Seabrook Station
Feedwater Reg Valve Internal Erosion
OR17 – Fall 2015

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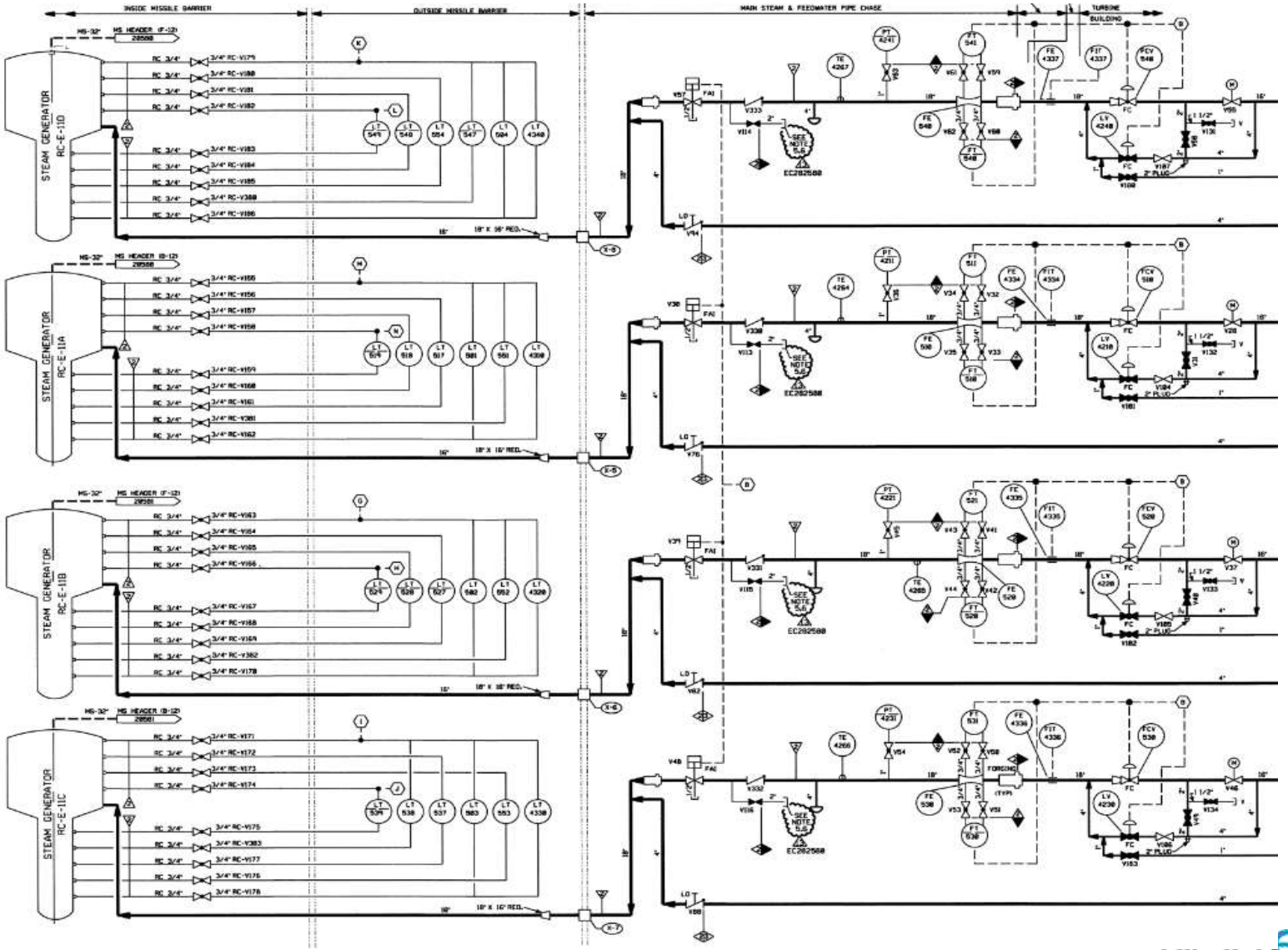
Feedwater System Engineer

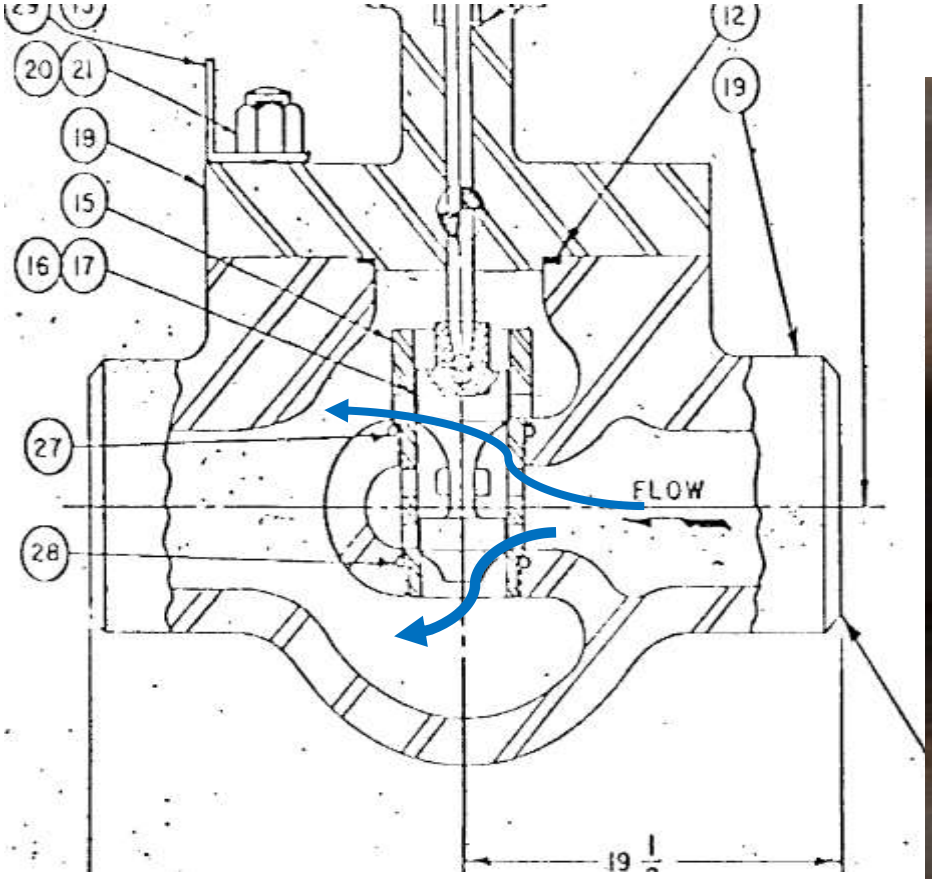
Seabrook FRV Setup



Seabrook Station – FRV History

- **Started Commercial Operation in 1990**
- **Feedwater Regulating Valves were Purchased to Nuclear Spec**
  - ASME Code Class 3 Valves – But installed in B31.1 Piping.
  - Valves receive a close signal but not safety related.
  - Valve body material was ASME SA352 Gr. LCB
  - Had this been B31.1 not ASME valve would have been more durable WCB material
- **Replace Internal Trim in First Refueling Outage**
  - Common issue with valves at the time
  - Internal flow forces would force valve stem to move. Addressed for one cycle by tightening packing

Original Trim and Flow Path



Modified Trim

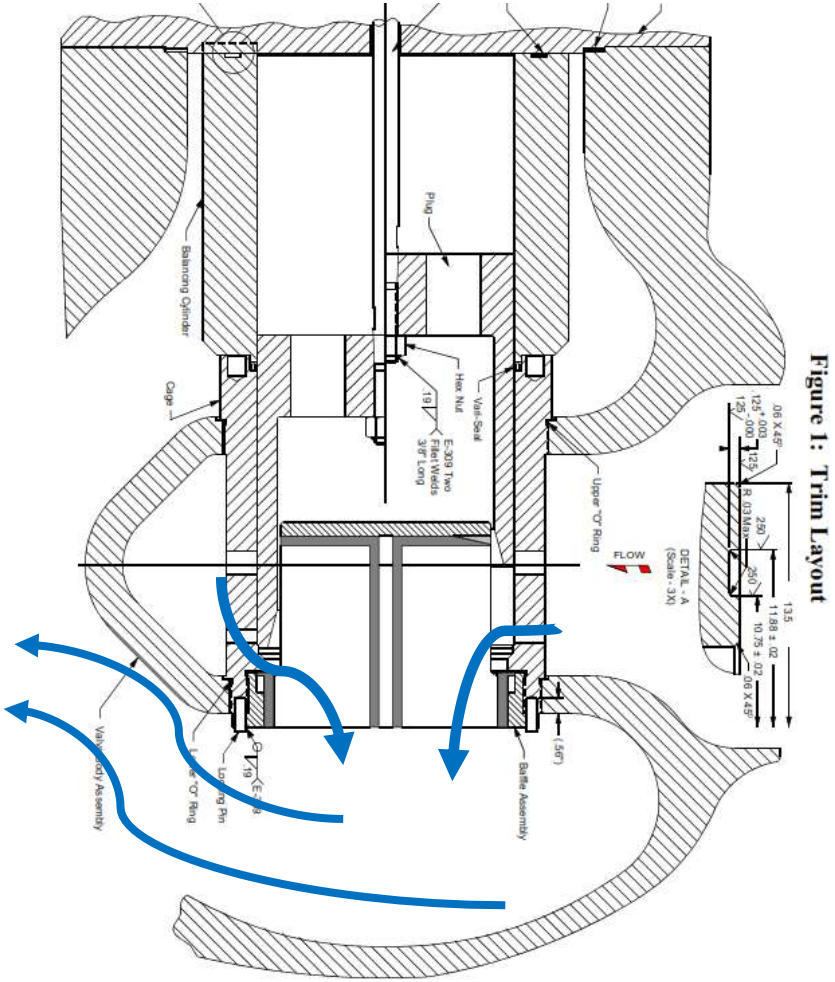
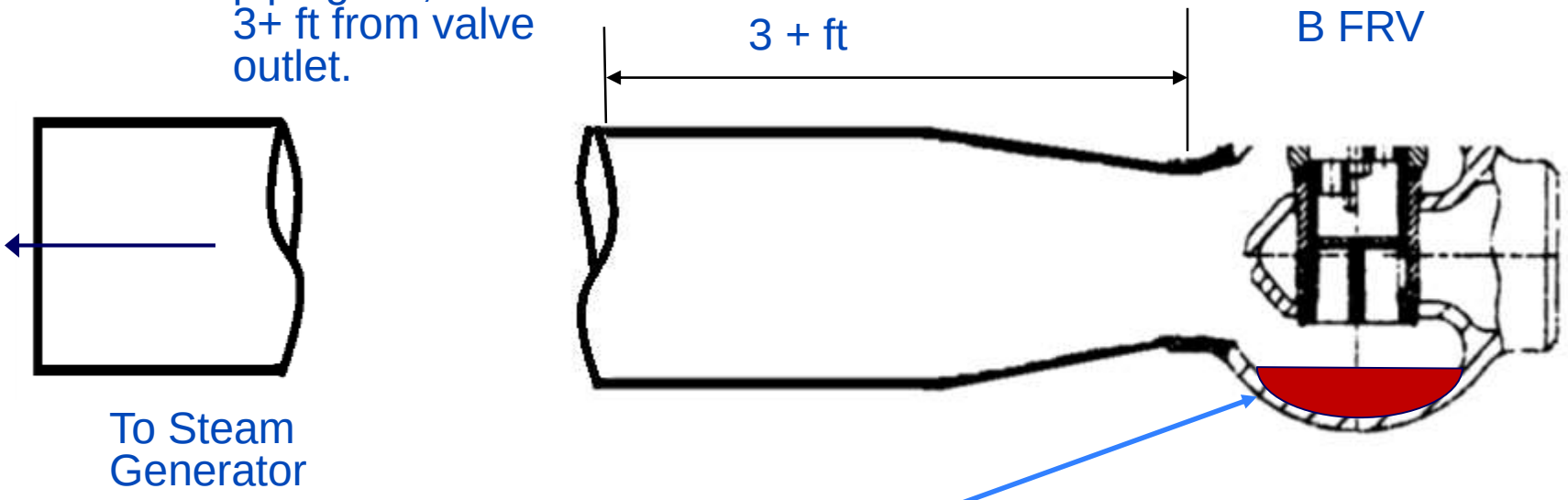


Figure 1: Trim Layout

FAC Piping Replacement Downstream of B and D Valves

Seabrook performed FAC piping replacement in Fall of 2015.

Downstream piping cut, about 3+ ft from valve outlet.

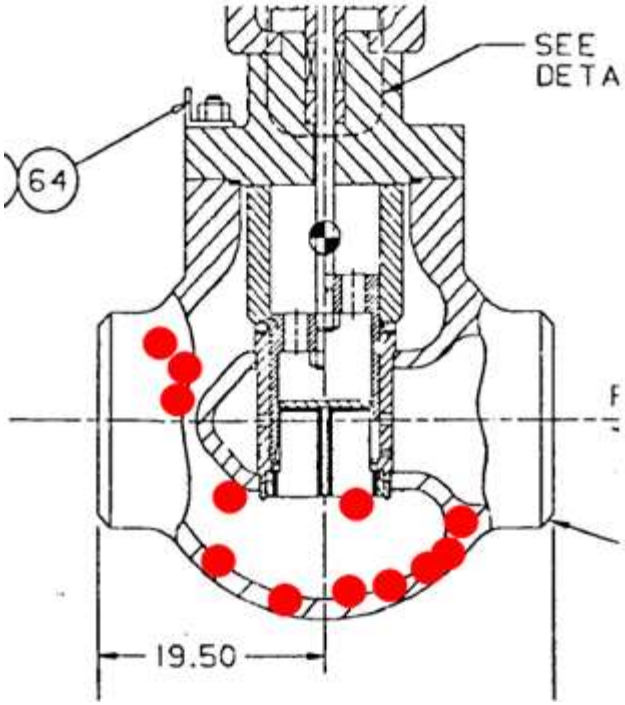


Water pocket left in in low spot of valve body – rusty water could not see through.

Maintenance Supervisor asked for water to be pumped out for before signing off final FME closeout

Inside B FRV

B FRV



D FRV

D FRV – View of Largest Flaw

Evaluation – Extent of Condition

- **Need to determine wall remaining and wall required**
- **External UT – rough surface, off angles, poor material – no results**
- **Miller pipeline – Internal UT, Contour Gauge Readings**
  - Not able to get readings in all locations.
- **Contacted OEM (Copes-Vulcan, now SPX) to determine minimum wall required on valve body**
- **OE from Beaver Valley – not similar.**
- **EOC – A and C FRV?**
  - Cut 4 inch bypass line and used borescope to inspect.
  - Similar overall, but not able to measure wall loss.

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Quick Set Two Part Plastic Modeling of Erosion Sites

- Used a two part quick setting plastic modeling compound to fill and measure erosion locations.
- Provided information on size of erosion sites, but not a measurement of wall thickness remaining.
- Used nominal wall thickness to get maximum possible wall loss

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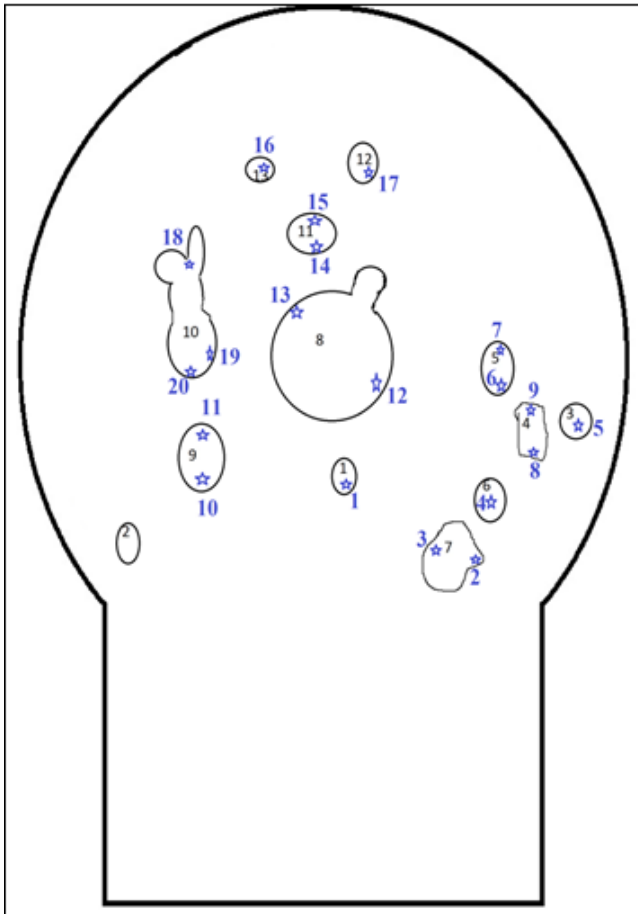
Results



Plastic Putty Results

Putty Indications are blue numbers and stars for measurement points.

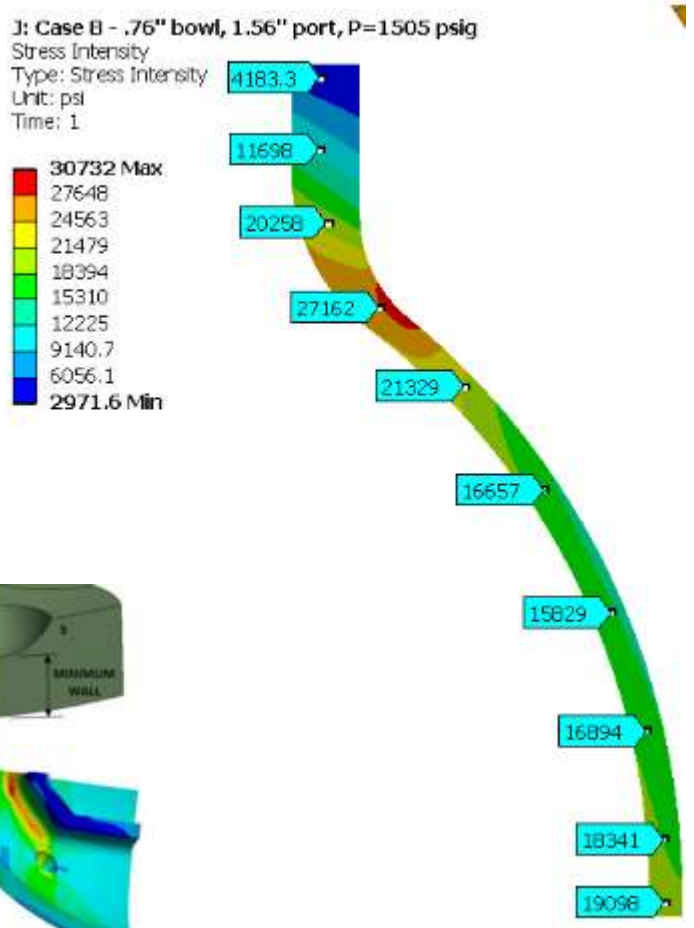
Location	Mold Measurement #	Depth from Mold Measurement (inch)	Remaining Wall Thickness Based on Putty and OEM Min wall. OEM Min wall for valve is 1.56 inches. These results are bounding but , potentially over conservative.	UT, inch, in Base Metal	Base Metal UT minus Mold Measurement Due to limited locations for UTs and poor reference point for mold indications these number may be non-conservative.
1	13	0.45	1.11	2.29	1.84
	14	0.51	1.06		1.79
2	11	0.25	1.31	1.94	1.69
	12	0.32	1.24		1.62
3	8	0.37	1.19	1.96	1.59
	9	0.34	1.22		1.62
4	7	0.44	1.12	1.96	1.52
5	6	0.54	1.02	2.01	1.47
	5	0.67	0.89		1.34
6	1	0.47	1.09	1.80	1.32
	2	0.27	1.29		1.53
	3	0.71	0.86		1.09
	4	0.33	1.23		1.47
7	10	0.12	1.44	No parallel surface for UT readings	N/A
8	Could not be reached for measurement. Visually looked to be less than 3/16th inch erosion.				

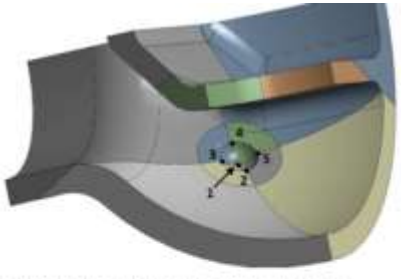
Minimum Wall Required – SPX Copes-Vulcan

Review to look at minimum wall required for system pressure.

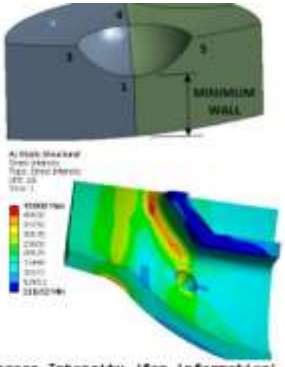
Looked at overall wall thickness and localized flaws.

“Design Pressure” was a site discussion based on original design revisions and possible worst case.





Path Lines and Location of Eroded Area



Stress Intensity (for information)

Case		1	2	3	4	5
internal pressure	psig	1505	1505	1505	1505	1505
end load	lbf	225692	225692	225692	225692	225692
sphere diameter	in	2.50	2.50	2.50	2.50	2.50
original wall at eroded area	in					
minimum wall at eroded area	in	1.0672	0.94224	0.81724	0.69224	
erosion penetration depth	in					
diameter of eroded area	in	2.3519	2.4289	2.477	2.4985	
membrane stress at 1 (center)	psi	7564.9	7566	7627.7	7772.5	
membrane stress at 2	psi	**10958**	11289	11662	11949	
membrane stress at 3	psi	7970.4	7814	7695.8	7605.1	
membrane stress at 4	psi	10812	**11411**	**12091**	**12462**	
membrane stress at 5	psi	6691.6	6472.5	6340.3	6298.3	

Repair Options and Plans

- **Replace FRV in current outage.**
  - Seabrook has unit 2 valve bodies.
  - Trim in Unit 2 valves was not updated.
  - 20 day (minimum) estimate to replace valves in outage. Instrument tubing and cable tray interference. Difficult rigging location.
- **Internal Weld Repair –** no access.
- **Encapsulation**
  - Huge box, would need own supports,
  - time to build and install could be longer than replacing valves.
  - High cost

Repair Options and Plans

- **Accept As-Is – little basis for wear rate, reduced current margin**
  - External Weld Overlay
  - Difficult location
  - Several days of welding
- **External Weld Overlay – Implemented to ensure 1 cycle of operation**
  - Week of welding,
  - Little impact on supports or near equipment.
  - Low temperature welding to reduce risk to valve body

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Weld Overlay

- B and D FRV had a 0.25 inch weld overlay applied to lower valve body based on results of internal inspections.
- A and C FRV had a 0.5 inch weld overlay to allow for uncertainly.

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Long Term Options

- **Weld overlay was used to ensure operation for one more cycle.**
- **Site is planning to replace all 4 FRV in next outage.**
- **Still in planning stages**
  - Could update valves to “state of the art”
  - Could use unit 2 valves and monitor for future wear
  - Like for Like – replacement with different valve body material and updated trim that allows removal for future inspections while keeping same performance and actuator.

Conclusions

- **Visual Inspection for internal wear on some Feed Reg Valves may be required.**
- **Trim changes and Uprates impact flow pattern in valve**
- **Replacement trim design (~1990) makes internal inspection of lower valve body almost impossible during a normal valve inspection. Borescope or pipe removal may be required.**
- **External UT will probably not detect localized erosion.**
- **Weld overlay did not impact valve operation (full calibrations done on valve after welding) and was successful to establish required wall thickness.**

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