 - Increases wetted particulate



Flue Gas Control, Emissions & the Cost of Compliance

NEUNDORFER CASE EXAMPLE:

- 230 MW Midwestern Generating Unit
- Powder River Basin Coal
- Particulate Control via Electrostatic Precipitator
- Develop a strategy for achieving *particulate limit of 0.03 lbs/MMBtu.*

Data & Slides Courtesy of



Flue Gas Control, Emissions & the Cost of Compliance

NEUNDORFER CASE EXAMPLE:

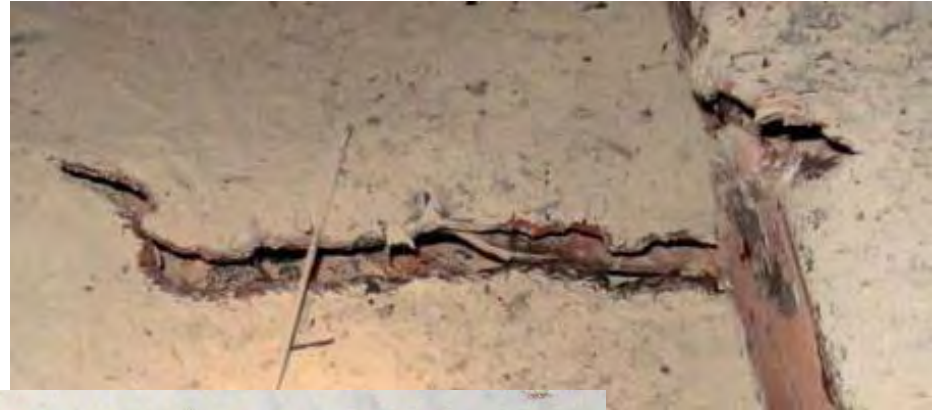
Data & Slides Courtesy of



		Projected Particulate Emissions (lbs/MMBtu)					
		A	B	C	D	E	F
ESP Configuration / Upgrade Project		Current ESP Inlet Conditions	Reduce Gas Temperature to 320 °F	Moderate Gas Velocity Distribution Improvement	Large Gas Velocity Distribution Improvement	Reduce Gas Temp and Moderate Gas Velocity Improvement	Reduce Gas Temp and Large Gas Velocity Improvement
0	Baseline (Existing Condition)	0.0578	0.0474	0.0390	0.0307	\$4.5 Million + New AH Baskets	
1	Sectionalize Inlet	0.0478	\$4.5 Million		0.0249		
2	Sectionalize First 2 Fields	0.0444	0.0380	0.0291	0.0224	0.0242	0.0183
3	Sectionalize and Rebuild Inlet	0.0454	0.0390	0.0299	0.0232	0.0250	0.0190
4	Full Rebuild	0.0415	0.0257	0.0260	0.0206	0.0224	0.0168
Future Particulate Limit = 0.03 lbs/MMBtu		\$8-9 Million					
		Safely within Future Particulate Limit (<0.02)					
		Marginally below Future Particulate Limit (0.02 - 0.03)					
		Exceeds Future Particulate Limit (>0.03)					

Cycling, Fractures, Air In-Leakage

- Mechanical damage
 - stress fractures
 - weld cracking
 - refractory failure
 - etc.



Traditional Repair Options

- Weld Repair
- Refractory



Lack of reliability ensures repetitive maintenance (...which often gets delayed while efficiency is lost and ash continues to build-up.)



Traditional Repair Options

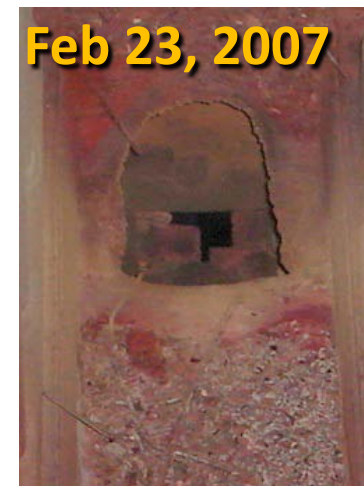
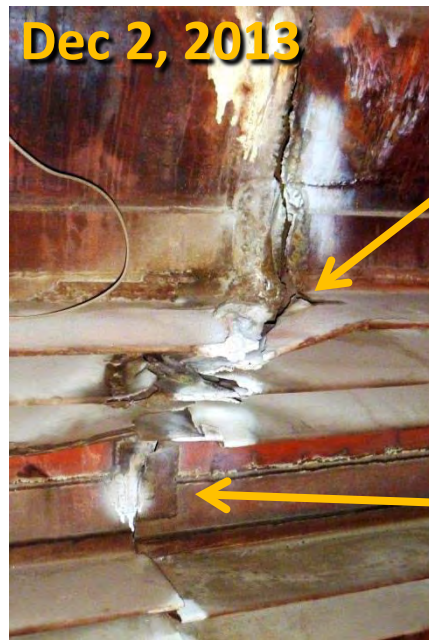
- Weld Repair
- Refractory

Lack of predictability can cause sudden spikes in excess air that can jeopardize emissions compliance



Traditional Repair Options

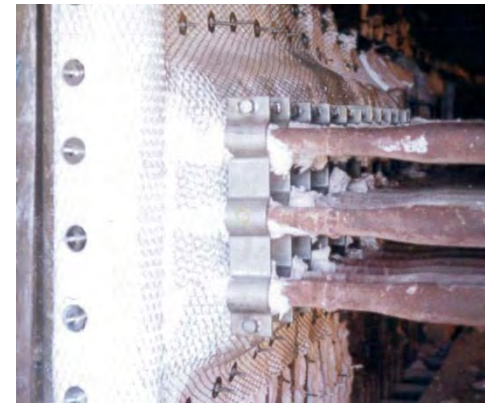
- Weld Repair
- Refractory
- **Doing Nothing**
 - *Universally, this has been a function of budget limitations*



ISOMEMBRANE®

Flexible, Resilient, Adaptable

- High temperature threshold (1,800+°F)
- Resilient in multi-plane movement, cycling environments
- Malleable, long-term sealing
- Adaptable in-situ fabrication
- No custom engineering details required
- Lowest installed cost
- Budget flexibility
- Fast & cost-effective way to eliminate leakage in dead air spaces & ductwork



ISOMEMBRANE®: A Quick History

- ISOMEMBRANE® is a patented, multi layered, flexible sealing system designed specifically to solve leakage issues in high-temperature environments that experience cycling and multi-plane movement.
- 1982: Invented in Denmark
- 1992: Introduced to the USA
- 1993: 1st US Boiler Penthouse Installation
- 1995: 1st US Expansion Joint Installation
- Today: Over 1000 installations worldwide

ISOMEMBRANE® Technology

Multi-layered Malleable Sealing System

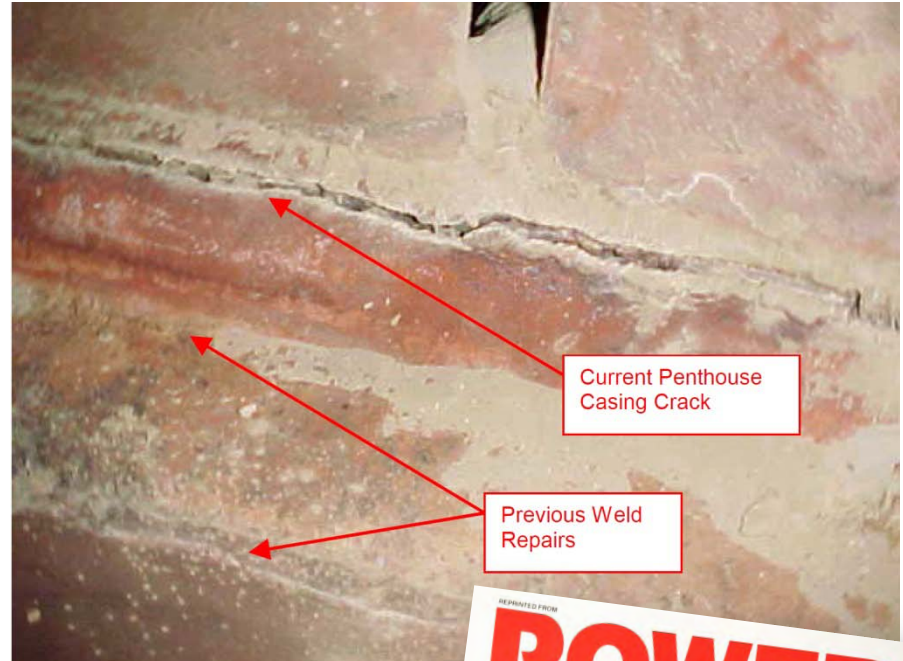
- Multi-layered system of several specially developed components:
 - ISOBLANKET-E®: HTT's proprietary weave, high tensile strength, high temperature blanket
 - ISOBOND-E®: HTT's proprietary high strength, high temperature adhesive
 - ISOCOAT®: HTT's proprietary topcoat layer
 - ISOSTUD®: HTT's proprietary stud design that increases seal gasket attachment uniformity >26%, and reduces total installation time ~10%
 - These components work in unison to optimize sealing by merging flexibility, impermeability and robustness
- Fabricated in-situ to the specific application
 - No prefabrication or pre-engineering is required.
 - Fast & economical to deploy & install

ISOMEMBRANE® as a Tool Boiler Applications

- A **maintenance-free alternative** to refractory and weld repairs
- Provides reliable crack & penetration sealing service-life that typically lasts the life of the tubes



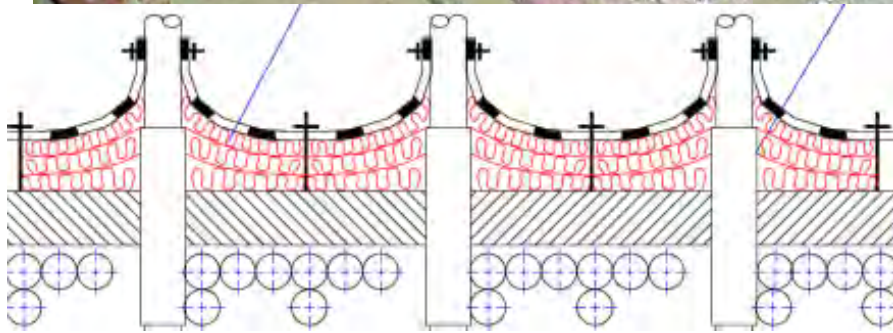
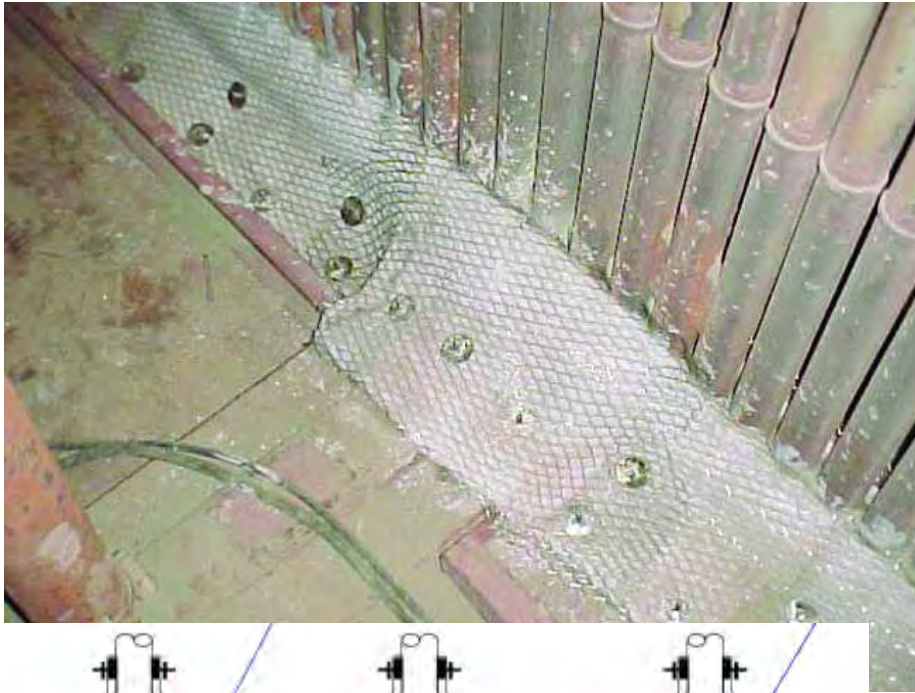
Case Study: Gorgas Electric Generating Plant



Images Courtesy of POWER Magazine & Innovative Combustion Technologies, Inc.

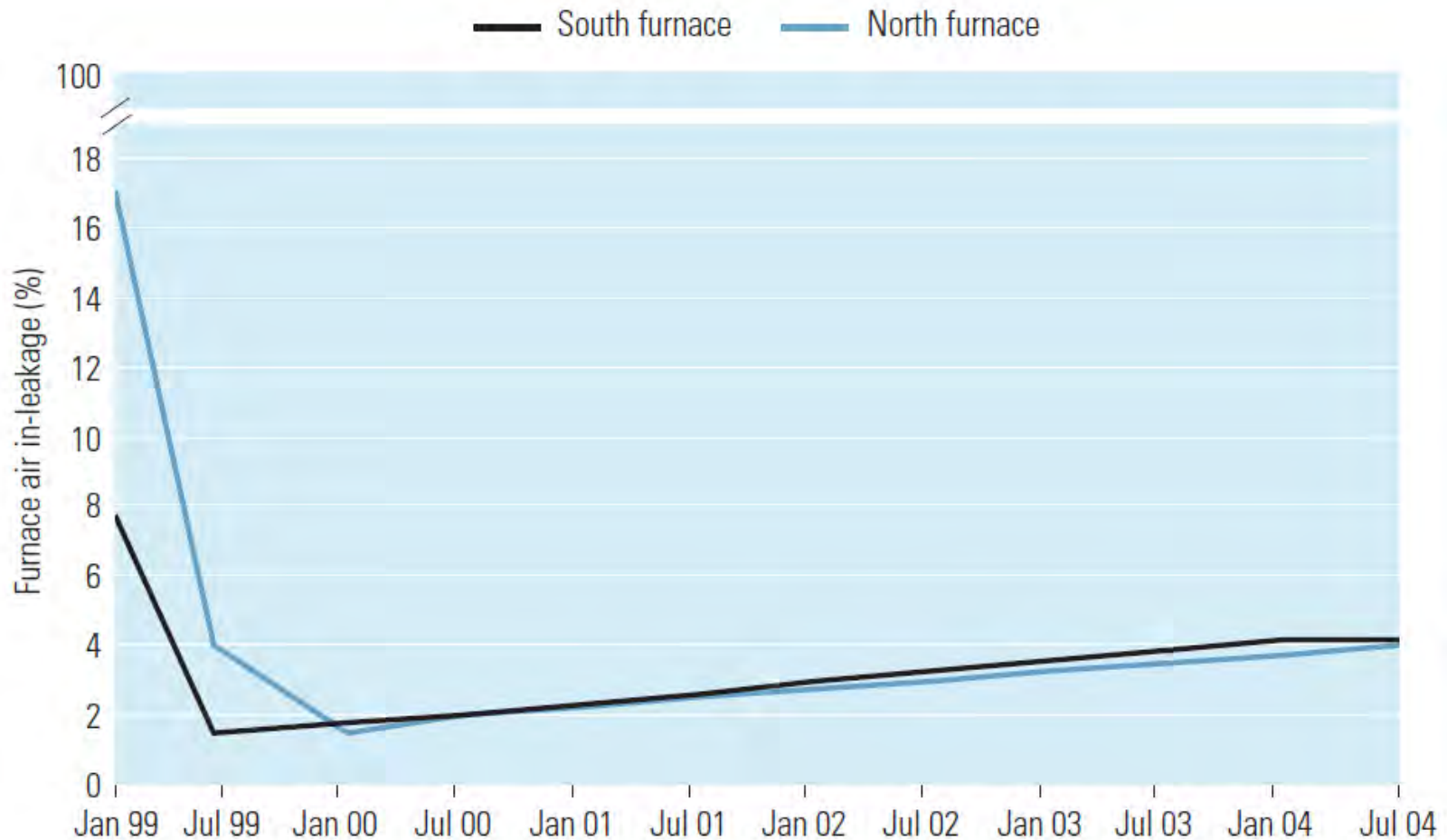
Case Study: Gorgas Electric Generating Plant

Plant reports, after **16 years in-service**,
ISOMEMBRANE® still providing reliable sealing



Images Courtesy of POWER Magazine & Innovative Combustion Technologies, Inc.

Case Study: Gorgas Electric Generating Plant Air In-Leakage - Excess Oxygen Levels



Graph Courtesy of POWER Magazine & Innovative Combustion Technologies, Inc.

Case Study: Gorgas Electric Generating Plant Cost Savings

Parameter	Quantity	Assumed cost or penalty	Annual saving
Flyash loss on ignition	2% reduction in loss on ignition	24.2 Btu/kWh	\$233,400
Lost generation (300-MW de-rate to shed furnace slag)	8 hours/outage; one outage every two months	\$35/MWh	\$504,000
Reduced auxiliary horsepower for 1,000-hp induced draft fans	Four fans (with 70% capacity factor) x 745 kW saving x 8,760 hours = 18,385 MWh	\$0.02/kWh bus bar price	\$367,700
Desuperheating reheat spray flows	0.2% heat rate for 1.0% of main steam flow	37.2 Btu/kWh	\$359,000
Reduced boiler exit gas temperature	10F reduction	23.25 Btu/kWh	\$217,600
Total annual savings			\$1,681,700

Assumptions: Heat rate = 9,300 Btu/kWh; fuel cost = \$50/ton; fuel heating value = 12,000 Btu.

- Avoided annual labor & material cost to repair recurring refractory & penthouse casing cracks.
 - Conventional Procedures \$20,000 to \$40,000 in materials
 - Man hours (~160 for each repair, \$8,000-\$10,000).
 - Additional delays and cost associated with vacuuming the penthouse.
- Total cost of the two ISOMEMBRANE® Seals was less than \$100,000.

Chart Courtesy of POWER Magazine & Innovative Combustion Technologies, Inc.

Case Study:

Duke Marshall Penthouse

- Unit 4: 700 MW Supercritical Unit
- 3-5 feet of ash accumulation
 - approximately 100 tons
- Ingress of flyash caused typical problems
 - Safety
 - Reliability
 - Efficiency
 - Housekeeping

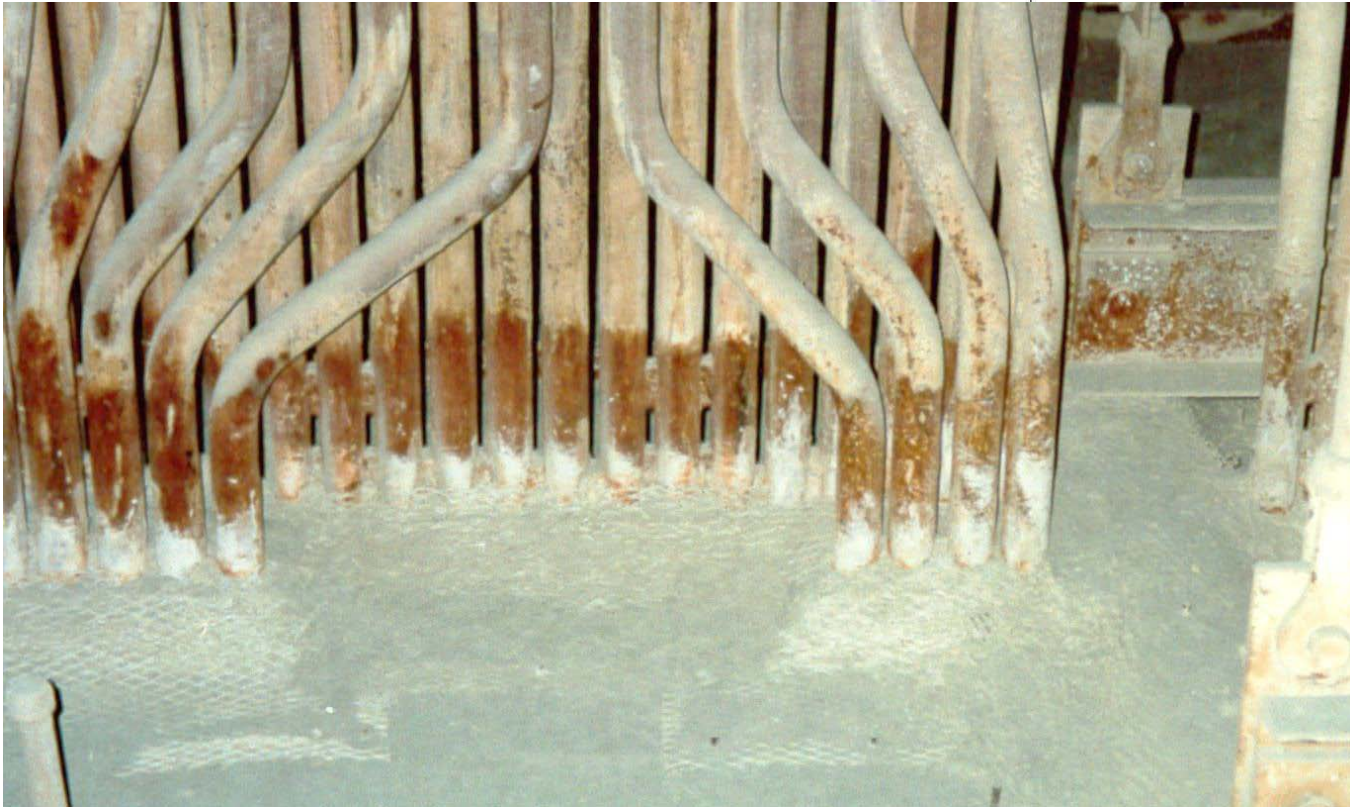
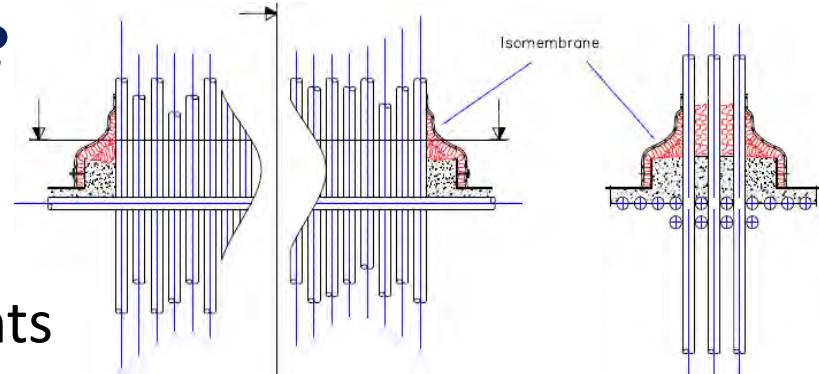


***Prior to installation of
ISOMEMBRANE® in 1994***

Case Study: Duke Marshall Penthouse

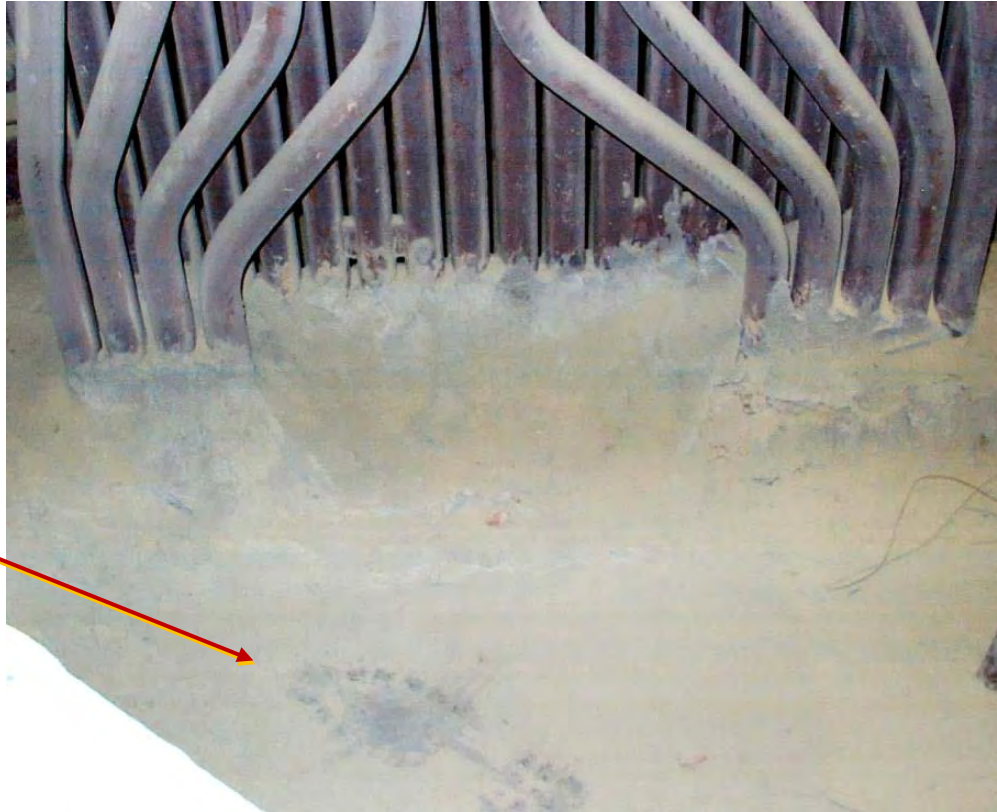
After 1 Year in Service

- No vacuuming required
- Reduced outage requirements
- Reduced costs and labor requirements



Case Study: Duke Marshall Penthouse *After 10 Years in Service*

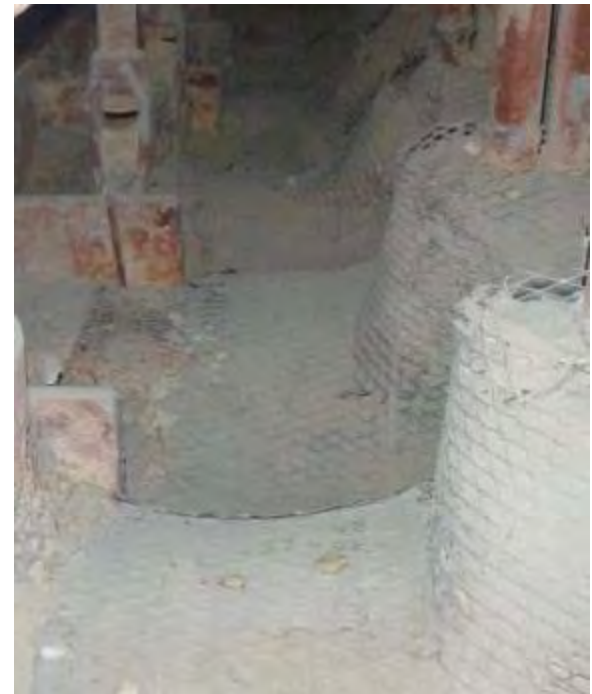
- Still no vacuuming required, only minor ash dusting exhibited
- Improved outage costs, budget flexibility, labor and safety
- Significant payback in reduced vacuuming & inspection costs alone



*Minor ash dusting
(note foot print)*

Case Study: Duke Marshall Penthouse *After 19 Years*

- No ISOMEMBRANE® maintenance required
- Improved outage effectiveness, safety, and time & budgetary savings



Original ISOMEMBRANE® Installation in 1994, photos taken May 2013

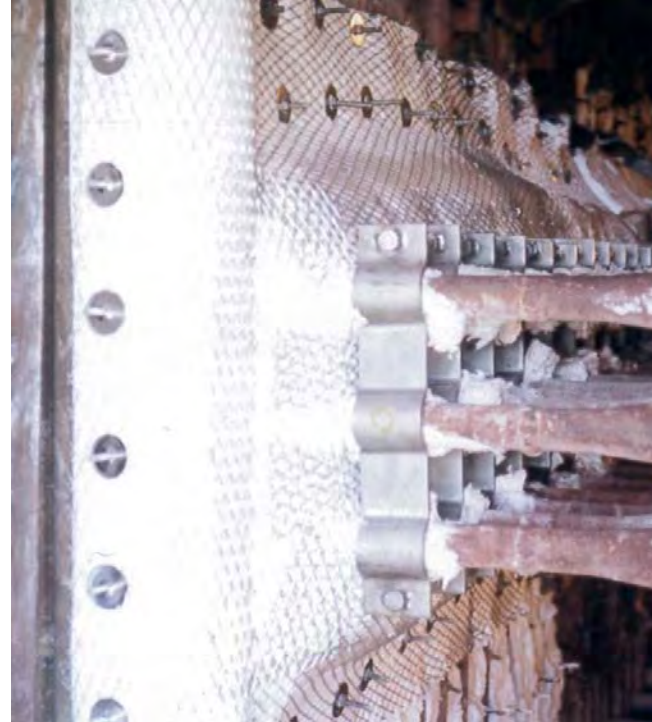
Case Study: Header Vestibule - Tube Penetrations

Before

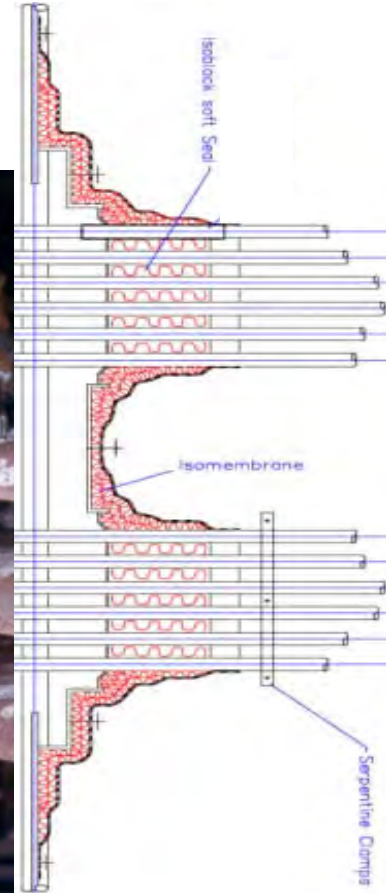


- *Opposing movements cause repetitive failure of traditional repair & sealing tactics, allowing excessive air in-leakage.*
- *This plant was experiencing escaping flames in the rear corners.*

After



- *ISOMEMBRANE® creates a flexible, yet robust “boot,” that allows for the inevitable tube movement, while ensuring a reliable*



Case Study: Header Vestibule - Tube Penetrations



Case Study: Header Vestibule *After 10 Years in Service*

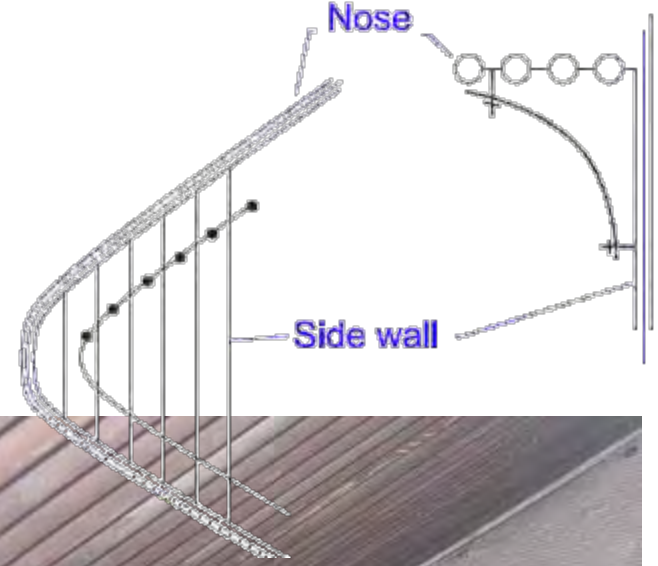


Case Study: Nose Arch – Side Wall Seals

Before



After



Case Study: Lower Dead Air Space



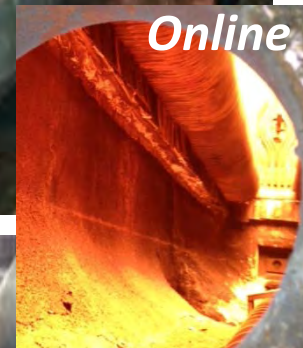
Case Study: Bottom Water Trough Seal NOx Control, Improved Efficiency

- *Trough seals inherent lack of reliability renders them ineffective.*
- *The failed trough seal allowed excess air, resulting in excess NOx emissions, lower furnace slagging & heat loss out of the bottom of the boiler (impacting safe access to the area).*
- *Plant Reported Results:*
 - *“a significant reduction in the excess air leakage*
 - *NOx emissions are controlled.”*
 - Improved unit efficiency.*
 - *ISOMEMBRANE® “has been very reliable & looks the same as when it was first installed.”*

Before



After



Case Study: Center Waterwall Header

Before



ISOMEMBRANE® in the
4th & 5th stages of installation

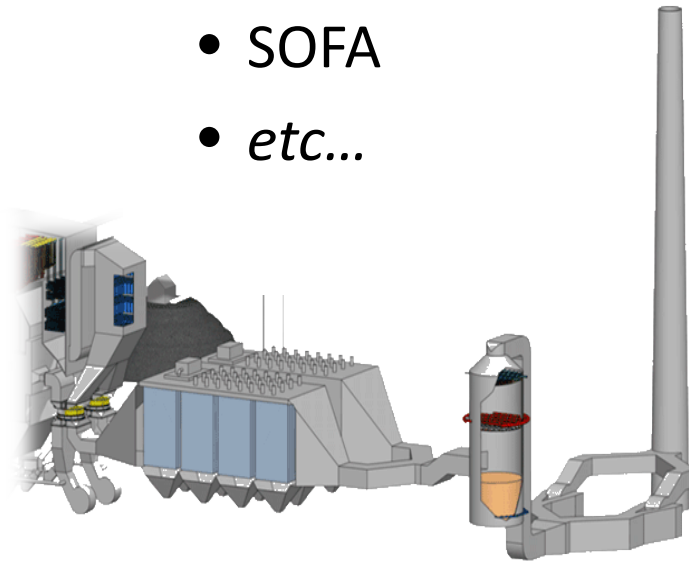


ISOMEMBRANE[®] as a Tool Expansion Joint Encapsulations

ISOMEMBRANE[®] consistently provides service life and effectiveness that exceeds OEM type replacement joints.

- By encapsulating the existing joints with ISOMEMBRANE[®] & retiring them in place, the plant effectively gets new joints without the cost & labor time associated with specification engineering, procurement, demolition, etc.
- Joints can be encapsulated beyond corroded flanges & ductwork to good metal restoring the integrity of the flue gas path
- ***Many joints can be encapsulated while online***
- ***Installations of this type are often capitalized***

- Economizer
- FD/ID Fan
- Air Heater
- Scrubber
- Baghouse
- Stack
- Primary Air
- SOFA
- *etc...*



Case Study: Expansion Joint Internal Joint Encapsulation

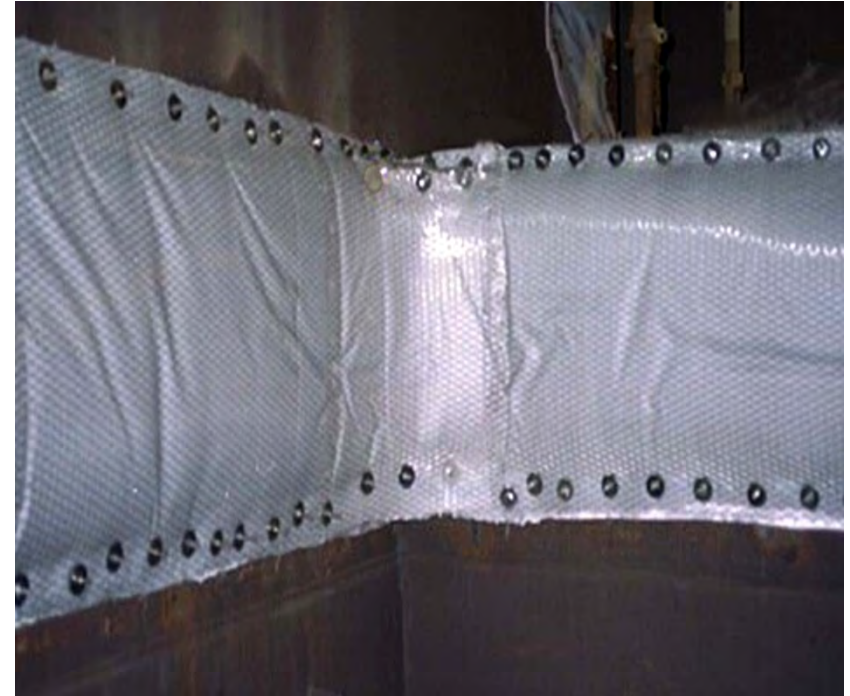
Retire Existing Joint In-place – Capital Budget Item



Expensive & time-consuming to replace.

NOT required with ISOMEMBRANE®:

- **Demolition, flange/metal repair & fabrication**
- **No pre-engineering or detailed specs required.**



- *ISOMEMBRANE® bridges beyond corroded flanges & ductwork to good metal.*
- *Restored the integrity of the flue gas path*
- *Installed in 2 shifts.*

Case Study: ID Fan Joint Failure after SCR Install – *ON-LINE Encapsulation*

Before

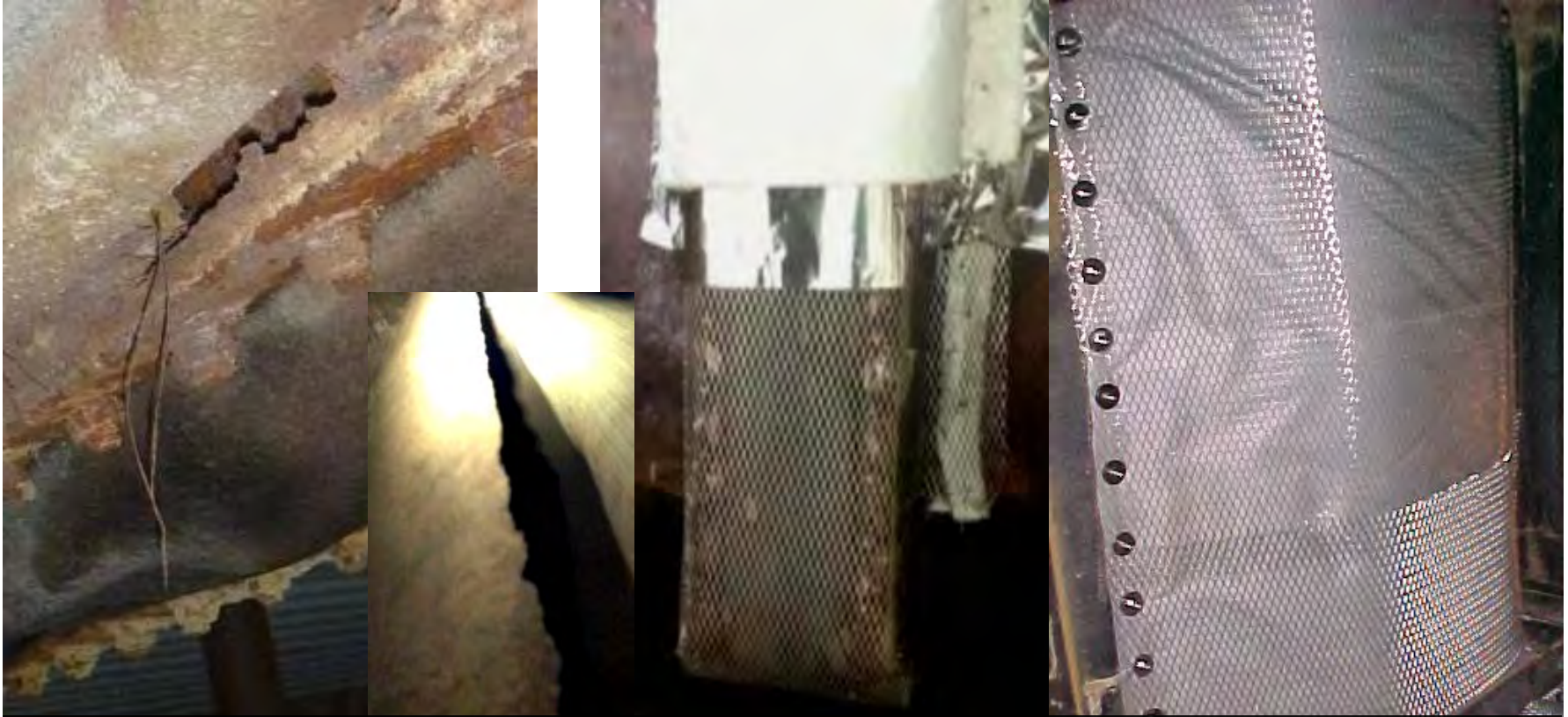


After



- SCR system installed
- Joint blew when unit came on-line.
- Derate of 20MW
- The operating pressure was negative 20-25" H₂O.
- The plant dialed down the draw to about 6-8" H₂O.
- Installed in 1 ½ shifts, (in 20 degree weather!, which is why it's not the prettiest installation.)
- After 1st layer of ISOMEMBRANE® was installed, the plant returned to full load
- Immediately recovered 20MW
- Project Cost: \$21,000
- Installed in 2003.
- Still in-service

Case Study: Gas Recirculation Fan Joint Over Flange Installation, Bridge Over Corrosion



- *Catastrophic failure of corroded ductwork adjacent to the gas recirculation fan outlet expansion joints shutting the unit down during peak summer demand.*
- *HTT installed the ISOMEMBRANE® sealing the joint and beyond ductwork breach.*
- *After the ISOMEMBRANE® was installed, along with other repairs, the station successfully passed their capacity test for the first time in 3 years, restoring capacity payments.*

Case Study: FD Fan Expansion Joint

Customer Reported Results- *Restored 68MW to the Grid*

- Sudden Joint Failure
 - Decreased output from 198 MW to 130 MW
 - Decreased duct pressure from 54" H₂O to 30" H₂O
- Installed 1 ½ shifts
- Project Cost: \$25,000



Case Study: Economizer Outlet Joint

Customer Reported Results-

Heat Rate Improvement of 0.27%

- LOI decreased on “A” side from 8% to 6% for a heat rate improvement of 0.1%
- MS & RH temperatures improved by 5°F for a heat rate improvement of 0.12%
- Electrical auxiliaries decreased for a heat rate improvement of 0.05%
- Decreased average coal feeder speed from 8.2 to 7.8 rpm
- Total 0.27% effect on heat rate: \$50,000/year at 60% capacity factor
- Project Cost: \$30,000



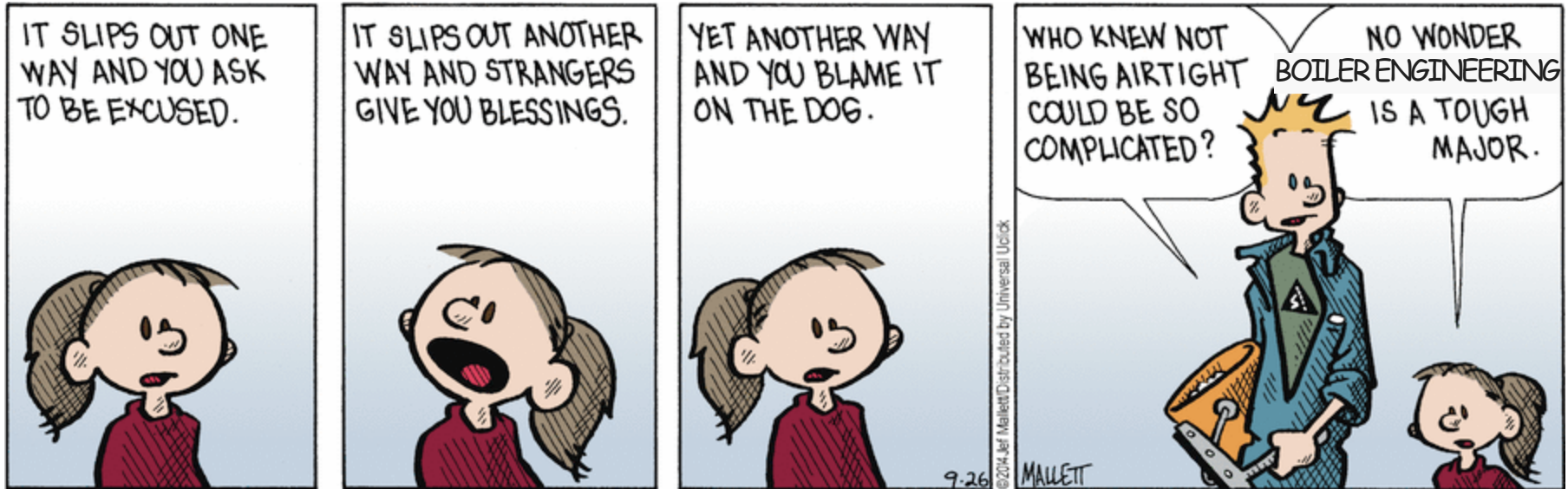
CASE STUDY: Air Heater Expansion Joint *After 18 Years*



Original ISOMEMBRANE® Installation in 1996, photos taken Jan 2013

Ah...the Challenges of Air & Gas Control

FRAZZ



No matter which,
leakage needs to be addressed.



www.isomembrane.com

Thank You

HIGH TEMPERATURE TECHNOLOGIES, INC.

4324 Barringer Drive
Charlotte, NC 28217
704-375-2111

Patrick Fitzgerald
Air In-Leakage Reduction Manager
cell: 704-621-2465
patrick@isomembrane.com