

Improving Thermal Reactor Safety With Refractory Enhancements

By

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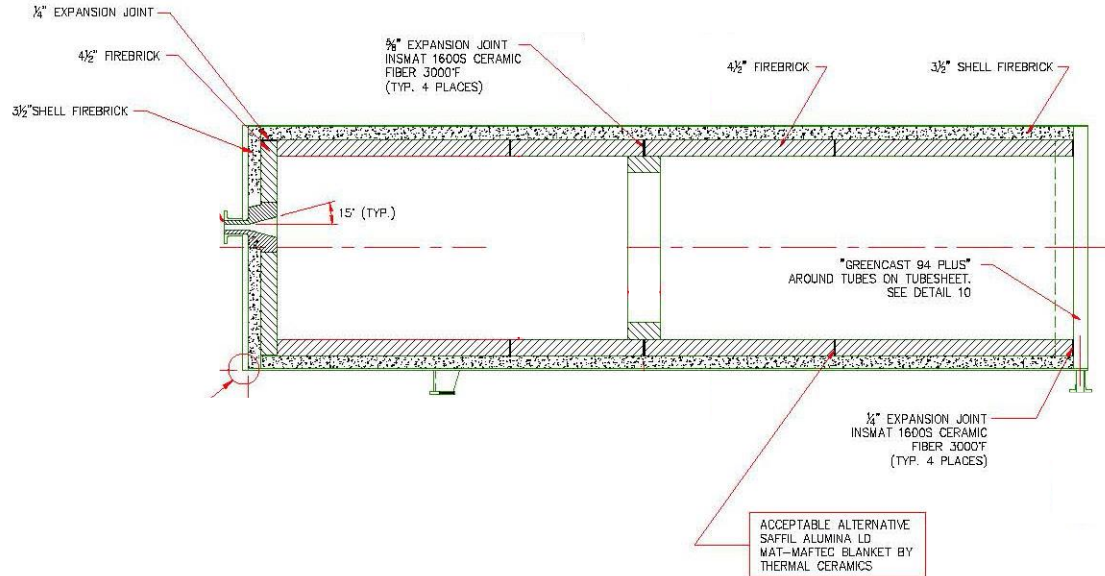
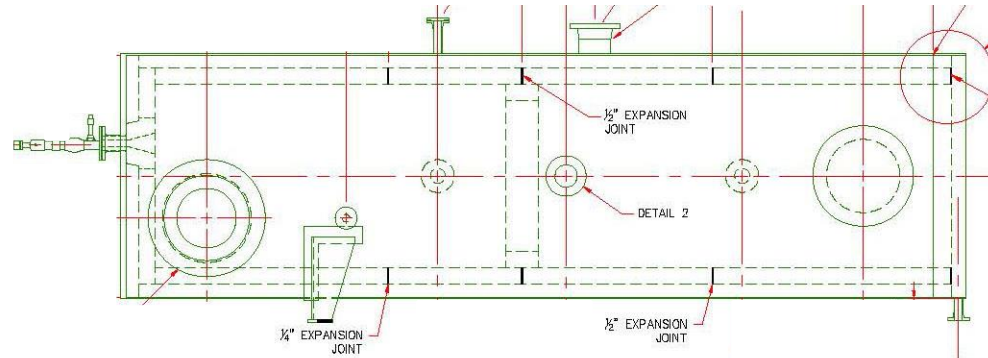
Jeff Proctor – Thorpe Specialty Services Corp

Andy Piper - Thorpe Specialty Services Corp

Equipment Description

- Two parallel, identical, two-zone, tangentially fired Modified-Claus trains
 - North and the South units
- 1971 - Commissioned
- 1974 – Added ARCO designed TGU – SCOT like
- 2006 - Added Cansolv TGU w/ SO₂ recycle to Thermal Reactors

Vessel Outline



- O2 enrichment to 26%
 - Typical front zone temperature between 2400F-2800F (1315C-1540C)
 - Inspection evidence of 3000F+(1650C+) (Refractory Glazing)
- Common feeds that include Amine Acid Gas, Sourwater Acid Gas, and SO2 recycle

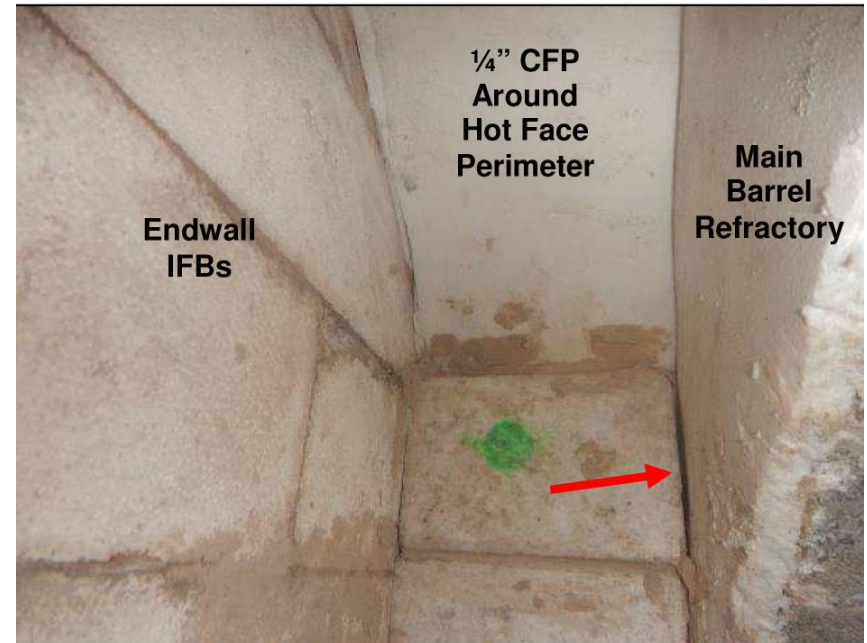
- Numerous documented refractory issues noted in most inspection and maintenance records since initial operation
- Specific issues noted trying to resolve design issues related to flat endwall and peep sight design

- Historically other issues existed, but not with the frequency or consistency of the endwall. Examples included:
 - Glazing & cracking of hotface brick
 - Burner brick cracked or displaced
 - Slumping overhead brick
 - Manway nozzle corrosion and brick bullseye issues
 - Ferrules backing out
 - Vibration issues

- Based on request to provide an enhanced refractory lining for the flat wall area only.
 - Flatwall design – Always a problem for high temperature severe service (i.e. Thermal Reactors).
 - Reliance upon maintenance approach to repairs rather than an engineered approach
 - Not understanding flatwall issues and belief that the monolithic anchors in viewport would hold wall ... or worse, thinking a brick bullseye with no anchors would stabilize the wall
 - Compounding issues with excessive ceramic fiber joints

Inspectors Report S. MRF – October 2017

- “It was recommended that a ¼” thick ceramic fiber paper (CFP) layer was installed between the steel shell and the hot face bricks along the endwall perimeter **where no insulation back-up was present** and a ½” thick CFP was installed **between the hot face endwall refractory and the main barrel brick.**”



Gaps (red arrow) in installation due to deviations in the existing main barrel refractory.

These are engineering decisions being made in the field by the maintenance contractor &/or the refractory inspector

Inspectors Report S. MRF – October 2017

- “Due to movement in both the removed endwall bricks and the remaining main barrel bricks many areas required more than ½” of CFP. **Approximately 1”- 1½” of CFP was required to be installed between the endwall hot face refractory and the main barrel refractory to allow for a tight fit. The final CFP expansion joint was sealed with mortar** after approval and sign-off of the installation.”



CFB joint between the endwall and main barrel refractory measuring up to 1.5”.

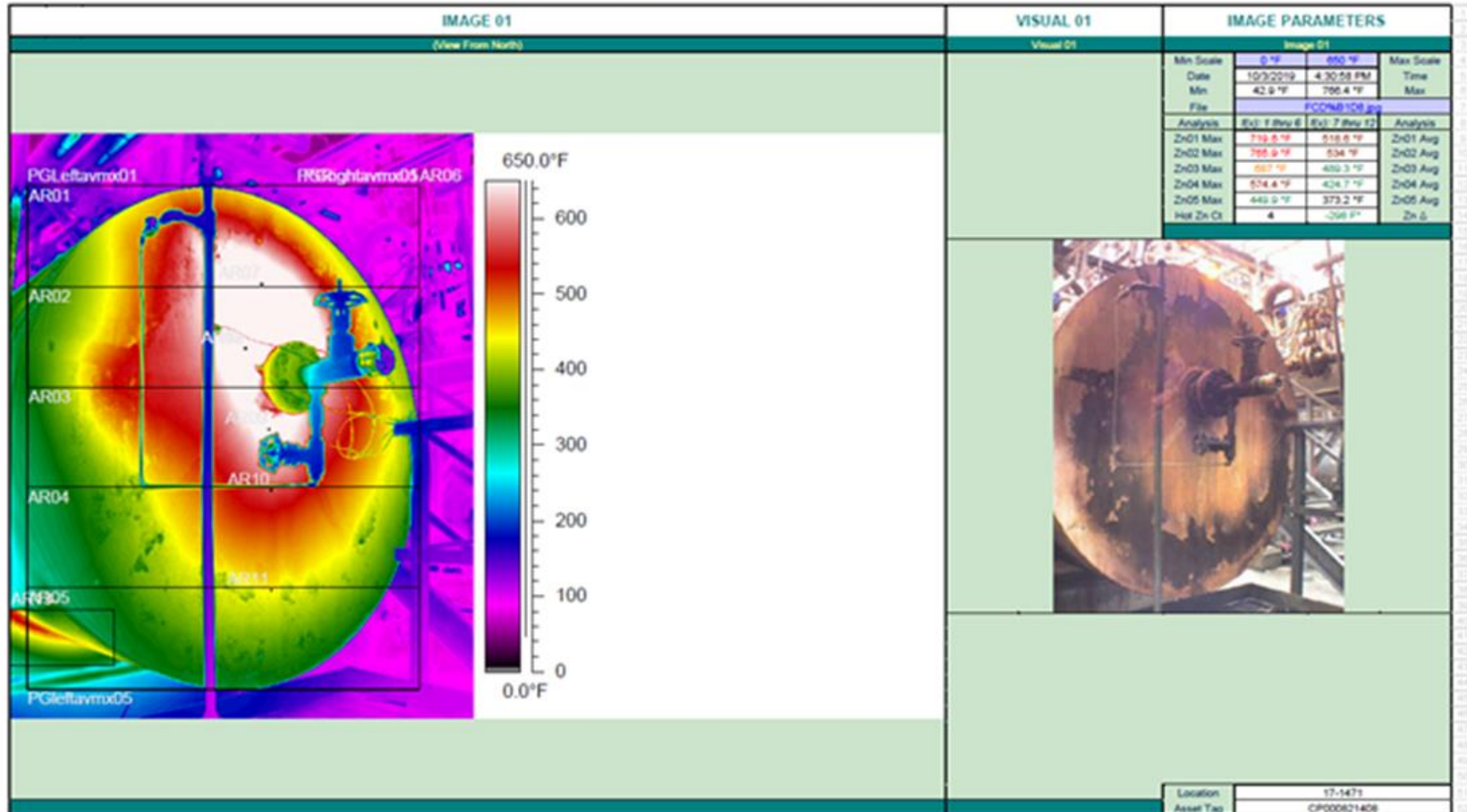
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October 2019 Thermal Scan

October 03, 2019



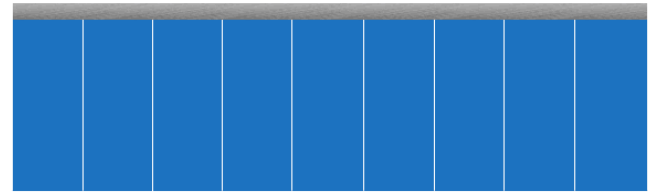
CP17-1471 South Main Reaction Furnace External - Monitor 28 - Part 1 of 1



Endwall



Thermal Gradient Effect



January 2020 Inspection

- ~1" gap between IFBs & steel
- Upon demo gap found to extend to outer rim



Other Recent Outage Examples



2012



2015



2017



2019

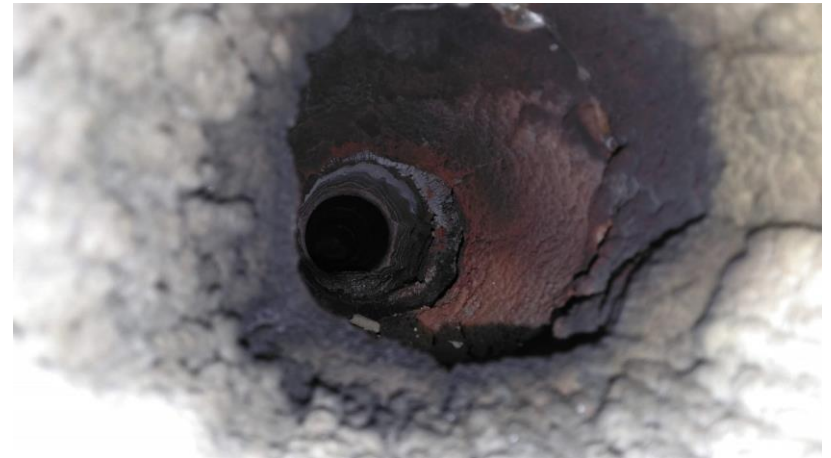
Other Recent Outage Examples



2016



2017



2021

Main Goal :

- Different refractory design approach with Thorpe (Houston) to stabilize the head refractory

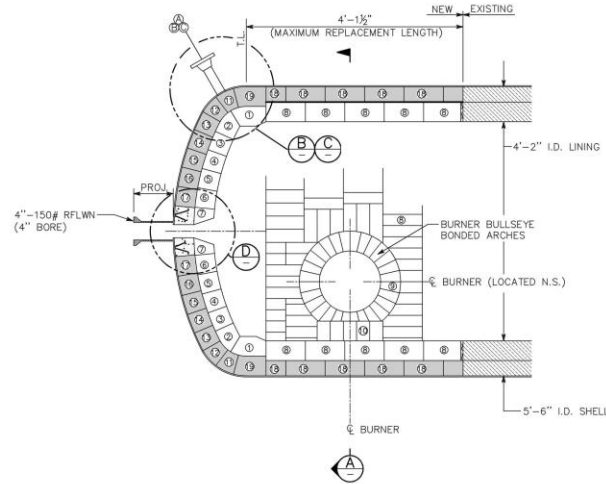
Secondary Goals:

- Improve head viewport opening
 - Was considered a contributor to head hotspot
- New flame scanner technology w/ optional ports
 - With placement input from Thorpe to minimize impact to the refractory lining and provide optimal scanner locations
- Reduce or eliminate future vibration events
 - Theorized flat wall was sending pressure wave back and forth

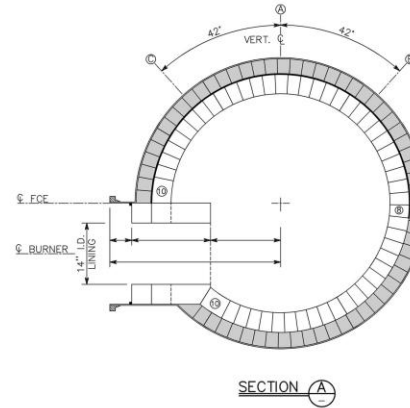
Thorpe's Approach

- Reoriented all brick geometrically to tighten against the shell during heat-up; eliminate need for anchors
- Requires proper connection to barrel lining
 - Due to burner location, had to extend past burner
- Supply input for all nozzles (location, size, angles, etc.) in new area to limit impact to refractory lining
- Recommended removing internal brick burner shroud, but determined needed for process reasons
- Elected to increase IFB thickness in head for installation, stability and better insulation

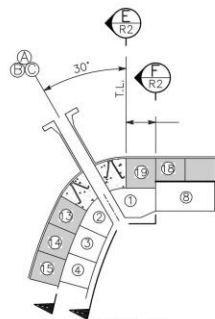
Thorpe Refractory Approach



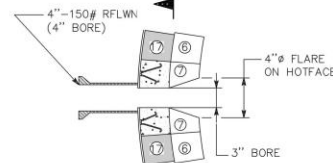
SECTIONAL ELEVATION



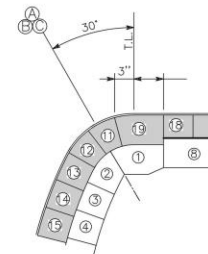
SECTION A



DETAIL B
TYP AT NOZZLES (A, B & C)



DETAIL D
VIEWPORT NOZZLE



DETAIL C
TYP AWAY FROM NOZZLES

Existing Lining

- 3-1/2" IFB
- 4-1/2" Firebrick

New Head Lining

- 4-1/2" IFB
- 4-1/2" Firebrick

GENERAL NOTES:

- 1.
- 2.
- 3.
- 4.

2	ADDED DIM TO DETAIL D, FIXED BRICK ON SEC A	SJP	4-30-21
1	ADDED NOTE 4	SJP	1-28-21
0	ISSUED FOR CONSTRUCTION	SJP	1-20-21
A	ISSUED FOR APPROVAL	SJP	1-7-21
NO	REVISIONS	BY	DATE

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Providing Plant Maintenance and Engineering

REFRACTORY INSTALLATION DRAWING
DISHED HEAD IMPLEMENTATION
NORTH THERMAL REACTOR / MRF 17-1461
BP WEST COAST PRODUCTS LLC
CHERRY POINT, WA

SCALE	DRAWN	CHECKED	APPROVED	DRAWING NUMBER	REV
NTS	STR	SJP	SJP	D-11-3085-R1	2
DATE	11-2-20	11-2-20	11-2-20		

Both Units – Endwalls Replaced with Elliptical Heads



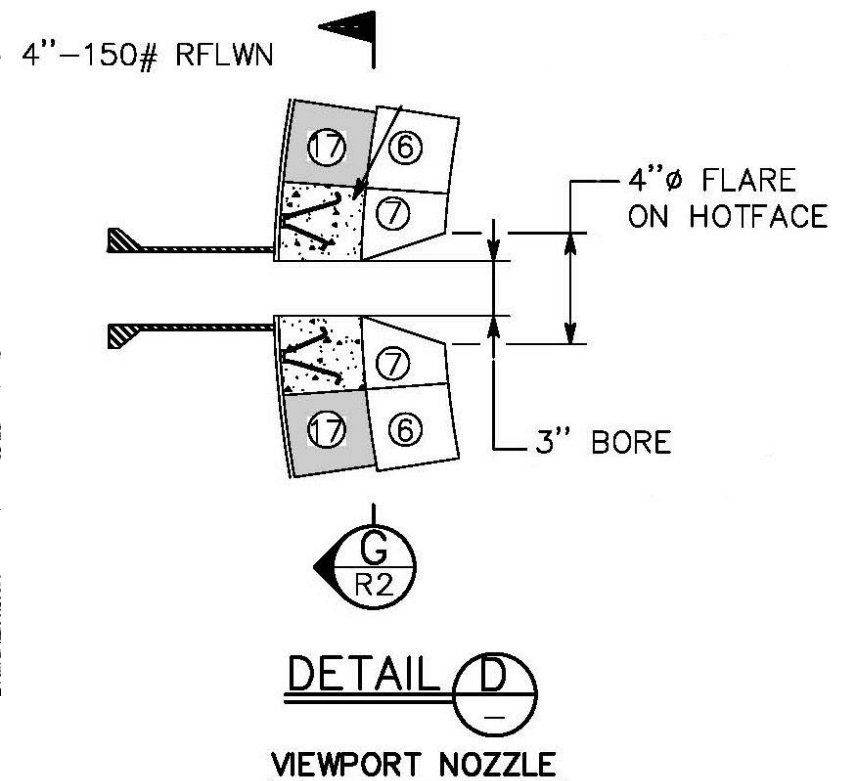
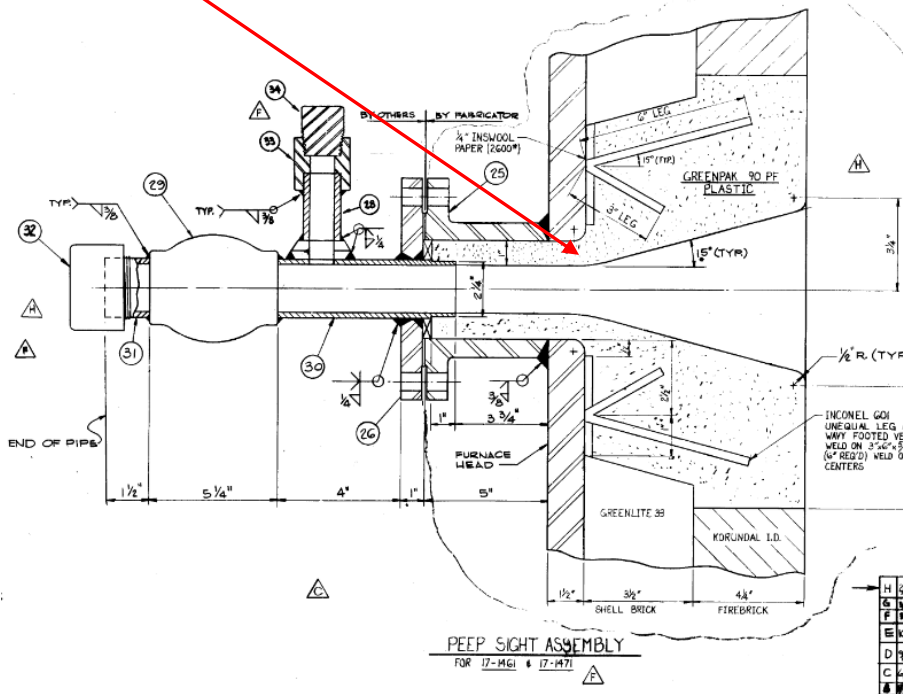
Peep Opening

Original Viewport

- No insulation material, all dense hotface material
- 1" refractory at shell

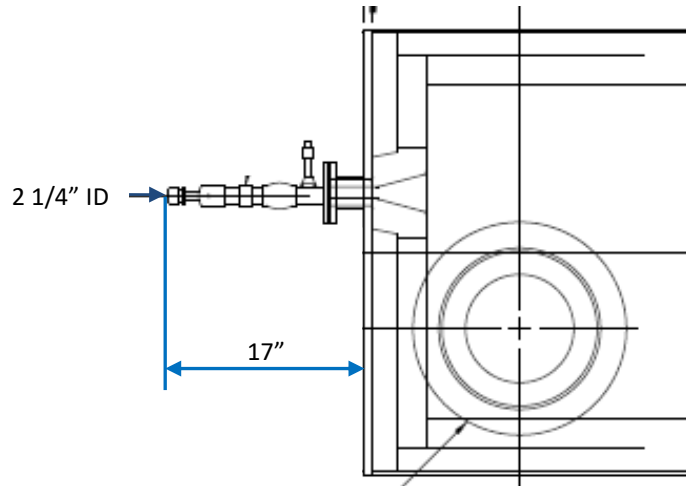
New Viewport

- 4-1/2" Insulation over shell, then 4-1/2" HF brick

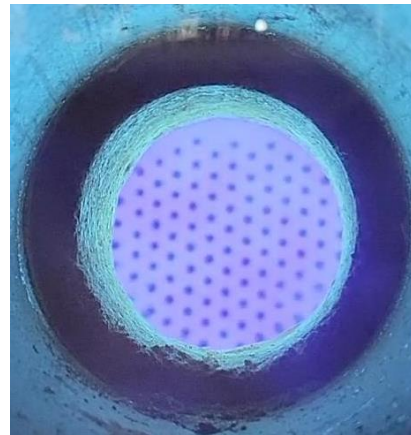
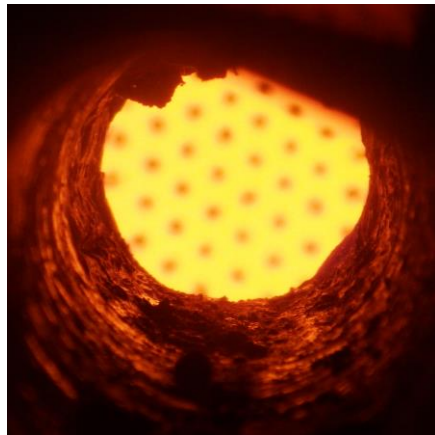
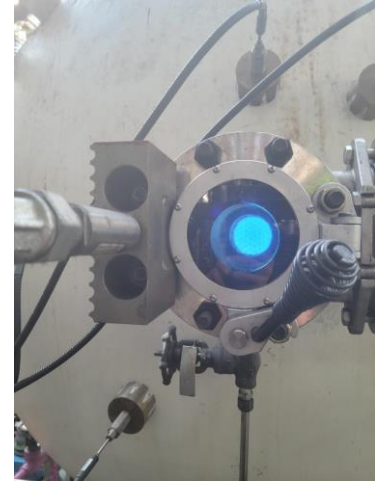
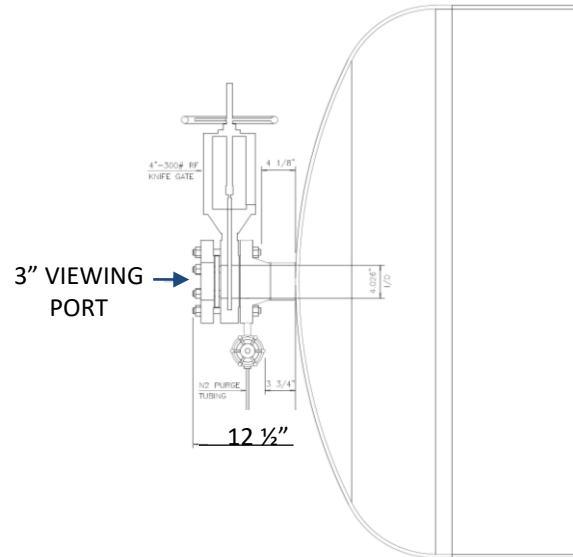


Peep Assembly

Before

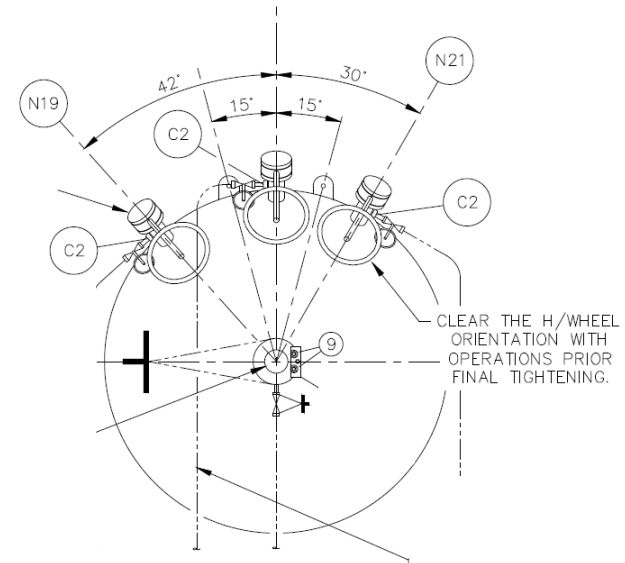
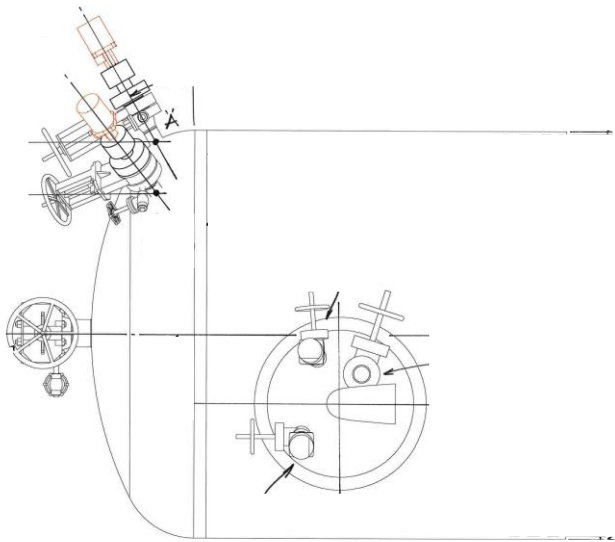


After

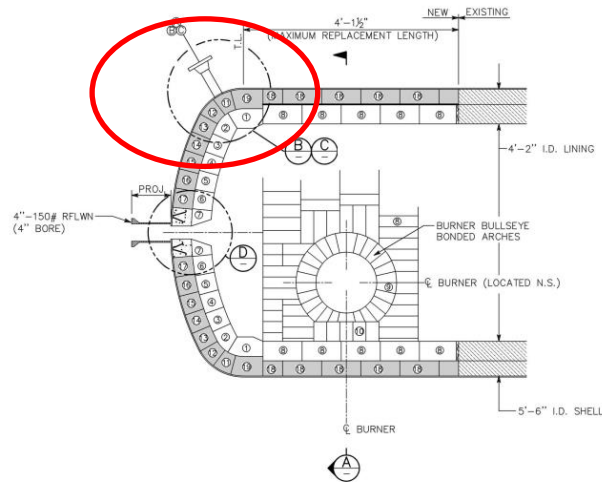


Flame Scanner Locations

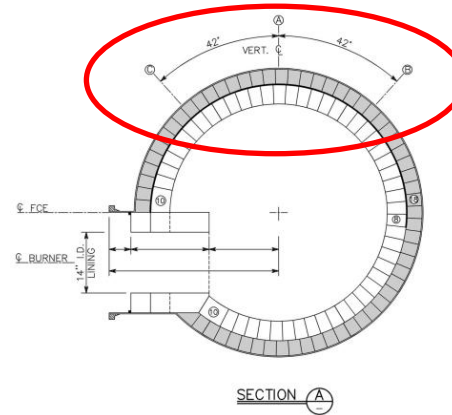
- Initial flame scanner locations being considered
- Decided to put all new nozzles onto the new elliptical head to minimize field construction time during outage.
- Many discussions held to find optimal position for flame scanners while minimizing the impact to the refractory lining



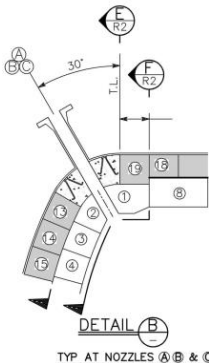
Optimized Flame Scanner Locations



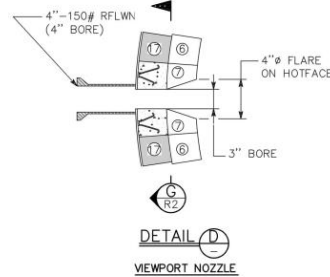
SECTIONAL ELEVATION



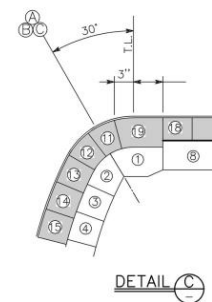
SECTION A



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TYP AT NOZZLES (A) & (C)



DETAIL D
VIEWPORT NOZZLE



DETAIL C
TYP AWAY FROM NOZZLES

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Flame Scanner Penetrations



May 2021

S MRF lining installed

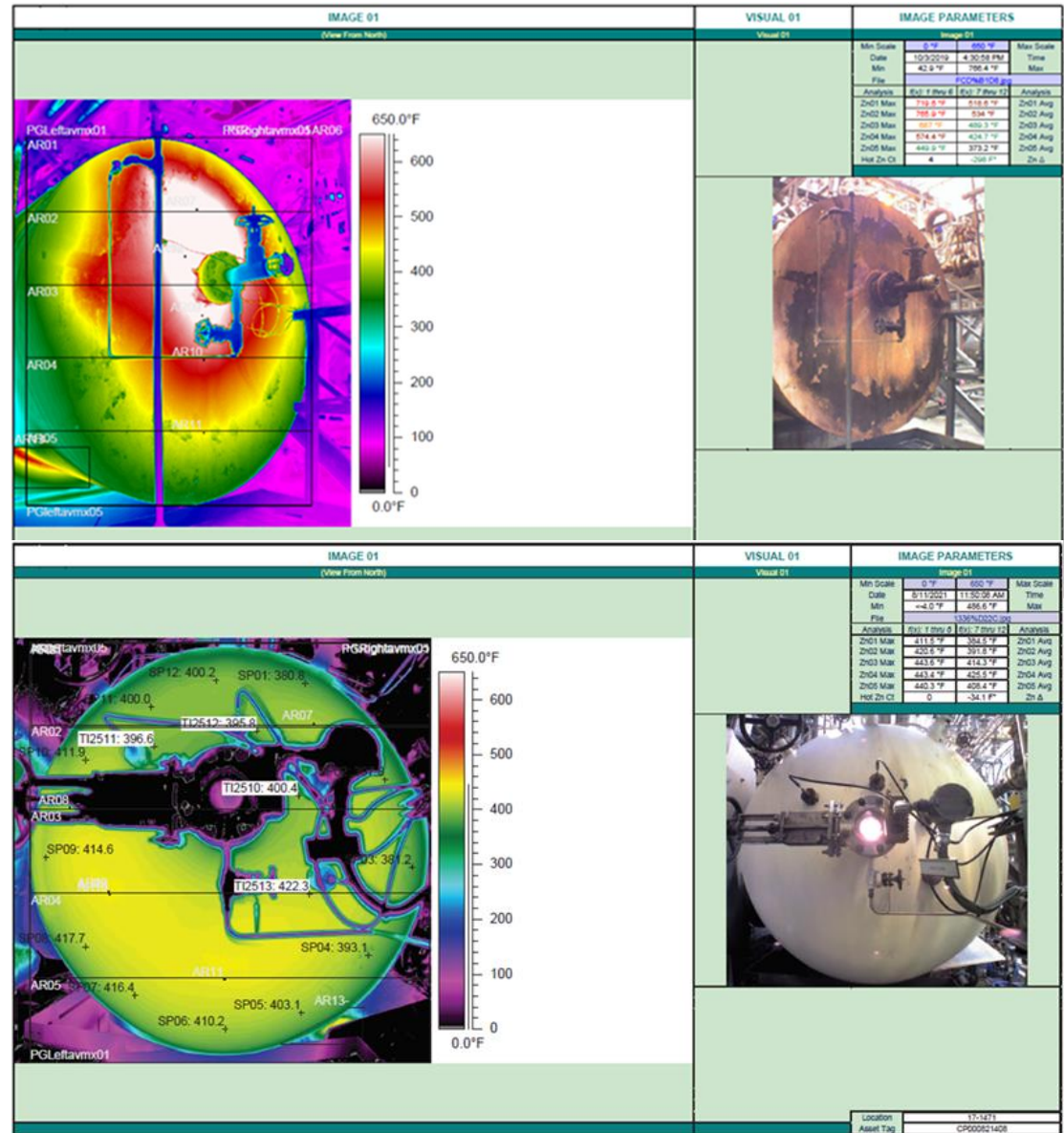


April 2021

N MRF lining Installed

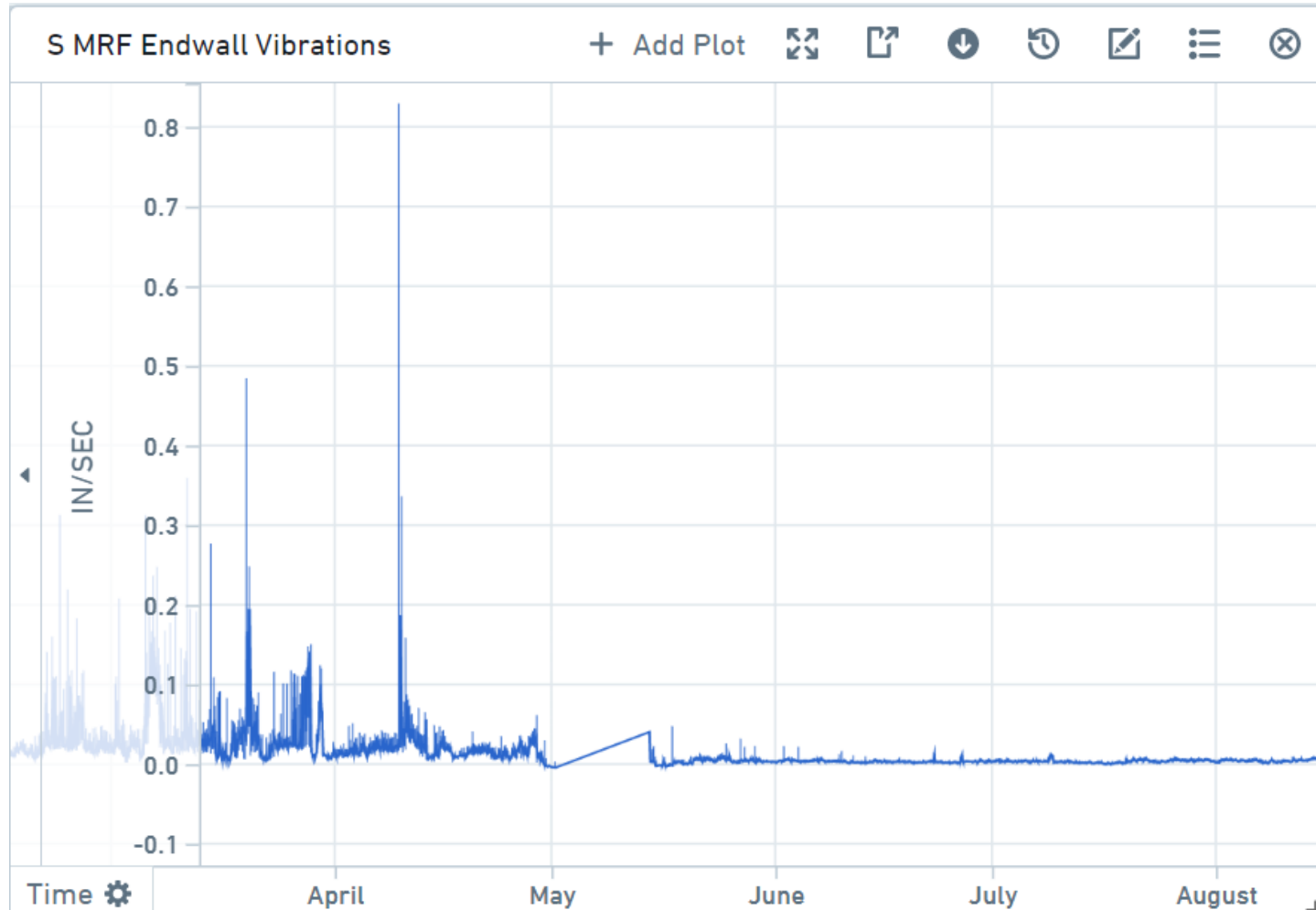


August 11, 2021



Vibration Monitoring

4 months of operation - no noticeable issues



Results after 3-4 Months

- Operating at full load
- No Hotspots
- Better view port visibility
- No vibrations
- New flame scanner ports ready for new scanners
- Early results, all goals successfully met

Conclusions

- Historical consolidation of individual issues helps to isolate needed fixes
- Maintenance vs Engineering approach to fixing problems
- Technical Meetings and industry experience provide opportunity to calibrate what is “normal”