

REINHOLD ENVIRONMENTAL Ltd.



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One
GREAT
Team

Southern Company Generation

Lessons Learned with Non-Metallic Materials in FGD Service

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July 17, 2012



Topics

- **Quality Process**
- **Expansion Joints**
- **Elastomers**
- **Fiberglass**
- **Tile Lined Concrete**
- **Borosilicate Block**



Topics

- **Quality Process**
- Expansion Joints
- Elastomers
- Fiberglass
- Tile Lined Concrete



What is a Lesson Learned?

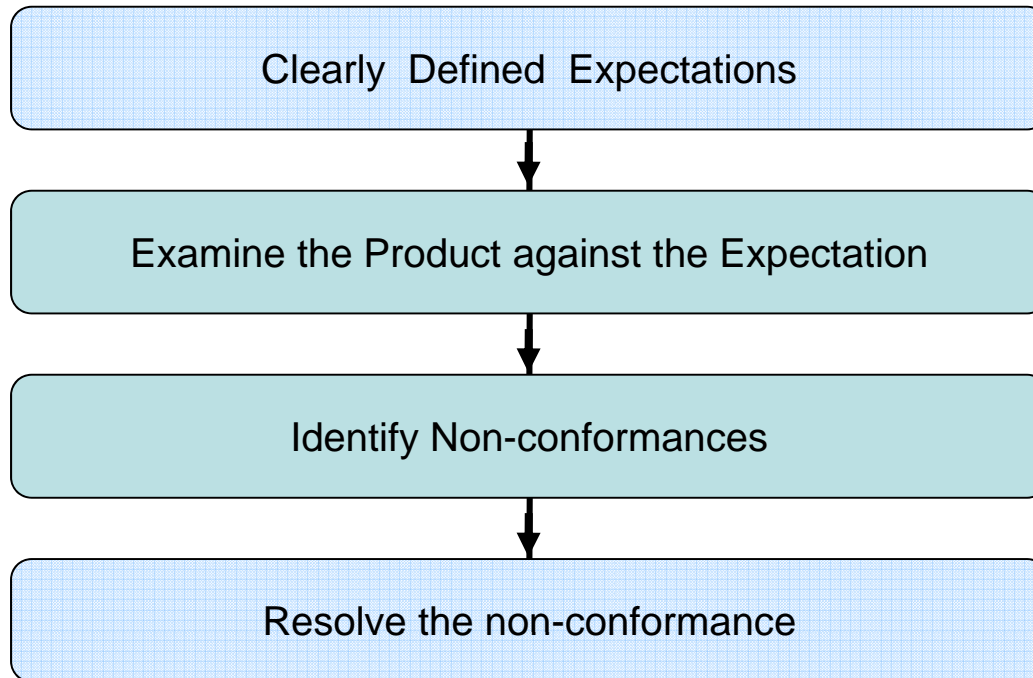
- Good decisions come from Experience
- Experience comes from bad decisions
- Lessons learned primarily come from getting something different than what was expected



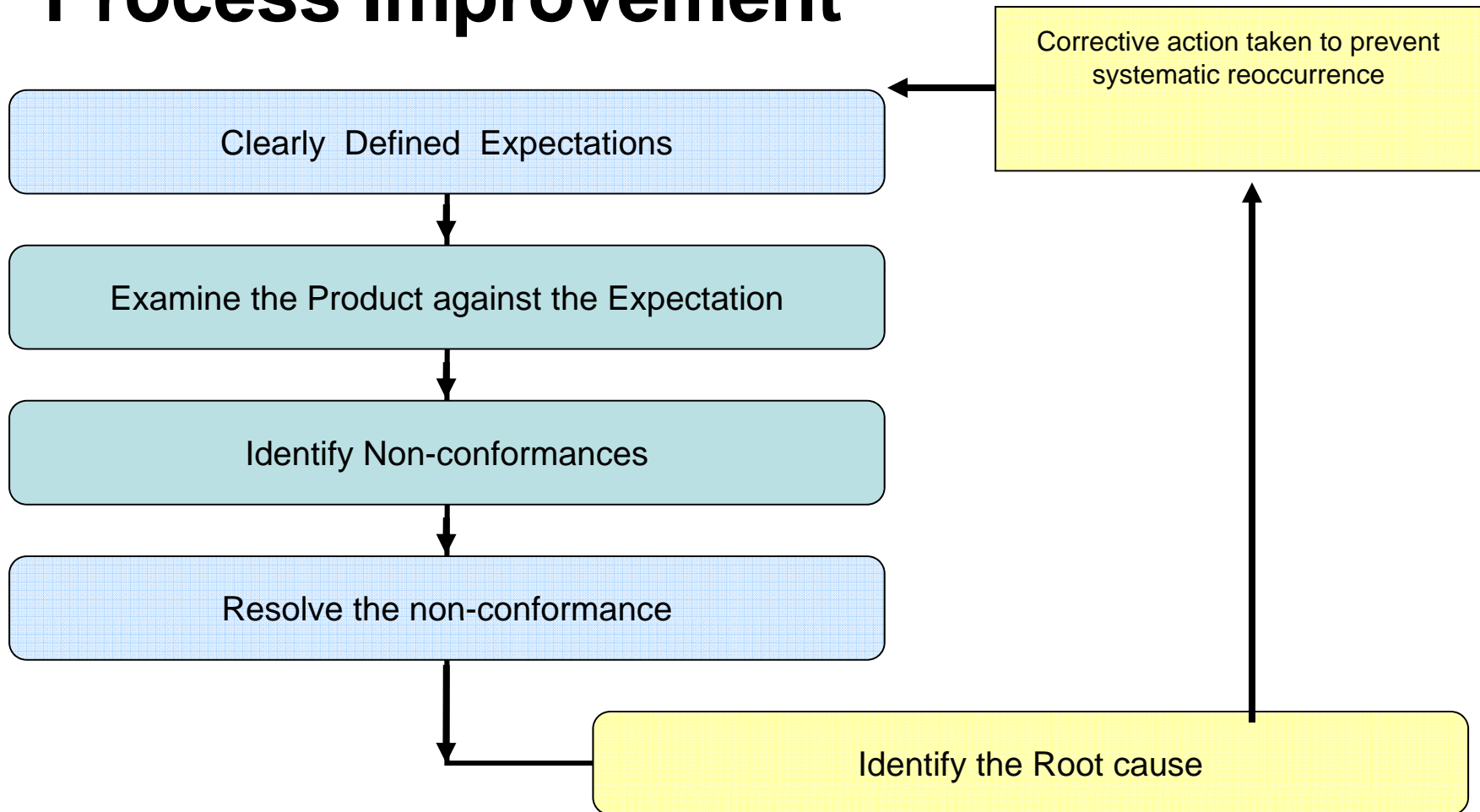
What is Necessary to Get What you Expect?

- Expectation is defined
- Expectation is communicated
- Expectation is understood
- Expectation is valued

General Quality Process



Process Improvement



Process Lessons Learned

- **Suppliers and End Users look at failures from different perspectives.**
 - “We’ve never seen this before” - Supplier
- **Poorly defined expectations result in poor results.**
 - “You should have known that this operating condition could have happened” – End User



Process Lessons Learned

- A solution and improvement can not be occur until the problem is identified and agreed to.
- Root cause of most RCA's is selecting the wrong "root cause".



Process Lessons Learned

- When it comes to a recommendation there is a significant difference between Assure, Ensure and Insure.
- “I have seen this fail before”, is more valuable information than “I think it will work”.

Process Lessons Learned

- **Do not give into Optimism Bias, which says**
 - “while case histories suggest there is risk, it won’t happen to me”
- **All case histories are not equivalent.**
 - Rarely are two vessels identical (temp, pH, SO₂, construction, etc.)
 - Some Vessels operate at their design, some operate below their design conditions, some operate above their design conditions.



Process Lessons Learned

- No news is not necessarily good news.
- If you don't know what you want, you probably won't get it.
- You don't get what you expect. You get what you inspect.

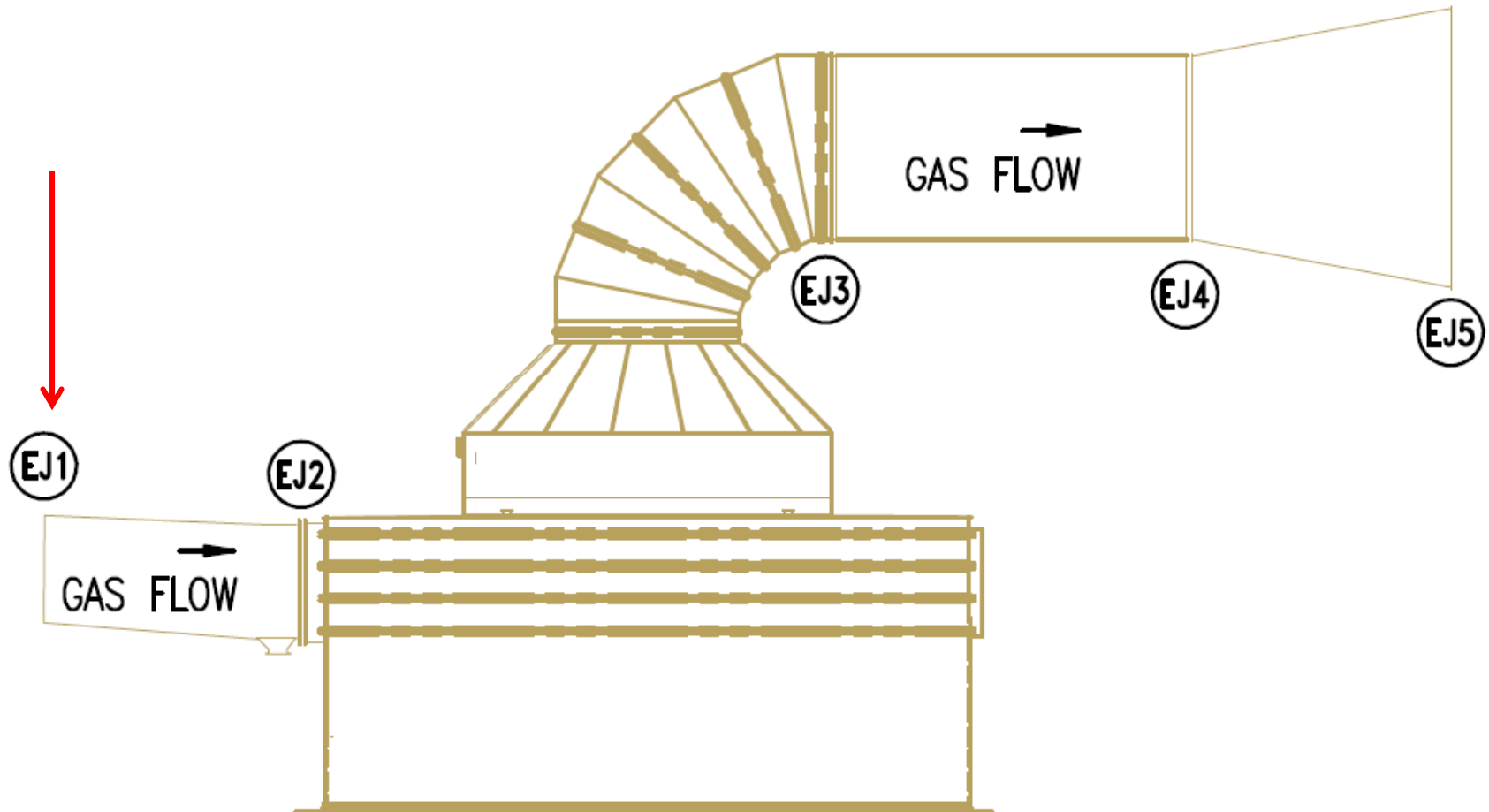


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Lesson Learned EJ1 Expansion Joints

- Expansion Joint at the Inlet to scrubber which experiences alternating wet and dry is the most severe FGD joint.
- Industry standard expansion joint not sufficient to handle the service due to the higher operating pressure (25 inH₂O).



Failure Modes

- Cuts and tears in elastomer
- Wicking & attack of glass reinforcement
- Cutting of glass reinforcement
- Leaking at bolt holes
- Delamination
- Blistering
- Swelling of inner surface

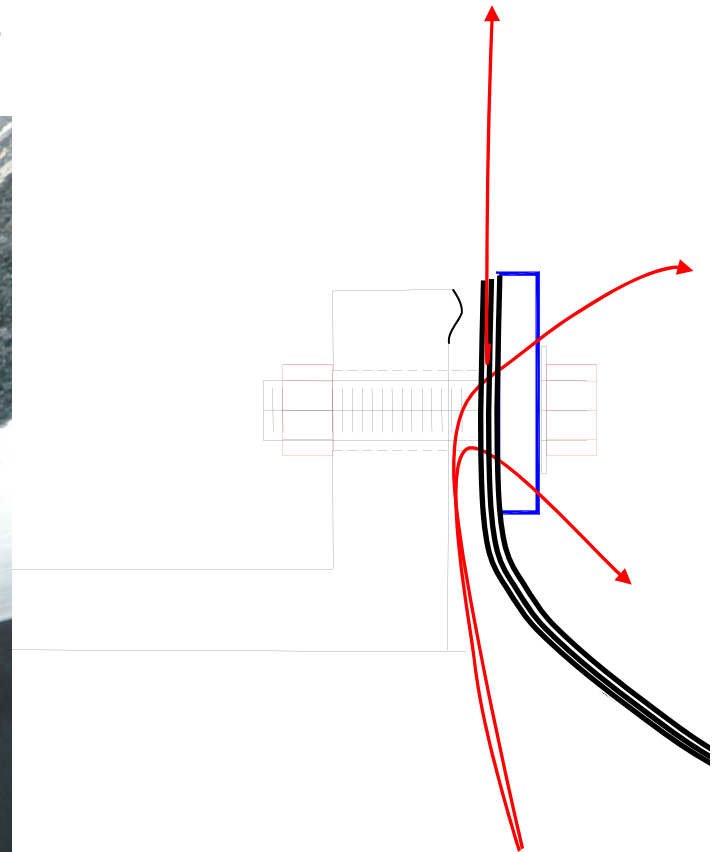
Cuts at Backing Bars



Blisters and Delaminations



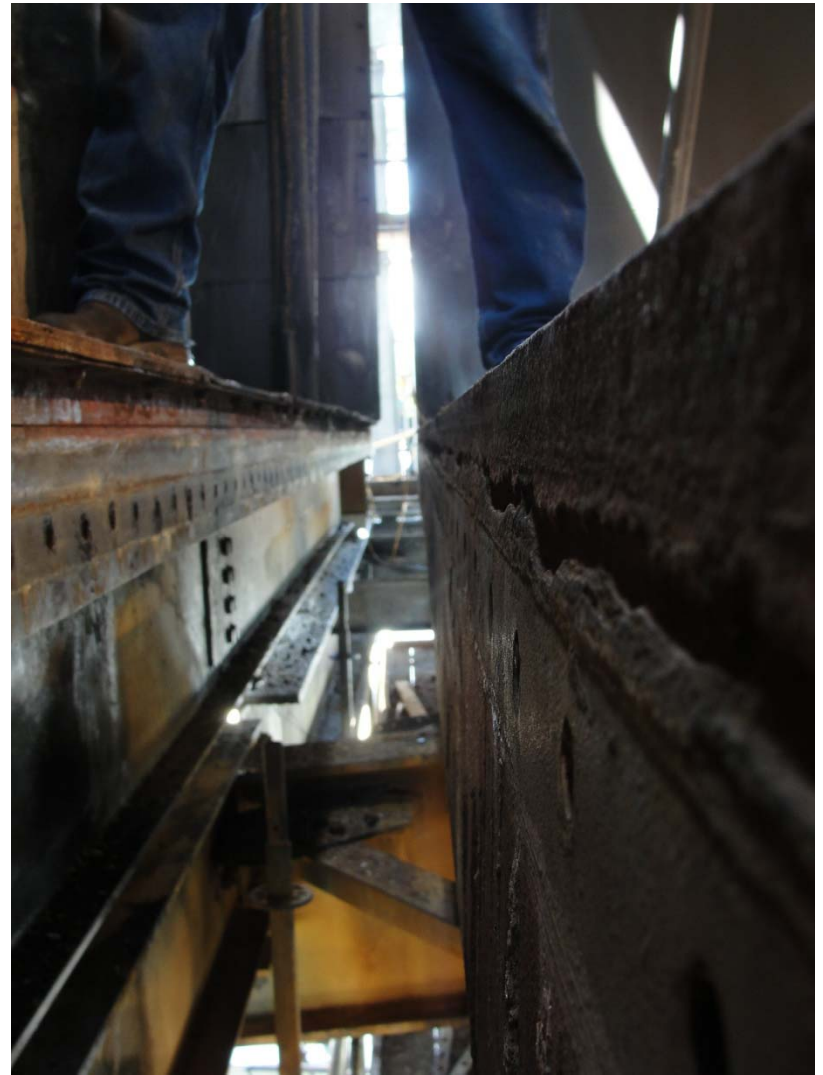
Leaks through Bolt Holes



Wicking and Attack of Glass



Acid Attack of Steel

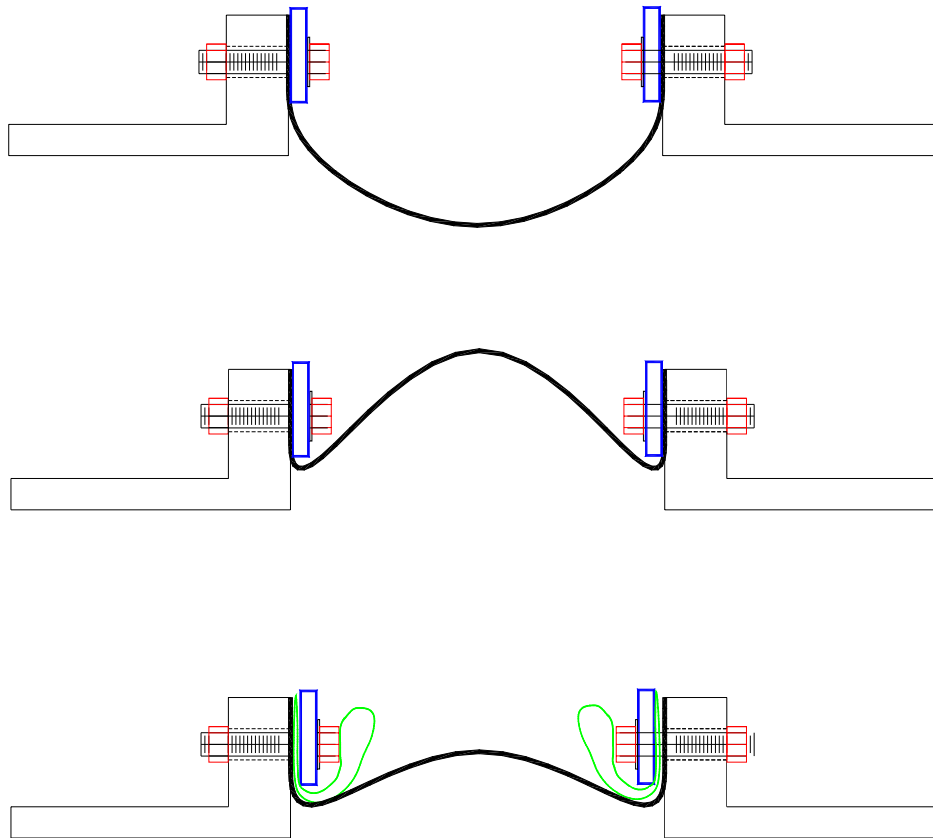




Root Causes

- Design
- Construction
- Operation

Root Cause Design

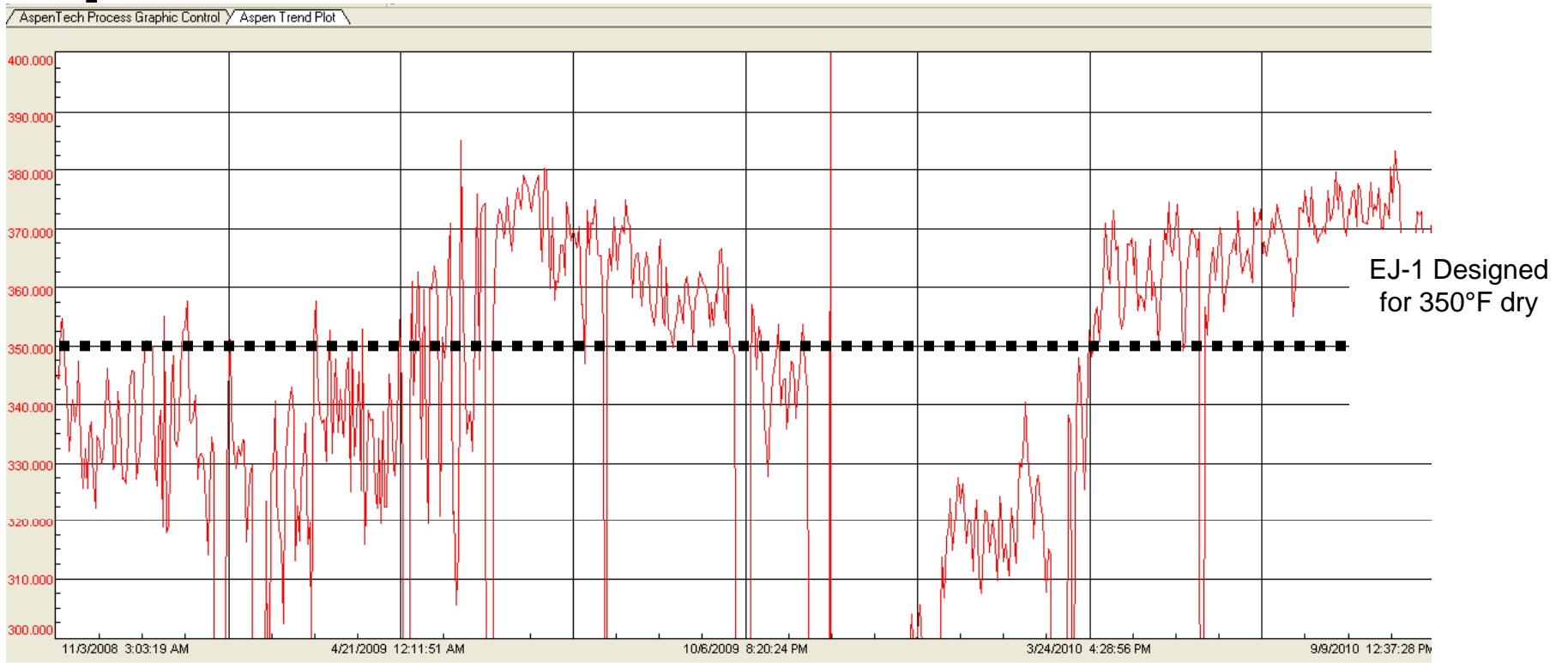


Root Cause Construction





Operation





Solutions

- Add tadpole gaskets
- Increase radius of backing bars
- Add Joint sealant to flange face
- ~~Change Viton from Grade B to Grade GF~~
Changed back to Grade B due to cracking of GF
- Change bolting and backing bars to 316L
- Reduced torque
- Developed installation guideline
- Changed reinforcement from fiberglass to one layer of Inconel Wire and one layer of Kevlar wrapped glass.
- Reduce gap from 12" to 6" face to face
- Added FEP liner to inner surface.

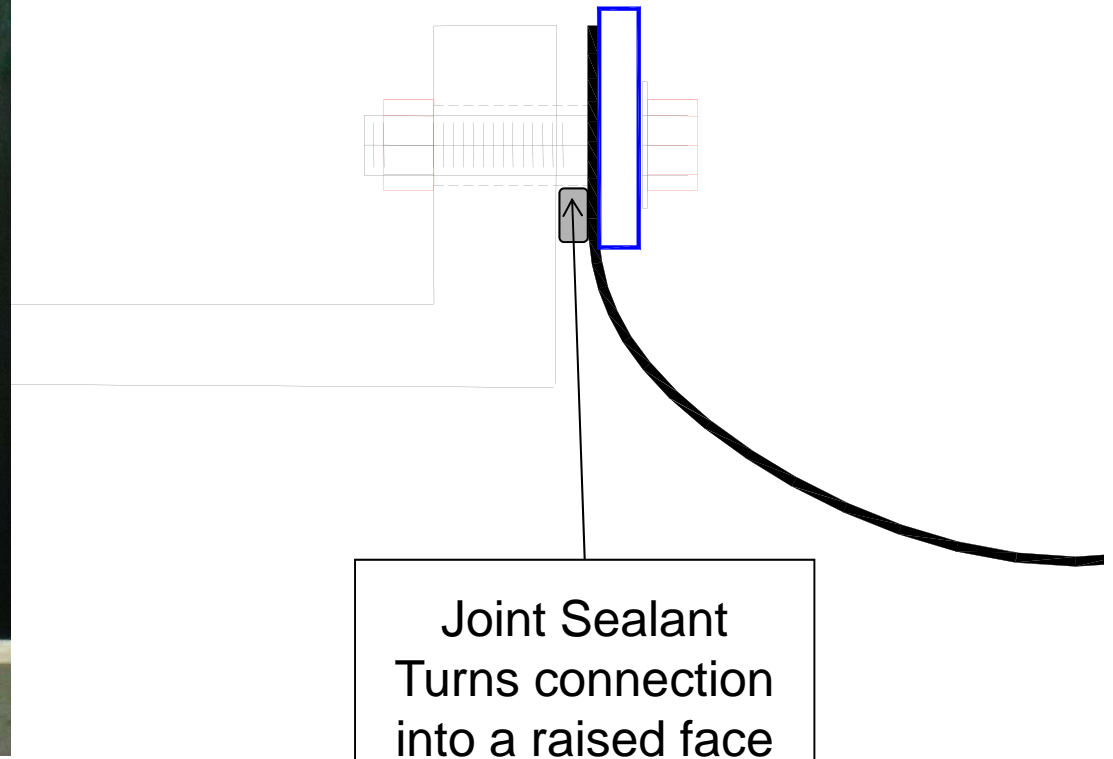
Solutions

Tadpole Gaskets



Solutions

Joint Sealant





Solutions

Replace 1 layer of Glass with Inconel





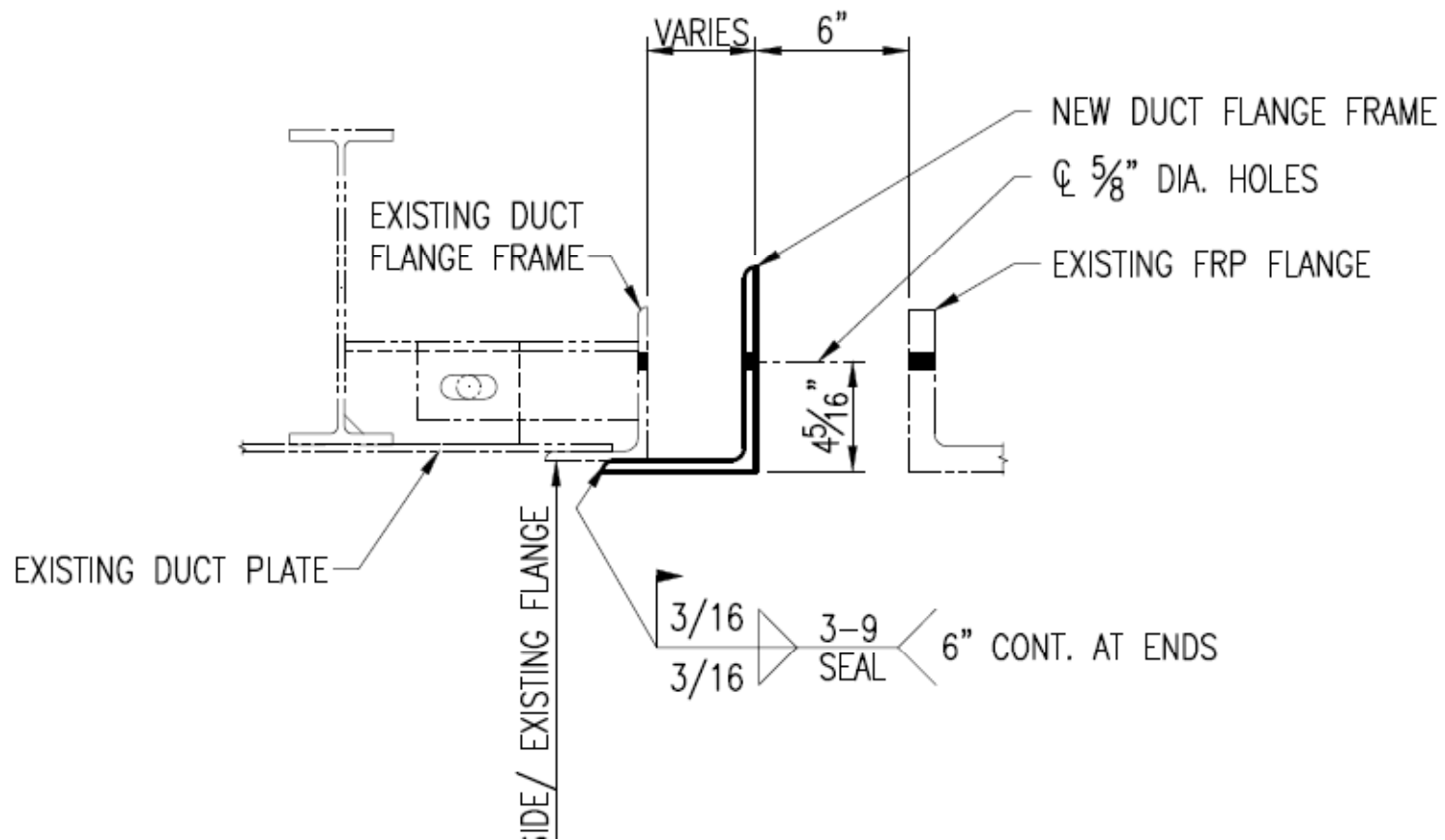
Solutions
Radius on Backing Bar

Backing Bars Rounded



Solutions

Gap Reduced from 12" to 6"





Expansion Joint Lesson Learned Single Layer Teflon

- Flutter is a killer.
- Typically at:
 - fan outlets
 - Locations near 0 psig or alternating + and – pressure.
- Commonly starts half way between flanges near the corners.

Single Layer Teflon - Flutter



Single Layer Teflon - Reversal

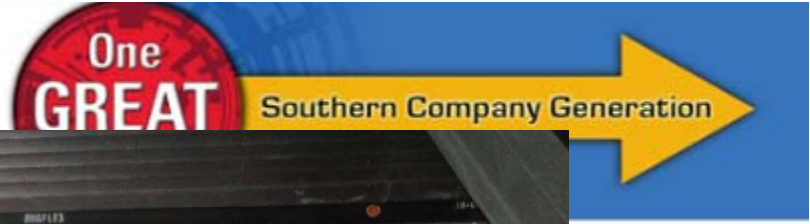




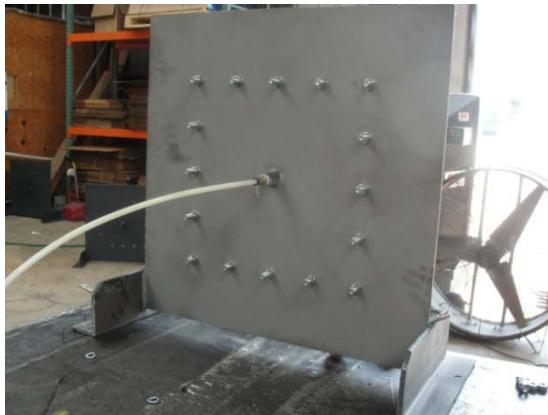
Expansion Joint Lesson Learned Concrete Vessels

- Interfaces between vessel and other materials are difficult to seal leak tight.

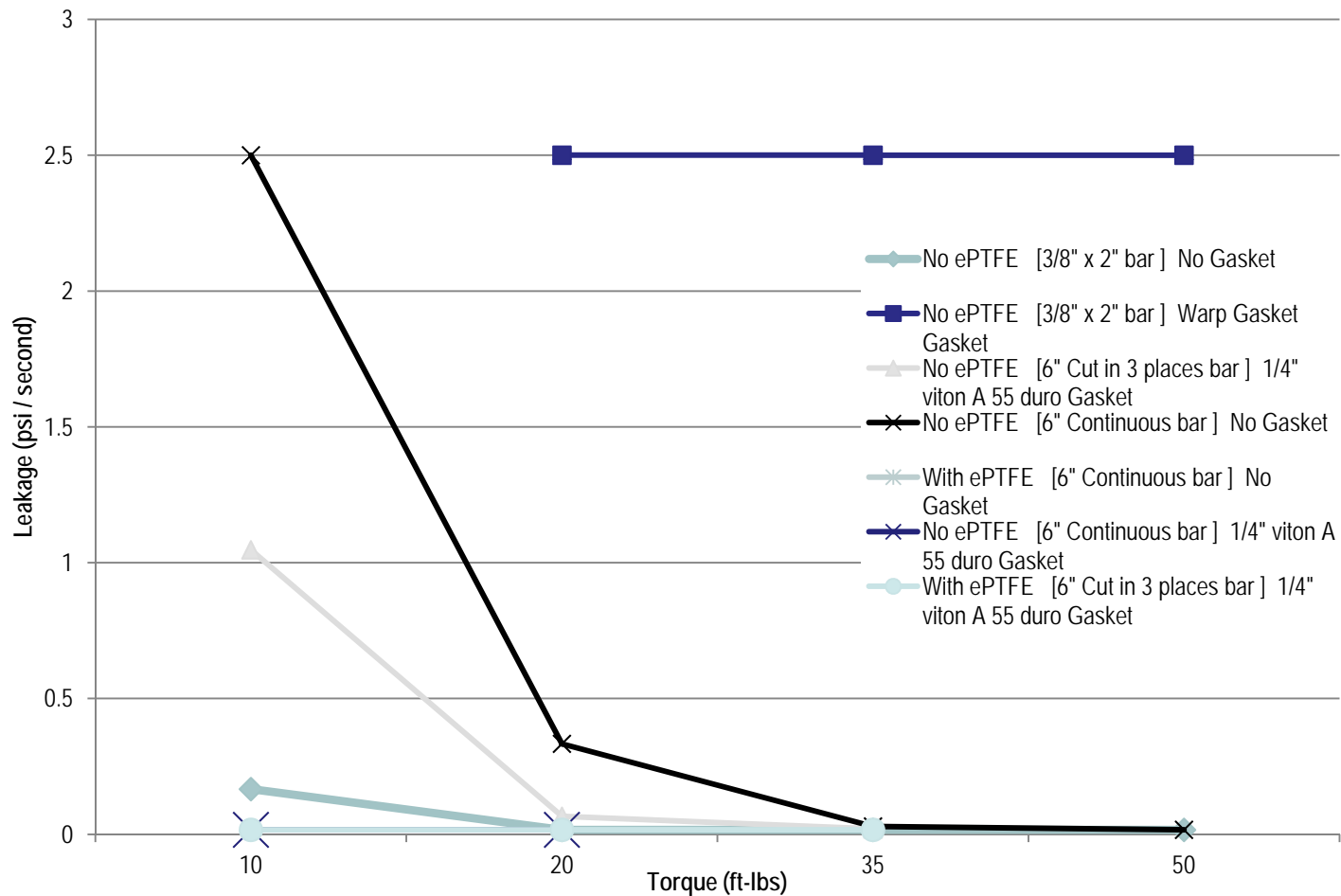
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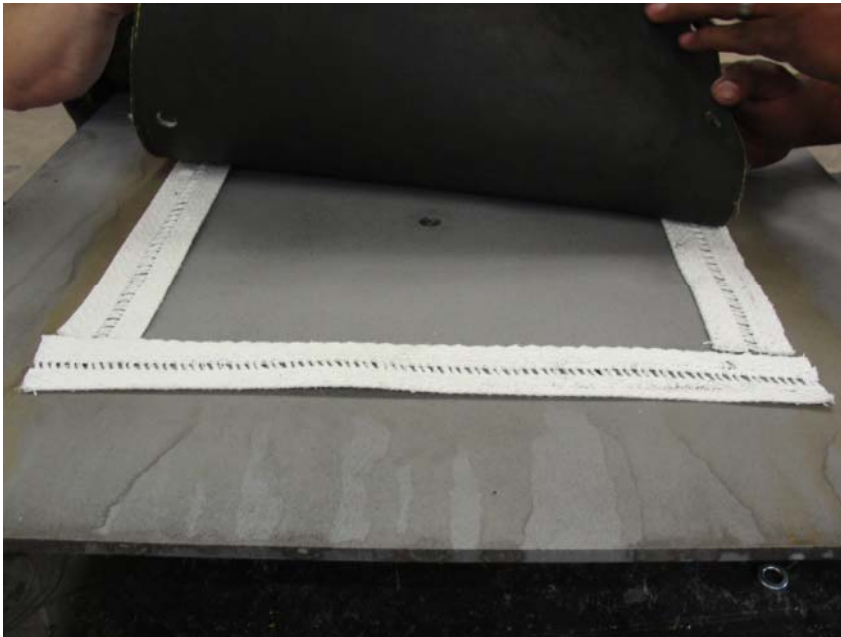
Expansion Joint Test Fixtures



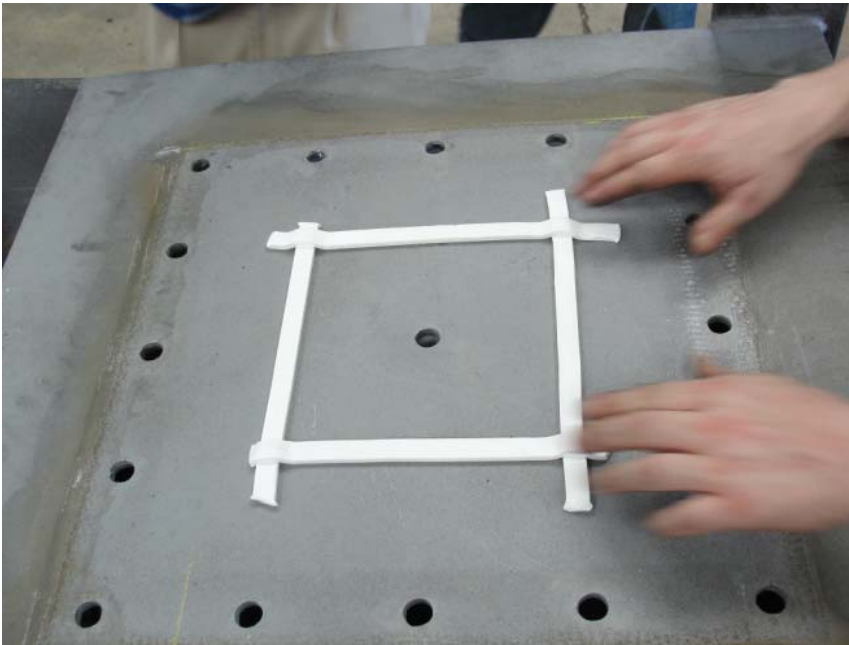
Lessons Learned From Test Fixture



Drop Warp Gasket Should not be used on Sealing Surface.



ePTFE Joint Sealant allows sealing at very low torques.





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Lesson Learned Rubber Lined Valves

- Valves designed for rubber lined steel can have problems when mated to larger ID piping such as FRP.

Rubber Lined Valve

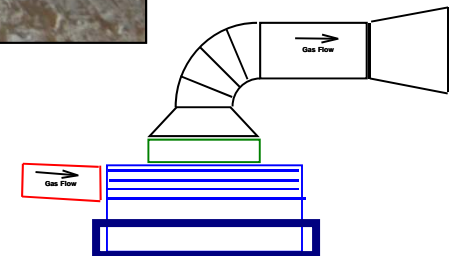


Rubber Lined Valve





Agitator Rubber Damage





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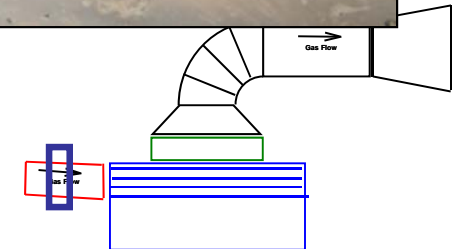
OD Variations Caused Support Issues



Relative Movement between Parts will lead to Significant Wear

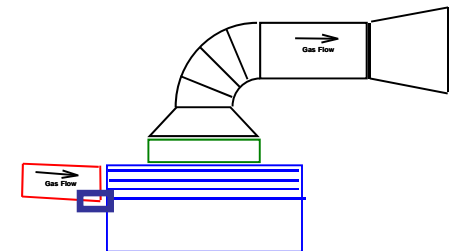


Particles in High Velocity will cause excessive erosion in surfaces normal to the flow.



Erosion in surfaces parallel to flow will erode, but at a slower rate.

$$\text{Energy} = \text{Mass} \times (\text{Velocity})^2$$



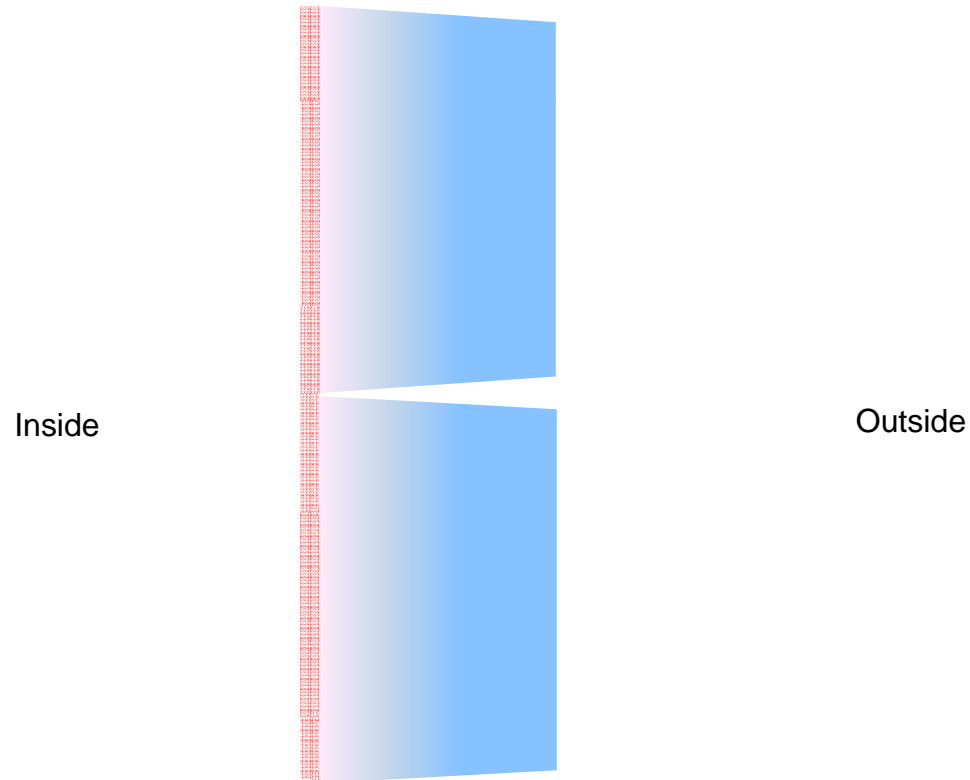


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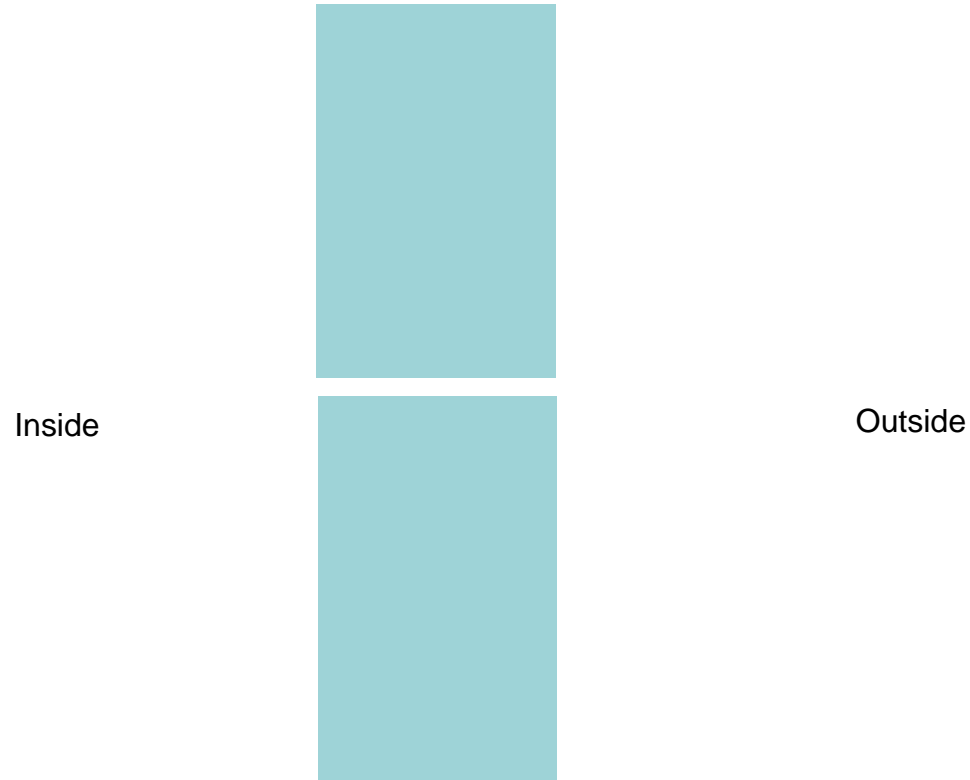


Through Wall Crack (running)



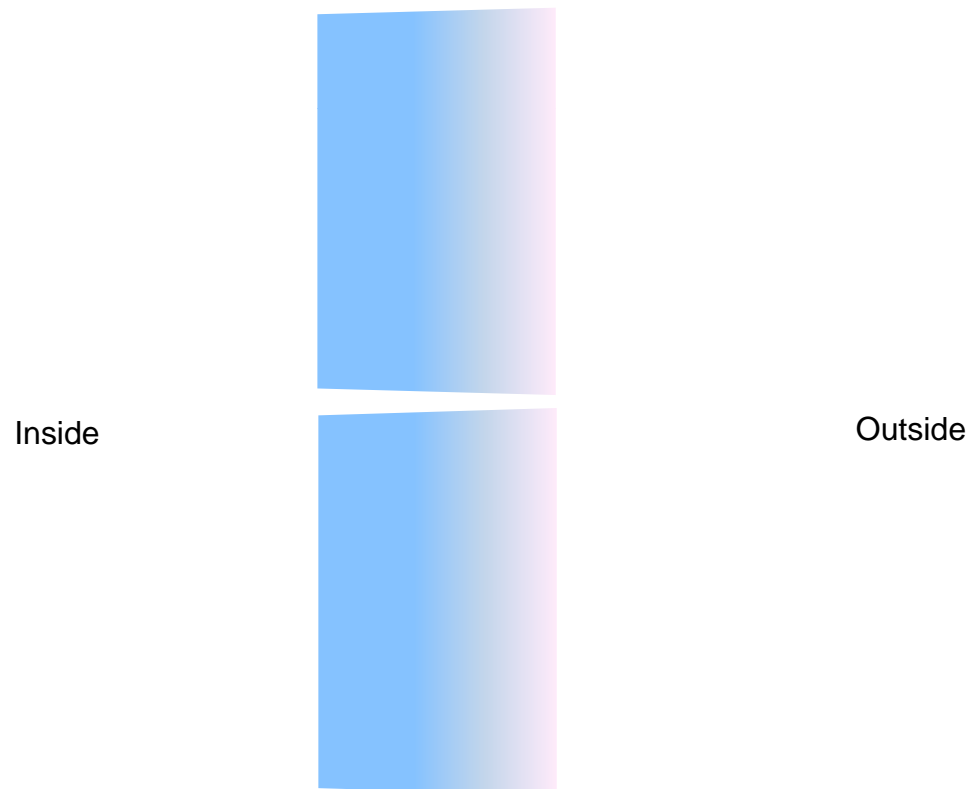


Through Wall Crack (start-up)





Through Wall Crack (dilution with cooler water)





Lesson Learned Tile Lined Concrete

- Rectangular vessels have internal cracks where they have not been seen on the round vessel.
- Thermal gradient across vessel thickness is a larger factor to leakage than % solids.

Lesson Learned Tile Lined Concrete

- Scale build-up on internal cracks can reduce leakage, but reverse thermal gradient (cooler on inner surface) will cause
- Cracks on the inner surface that correspond to cracks on the outer surface that leak on start-up and shut-down are through wall cracks that expose the inner structure to the process fluid and must be repaired.



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- **Borosilicate Block**



Lesson Learned Borosilicate Block

- **Block can become saturated with liquid.**
- **Can “popcorn spall” when used in an alternating wet / dry environment at the inlet breech (Temp >300F).**
- **Covering the borosilicate block with C-276 can mitigate the damage to borosilicate block.**



Questions