RAS M-350

Engineering Report No. VY-RPT-04-00010 **Rev.** 0
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Plus attached CD

Entergy

ENTERGY NUCLEAR NORTHEAST

Engineering Report Cover Sheet

Engineering Report Title:

VERMONT YANKEE PIPING FLOW ACCELERATED CORROSION INSPECTION PROGRAM (PP 7028)
2004 REFUELING OUTAGE INSPECTION REPORT
(RFO 24- Spring 2004)

Engineering Report Type:
New ☒ Revision ☐ Cancelled ☐ Superceded ☐

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*: For ASME Section XI Code Program plans per ENN-DC-120, if required.

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Template Secy-028

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August 12, 2008 (11:00am)

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U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of Entergy Nuclear Vermont Yankee LLC

Docket No. 50-271 Official Exhibit No. E4-37-VY

OFFERED by: Applicant/Licensee Intervenor _____

NRC Staff Other _____

IDENTIFIED on 7/23/08 Witness/Panel NEC 4

Action Taken: ADMITTED REJECTED WITHDRAWN

Reporter/Clerk MAC

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PLUS CD CONTAINING JPEG FILES of 36 INCH DIAMETER CROSS AROUND PIPING PHOTOS

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1.0 EXECUTIVE SUMMARY

External UT measurements were taken on 26 large bore piping components in the Feedwater, Condensate, Extraction Steam, and Main Steam Drain Systems. External UT inspections were performed on 11 sections of small bore piping on the turbine bypass valve first seal leakoff piping, the high pressure turbine pocket drain line, and the feedwater pump warm-up line. Internal visual inspections of the turbine cross around piping were performed in all four 36 inch diameter lines A to D, and the two west 30 inch diameter lines C and D.

Component selection was based on a combination of; previous inspection data, industry events, analyses using the EPRI developed CHECWORKS computer code, and the consequences of component failure. A detailed selection process was used and was documented in reference (4).

The large bore results were evaluated using a three level screening process defined in plant procedure DP 0072. All components inspected were found to have a wall thickness greater than the code minimum wall thickness. The predicted thickness at the next refueling outage was greater than the code minimum wall thickness for all components. No large bore piping components required repair or replacement during the refueling outage.

Small bore inspections on line 1SLBPV identified localized wall loss and a local "like-for-like" carbon steel replacement at inspection location 04-SB04 was performed during RFO 24. Engineering Request ER 04-0964 was written for replacement of the entire 1SLBPV line with FAC resistant material.

A summary of the large bore piping component screening is contained in Attachment 1. Attachment 2 contains a summary of the small bore piping inspection results.

Section 6.0 discusses the criteria used to screen components as requiring future monitoring. Attachment 3 contains a summary of piping components recommended for future inspections.

Section 7.0 identifies components repaired or replaced during RFO 24.

Section 8.0 contains conclusions and recommendations for future FAC Inspections. There were no immediate operability concerns as the result of FAC inspections performed during RFO24.

2.0 PURPOSE

Each refueling outage, ultrasonic thickness (UT) measurements and or/internal visual inspections are performed on plant piping per the Vermont Yankee Piping Flow Accelerated Corrosion (FAC) Inspection Program, PP7028, reference (1). This report summarizes the results of the inspections performed during RFO 24-Spring 2004.

3.0 ASSUMPTIONS

There are no assumptions.

4.0 2004 REFUELING OUTAGE INSPECTION PLAN

The 2004 refueling outage inspection scope was developed to satisfy the following goals:

- Inspection of large bore components requiring follow up inspections, based on UT data from previous refueling outages.
- Inspection of components identified by the EPRI CHECWORKS computer code as being ranked high for susceptibility to wear and/or having the least time remaining to reach code minimum wall thickness.
- Perform repeat inspections on selected large bore components for calibration of the CHECWORKS models.
- To incorporate industry experience into the program through inspection of components at VY that are similar to those that have either failed or showed significant wall thinning at other plants. During the 2004 RFO, inspections were performed on large bore piping connected directly to the condenser which serves as a drain collector for several small bore lines.
- Perform an internal visual inspection of all four 36" turbine cross around lines exiting the high pressure (HP) turbine. These inspections are to baseline the condition prior to changes in flows due to the HP turbine modifications and power uprate. A priority is to assess the condition of a 12 inch diameter carbon steel stub piece visible from inside the 36"A line.
- Perform an internal visual inspection of the 30" C and D cross around lines to confirm the condition of previous P22 material replacements.
- Inspection of selected small bore components contained in the Small Bore Database which have not had an initial inspection.
- Inspection of selected small bore components based on previous wear or leaks, primarily on the turbine bypass valve chest first seal leak off piping.

- Inspection of selected small bore components connected to the HP turbine to baseline the condition prior to changes in flows due to the HP turbine modification and power uprate.

- Large and small bore piping components subjected to off normal flow conditions, such as components downstream of normally closed valves with seat leakage are generally performed each refueling outage. These components are typically identified by the cognizant Systems Engineer, using the turbine performance monitoring system. No components were identified during the scoping for RFO 24.

- All four HP feedwater heaters were scheduled for replacement in the 2004 RFO. This limits access to piping in the upper heater bay. To optimize the inspection scope a number of inspections will be performed in the feedwater pump room on both the feedwater and condensate systems. These inspections will serve to baseline conditions prior to the increased flows from power uprate.

The planned duration for RFO 24 FAC activities was approximately 18 days. Given the shorter duration consideration was given to optimizing the locations and number of components to be inspected, and also to be consistent with previous outage inspection efforts. The detailed reasoning for component selection is contained in the Inspection Location Worksheets, reference (4). The complete planned scope for RFO 24 is contained in reference (5).

5.0 EVALUATION OF INSPECTION RESULTS

5.1 Large Bore Piping

The planned large bore piping inspection scope for RFO 24 included external UT exams on 26 large bore piping components at eleven locations on the Feedwater, Condensate, Extraction Steam, and Main Steam Drain Systems. All 26 components were inspected using external UT.

The thickness data were evaluated using a three level screening process as defined in procedure, DP 0072. The UT inspection results for each component were reviewed for anomalies and consistency with piping geometry. Wear rates (wear/cycle) were calculated for each component using methods specified in DP 0072, and are consistent with NSAC-202L, reference (6). For component UT results which indicated no wear or minimal wear has occurred, a minimum wear rate of 0.005 inches/cycle was used. Using the calculated wear rates and the 2004 measured thickness, the predicted thickness at the end of the next cycle (2005 Tpred) was calculated using a safety factor of 1.2 on the calculated wear per cycle. Using both the wear rate and 2004 measurement data, the projected number of cycles beyond the Spring 2004 refueling outage (RFO24) for each component to wear down to the code minimum wall thickness was also calculated.

Components passing the Level 1 screen have 2005 Tpred greater than .875Tnom (the manufacturing tolerance of new piping) and require no further evaluation. The Level 2 screen is for components with 2005 Tpred less than .875Tnom but greater than Tmin (the code minimum wall thickness to resist pressure and mechanical loads). These components are acceptable for continued operation but future monitoring is recommended. The Level 3 screening is for components with 2005 Tpred less than Tmin. The Level 3 screening is a detailed analytical methodology. It also requires that additional piping components be inspected this outage (sample expansion), and considered for inspection during future refueling outages.

All components inspected were found to have wall thickness greater than code minimum wall thickness. All predicted wall thickness (at the 2005 refueling outage) values were above code minimum wall thickness. Of the 26 large bore piping components inspected, 14 (54%) passed the Level 1 screen, and the remaining 12 (46%) passed the Level 2 screen.

No large bore repairs or replacements were required. Eight components were recommended for future monitoring. These are discussed in Section 6.0 of this report. A summary of the large bore piping component screening is contained in Attachment 1.

5.2 Turbine Cross Around Piping

36 Inch Diameter Lines A to D:

Internal visual inspections of the four 36" turbine cross around lines exiting the HP turbine were performed. These inspections were performed to document the condition of the lines prior to operation with the modified turbine and increased flows from power uprate. Also, the visual inspection of a section of 12 inch diameter carbon steel pipe on line 12-ES-1A stub piece visible from inside the 36"A line was performed. This section was also included in the large bore external UT scope as inspection No. 2004-022.

Prior to entering the piping, FAC inspection reports and notes from previous refueling outages and reference (12) were reviewed to identify previously noted conditions.

No areas of active corrosion were identified. Previously identified surface tiger striping with no discernable depth, showed no change in surface extent. The piping is essentially in the same condition as noted in 1998 in reference(12).

Digital photos were taken in each line to document the condition during RFO 24. These will be used for comparison during future outages. The photos are JPEG files contained on the attached CD. Attachment 4 to this report is an index and description of each photo.

30 Inch Diameter Lines C & D:

An internal visual inspection of both the C & D 30 inch diameter cross around lines on the west side of the turbine was performed to confirm the condition of previous P22 material replacements. Both lines have been replaced with P22 Chrome-Moly piping material. The 30" C line was replaced in 1993. This was the first inspection since the replacement. The 30" D line was replaced in 1985 and the last internal inspection was performed in 1995.

Both lines have a smooth grey/blue interior surface with no evidence of wall loss or active surface corrosion. No photos were taken in the 30 inch diameter piping due to resource constraints. For the 30 inch C line the only notable feature is discoloration in the heat affected zone on the downstream weld at elbow CARCEL06 shown on FAC location Sketch No.084. For the 30 inch D line, original fabrication grinding marks on the extrados of elbow CARDEL05 (FAC Location Sketch 085) which were previously identified in 1995 are essentially the same as in 1995.

With 19 years of operation for the 30 inch D line and 10 years for the 30 inch C line, the ASTM A691 P-22 piping material shows no evidence of wall loss due to FAC and has proven as an effective replacement material for the original GE supplied carbon steel piping.

Lb

5.3 Small Bore Piping

Eleven sections of small bore piping were scheduled for external UT inspection during the 2004 refueling outage. One inspection was a new location from the small bore database. Five locations on the turbine bypass valve chest first seal leakoff line 1SLBPV were inspected to determine the extent of condition due to a through leak during the cycle, reference (9). A temporary engineered leak enclosure, reference (10), was removed and the damaged piping was replaced during the outage. One of the locations inspected on 1SLBPV, 04-SB04 had localized wall loss and was replaced with carbon steel pipe. Engineering Request ER 04-964, reference (11) was written to replace the entire 1SLBPV line with FAC resistant material.

The remaining five locations were on the HP turbine pocket drain line 1SPL2 located directly under the HP turbine. These were repeat inspections performed to assess the condition of the piping prior to the HP turbine modifications and operation under power uprate flows.

No significant wear was found in the small bore piping inspected except for location 04-SB04 on line 1SLBPV. A summary of the small bore piping inspection results and recommendations for future inspections is contained in Attachment 2.

5.4 Feedwater Heater Shells

All four HP feedwater heaters were replaced during RFO 24. All ten feedwater heater shells have been replaced with either chrome-moly or stainless steel materials. There are no planned UT inspections for the feedwater heater shells in the near term.

6.0 COMPONENTS REQUIRING FUTURE MONITORING

Components requiring future monitoring are identified using the predicted thickness at the next refueling outage (2005 $T_{Predicted}$), the "Screening Level" which the component passed, and the "Approximate Cycles to Tmin" shown in Attachment 1. From the wear rates and cycles to Tmin calculated in Attachment 1, five components were identified with less than 10 cycles to Tmin. These calculated times are based on conservative wear rate estimates. A detailed description is contained in Attachment 3. Re-inspections were recommended for 8 components with lowest calculated times to Tmin. The recommended inspection time is generally one-half the calculated time to reach Tmin.

The 2004 refueling outage inspection results will be incorporated into the existing CHECWORKS models of the Feedwater and Condensate Systems. The 2004 inspection data along with data from previous inspections will be used to refine the wear rate predictions. The results shown in Attachment 1 and the updated CHECWORKS analyses will be used to determine the inspection scope for future refueling outages.

7.0 COMPONENTS REQUIRING POSSIBLE REPAIR OR REPLACEMENT

No specific large bore components were identified as requiring repairs or replacements.

Small bore inspections on line 1SLBPV identified localized wall loss and a local "like-for-like" carbon steel replacement at inspection location 04-SB04 was performed during RFO 24. Engineering Request ER 04-0964 was written for replacement of the entire 1SLBPV line replacement with FAC resistant material.

No other small bore piping was identified as requiring repair or replacement.

8.0 CONCLUSIONS / RECOMMENDATIONS FOR FUTURE FAC INSPECTIONS

There were no immediate operability concerns as the result of FAC inspections performed during RFO24.

Based on results from the RFO 24 inspections, no new immediate or near term repairs or replacements are required. Replacement of small bore line 1SLBPV piping which has experienced through wall leaks in the past is being addressed in ER 04-0964.

The planned power uprate project underway at VY requires a complete review of program evaluations, piping modeling, and procedures to account for changes in equipment and flow regimes in plant piping systems. Inspection data taken this outage will serve as part of the baseline data prior to operation with the increased flows from power uprate.

9.0 REFERENCES

1. V.Y. Program Procedure PP 7028, Piping Flow Accelerated Corrosion (FAC) Inspection Program, Original Issue 5/10/01 with LPC 1 dated 12/06/01.

2. V.Y. Department Procedure, DP 0072, "Structural Evaluation of Thinned Wall Piping Components", Original Issue 5/17/01, with LPC 1 dated 10/02/01.

3. ENN-NDE-9.05, Revision 0, Ultrasonic Thickness Examination.

4. VY Piping FAC Inspection Program – 2004 Refueling Outage: Inspection Location Worksheets / Methods and Reasons for Component Selection, dated 3/27/03.

5. ENVY Memo: J.C.Fitzpatrick to S.D.Goodwin, subject: Piping FAC Inspection Scope for the 2004 Refueling Outage, VYM 2003/009, dated 3/27/03.

6. EPRI Report, "Recommendations for an Effective Flow-Accelerated Corrosion Program", EPRI NSAC-202L-R2, April 1999.

7. CHECWORKS - Computer Program User Guide, TR 103496, August 1994 by Altos Engineering Applications Inc. for EPRI.

8. VY Calculation No. VYPC 92-004, Rev. 0, "Turbine Cross Around Piping Wall Thinning Evaluation".

9. Vermont Yankee Event Report ER No. 2003-044, Turbine Bypass Steam Leak , Line #1 1SLBPV, Level 2.

10. Temporary Modification Package No. 2003-002, Installation of Steam Leak Repair Enclosure on 2" Steam Seal Off the Turbine Bypass Valves.

11. Engineering Request ER 04 -0964, Replace Turbine Bypass Valve Chest 1st Seal Leakoff Piping 1SLBPV.

12. VY Design Engineering - Bolton MEMO: J.C. Fitzpatrick to D.Girroir(VY-ISI), VYM 98/91, dated May 8,1998, subject:1998 Refueling Outage Turbine Cross Around Piping Inspections.

ATTACHMENT 1: SUMMARY OF LARGE BORE PIPING UT INSPECTION RESULTS

Inspect. No.	Component ID	DIA (in.)	T_{nom} (in.)	$.875T_{nom}$ (in.)	T_{min} (in.)	2004 Min.T_{meas} (in.)	Wear Rate (in./cycle) Note 2	2005 $T_{predicted}$ Note 3	Passed Screen Level	Approx. Cycles to T_{min} Note 4	Future Inspections Recommended	Comments
2004-01	FD01RD01	16	1.219	1.066	0.965	1.031	0.005	1.025	2	11.0		
		12	1.000	0.875	0.769	0.906	0.005	0.900	1	22.8		
2004-02	FD01EL01	16	1.219	1.066	0.984	1.074	0.005	1.068	1	15.0		
2004-03	FD01TE05	16	1.219	1.066	0.965	1.010	0.005	1.004	2	7.5	2008 RFO	Note 5
2004-04	FD01EL04	16	1.219	1.066	1.090	1.431	0.006	1.423	1	47.4		
2004-05	FD01SP04	16	1.219	1.066	0.965	1.065	0.005	1.059	2	16.7		
2004-06	FD02RD01	16	1.219	1.066	0.965	1.026	0.005	1.020	2	10.2	2011 RFO	
		12	1.000	0.875	0.769	1.052	0.005	1.046	1	47.2		
2004-07	FD02EL01	16	1.219	1.066	0.984	1.187	0.005	1.181	1	33.8		
2004-08	FD02TE01	16	1.219	1.066	0.965	0.986	0.005	0.980	2	3.5*	2007 RFO	Note 5 *See Note 6
2004-09	FD03SP01	16	1.219	1.066	0.965	1.068	0.008	1.058	2	10.2	2011 RFO	
2004-10	FD07SP02	18	1.375	1.203	1.085	1.197	0.014	1.181	2	6.8	2008 RFO	
2004-11	FD07EL03	18	1.375	1.203	1.160	1.385	0.009	1.374	1	20.2		
2004-12	FD14SP08US	16	1.219	1.066	0.965	1.113	0.007	1.105	1	18.7		
2004-13	FD14EL07	16	1.219	1.066	0.965	1.164	0.007	1.155	1	23		Rows 1 to 12
		16	1.219	1.066	0.965	1.021	0.006	1.014	2	5.2	2008 RFO	Row 13, pup piece
	FD19SP03DS	16	0.844	0.739	0.645	0.789	0.005	0.783	1	24.0		Rows 1,2 US pipe
2004-14	FD19TE01	16	1.219	1.066	0.645	0.910	0.005	0.904	1	44.2	CC N560	Row 3
2004-15	FD19RD01	16	1.219	1.066	0.645	1.151	0.005	1.145	1	84.3	CC N560	
		10	0.844	0.739	0.585	0.781	0.005	0.775	1	32.7		
2004-16	FD19SP04	10	0.844	0.739	0.450	0.778	0.005	0.772	1	54.7	CC N560	
2004-17	FD21SP01	10	0.844	0.739	0.460	0.796	0.005	0.790	1	56.0	CC N560	
	FD19TE01	10	0.844	0.739	0.460	0.769	0.005	0.763	1	50.5		Branch FD19TE01

ATTACHMENT 1: SUMMARY OF LARGE BORE PIPING UT INSPECTION RESULTS

Inspect. No.	Component ID	DIA (in.)	T_{nom} (in.)	$.875T_{nom}$ (in.)	T_{min} (in.)	2004 Min.T_{meas} (in.)	Wear Rate (in./cycle) Note 2	2005 $T_{predicted}$ Note 3	Passed Screen Level	Approx. Cycles to T_{min} Note 4	Future Inspections Recommended	Comments
	CD30SP03	24	0.688	0.602	0.472	0.660	0.005	0.654	1	31.3		Rows 1-2
2004-18	CD30TE02	24	0.688	0.602	0.520	0.902	0.005	0.896	1	63.7		Rows 3-10
		20	0.594	0.520	0.440	0.649	0.005	0.643	1	34.8		
2004-19	CD30SP04	24	0.688	0.602	0.472	0.629	0.005	0.623	1	26.2		Rows 11-12
2004-20	CD32SP04	20	0.594	0.520	0.394	0.512	0.005	0.506	2	19.7		New Designation
2004-21	CD32EL02	20	0.594	0.520	0.450	0.601	0.005	0.595	1	25.2		Rows 1-8
		20	0.594	0.520	0.394	0.535	0.005	0.529	1	23.5		Rows 9-10 on Pipe Stub
2004-22	ES1ASP01	12	0.375	0.328	0.180	0.305	0.005	0.299	2	20.8		
2004-23	MSD9TE01 to MSD9TE08	8	0.500	0.438	0.348	0.410	0.005	0.404	2	10.3	2010 RFO	
2004-24	MSD9EL05	8	0.500	0.438	0.380	0.432	0.007	0.424	2	6.5	2010 RFO	
2004-25	MSD9EL06	8	0.500	0.438	0.380	0.468	0.005	0.462	1	14.7		
2004-26	MSD9SP06US	8	0.500	0.438	0.348	0.482	0.005	0.476	1	22.3		

NOTES:

1. All thickness values are inches.
2. Wear/Cycle is approximately inches/18 months. The wear per cycle was calculated per DP0072 using 17.9 equivalent 18 month cycles based on approx. 157,000 operating hours up to 1996 outage, and 12000 ± hrs./cycle. Minimum Wear/Cycle used to calculate Tpred and Cycles to Tmin is 0.005 inches per cycle.
3. 2005 T predicted = 2004 T measured - F.S. * (Wear/Cycle), F.S. = Factor of Safety = 1.20.
4. Cycles to Tmin is calculated from: $\frac{(\text{2004 T measured} - \text{Tmin})}{\text{F.S. x Wear/Cycle.}}$ (i.e. Cycles from 2004 RFO)
5. Tee is fabricated from a 4 inch diameter Sweepolet installed on a 16 inch section of straight pipe.
6. 3.5 cycles to Tmin based on default wear rate. Actual point to point measurements from 1999 to 2004 indicate no wear.

SMALL BORE

Small Bore Inspection. Number (Note 1)	Description / Location	Sect.	Size (In.)	Sch	Tnom. (Inch)	.875Tnom (Inch)	T min. (Inch) (Note2)	2004 Min. Measured Thickness (Inch)	Apparent Wear Rate (Inch/cycle)	Cycles to Tmin. (Note3)	Comments
04-SB01	2"-1SLBPV Pipe @ ½' Weldolet at No.2 Turbine Bypass Valve.		2	80	.218	.191	.089	.120	0.006	4.3	Note 5
04-SB02	2"-1SLBPV Pipe @ 90 deg. SW elbow @ "C" Cross Around	Horizontal	2	80	.218	.191	.089	.155	0.008	6.9	Note 5
		Vertical	2	80	.218	.191	.089	.204	<0.005	19.2	
04-SB03 (No.98, 92-SB02)	2"-1SLBPV Pipe both sides of 90 deg. SW elbow	E-W run	2	80	.218	.191	.089	.197	<0.005	18	Note 5
		N-S run	2	80	.218	.191	.089	.200	<0.005	18.5	
04-SB04 (No.99, 92-SB03)	2"-1SLBPV @ 2x2x2 S.W. Tee	North	2	80	.218	.191	.089	.194	<0.005	17.5	* Replaced, See Note 4, Note 5
		South	2	80	.218	.191	.089	.097	<0.005	1.3 *	
		West	2	80	.218	.191	.089	.201	<0.005	18.7	
04-SB05	2"-1SLBPV @ 90 deg. SW Elbow	E-W run	2	80	.218	.191	.089	.202	<0.005	18.8	Note 5
		N-S run	2	80	.218	.191	.089	.197	<0.005	18.0	
04-SB06 (No.110, 93-SB49)	2 ½" – 1SPL2, HP Turbine Drain	Vertical	2 ½"	40	.203	.178	.094	0.177	<0.005	13.8	Re-inspect at pipe bend in 2007 RFO after EPU operation.
		Pipe bend Rows 30 to 34	2 ½"	40	.203	.178	.094	0.143	<0.005	8.2	
		Horizontal	2 ½"	40	.203	.178	.094	0.177	<0.005	13.8	

SMALL BORE - continued

Small Bore Inspection. Number (Note 1)	Description / Location	Sect.	Size (In.)	Sch	Tnom. (Inch)	.875Tnom (Inch)	T min. (Inch) (Note2)	2004 Min. Measured Thickness (Inch)	Apparent Wear Rate (inch/cycle)	Cycles to Tmin. (Note3)	Comments
04-SB07 (No.111, 93-SB50)	2 ½" – 1SPL2	Elbow Rows 1 to 6	2 ½"	40	.203	.178	.094	0.169	<0.005	12.5	
		Horizontal Rows 7 to 38	2 ½"	40	.203	.178	.094	0.174	<0.005	13.3	
04-SB08 (No.112, 93-SB51)	2 ½" – 1SPL2	Pipe Bend Rows 1 to 5	2 ½"	40	.203	.178	.094	0.140	<0.005	7.7	Re-inspect at pipe bend in 2007 RFO after EPU operation.
		Horizontal Rows 6 to 17	2 ½"	40	.203	.178	.094	0.173	<0.005	13.2	
04-SB09 04-SB09A (No.113, 93-SB52, No.114, 93-SB53))	2 ½" – 1SPL2	Pipe Bend Rows 1 to4	2 ½"	40	.203	.178	.094	0.140	<0.005	7.7	Re-inspect at pipe bend in 2007 RFO after EPU operation.
		Horizontal Rows 5 to 23	2 ½"	40	.203	.178	.094	0.160	<0.005	11	
		Elbow Rows 24 to 28	2 ½"	40	.203	.178	.094	0.177	<0.005	13.8	
04-SB10 (No.115, 93-SB54)	2 ½" – 1SPL2, 2 x 2-1/2" Reducer at 36" CAR	Reducer	2 ½" 2"	40	.203 .154	.178 .135	.094 .089	0.191	<0.005	16.2	
04-SB11	½inch piping at FDW Pump warm up line R.O.	D.S. of R.O.	½"	160	.187	.164	.116	0.190	<0.005	12.3	

NOTES:
1. Small Bore Database No. and previous inspection identification are shown in parentheses.
2. Tmin includes a 0.065 inch corrosion allowance per ANSI B31.1-1967.
3. Cycles to Tmin from 2004 refueling outage. SF (safety factor) = 1.2 was used on the apparent wear rate. Small bore wear is generally not trended for the purposes of repeat inspections. Small bore components will generally be replaced if significant thinning is observed.
4. South section was replaced with new C.S. pipe see W.O 03-000084-007.
5. Engineering Request No. ER 04-0964 was written to replace the entire carbon steel 1SLBPV line with FAC resistant materials.

LARGE BORE PIPING

Inspection	Component	Calculated Cycles to Tmin	Recommend Re-inspection RFO	Evaluation / Reasons for Recommendation
2004-03	FD01TE05	7.5	2008RFO	Estimated time for component to wear to code minimum thickness is based on the default wear rate of 0.005 inch/cycle. Time calculated based on multiple inspection point to point measurements indicates at least 12.5 cycles to code minimum wall. Recommended inspection at 2008 RFO is based on consideration of flow changes due to power uprate.
2004-06	FD02RD01	10.2	2011RFO	Estimated time for component to wear to code minimum thickness is based on the default wear rate of 0.005 inch/cycle. Time calculated based on multiple inspection point to point measurements indicates at least 50.8 cycles to code minimum wall. Recommended inspection at 2011 RFO is based on consideration of flow changes due to power uprate.
2004-08	FD02TE01	3.5	2007RFO	Estimated time for component to wear to code minimum thickness is based on the default wear rate of 0.005 inch/cycle. Time calculated based on multiple inspection point to point measurements indicates at least 21 cycles to code minimum wall. Recommended inspection at 2007 RFO is based on consideration of flow changes due to power uprate.
2004-09	FD03SP01	10.2	2011RFO	Initial inspection. Estimated time for component to wear to code minimum thickness is based on a conservative wear rate calculation. Recommendation for re-inspection at approx. ½ time to reach Tmin.
2004-10	FD07SP02	6.8	2008RFO	Initial inspection. Estimated time for component to wear to code minimum thickness is based on a conservative wear rate calculation. Recommendation for re-inspection at approx. ½ time to reach Tmin.
2004-13	FD14EL07@ DS pup piece	5.2	2008RFO	Initial inspection. Estimated time for component to wear to code minimum thickness is based on a conservative wear rate calculation. Recommendation for re-inspection at approx. ½ time to reach Tmin.
2004-23	MSD9TE01 to MSD9TE08	10.3	2010RFO	Initial inspection. Estimated time for component to wear to code minimum thickness is based on a conservative wear rate calculation. Observed thinning was localized to area below connections of small bore lines. Code min wall based on a conservative design pressure of 1250psi. Recommendation for re-inspection at approx. ½ time to reach Tmin.
2004-24	MSD9EL05	6.5	2010RFO	Initial inspection. Estimated time for component to wear to code minimum thickness is based on a conservative wear rate calculation. Observed thinning was localized to area below connections of small bore lines. Code min wall based design pressure of 1250psi considering this line connects directly into the condenser. Recommendation for re-inspection at approx. prior to time to reach Tmin.

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SMALL BORE PIPING

Inspection	Component	Calculated Cycles to Tmin	Recommend Re-inspection RFO	Evaluation / Reasons for Recommendation
04-SB01 04-SB02 04-SB03 04-SB04 04-SB05	½" & 1"-1SLBPV	4.3 Min	NONE	Engineering Request ER 04-0964 was written to replace the 1SLBPV line with FAC resistant material. Additional inspections will only be performed on this line, if the piping is not replaced.
04-SB06, 04-SB08, 04-SB09A	2-1/2"-1SPL2	8.2 7.7 7.7	2007RFO	The estimated times shown for locations on this line are constructed of bent piping. The calculated times for components to wear to code minimum thickness is based on the default wear rate of 0.005 inch/cycle. Time calculated based on multiple inspection point to point measurements at the piping bends are as follows: Inspection — Time to Tmin DEFAULT — Time to Tmin point to point 04-SB06 — 8.2 cycles — 27.2 cycles 04-SB08 — 7.7 cycles — 18.2 cycles 04-SB09 — 7.7 cycles — 53.7 cycles Recommended inspection at 2007 RFO is based on consideration of flow changes due to high pressure turbine modifications, power uprate flows, previous wall thinning of this line a Duane Arnold.

XX in JPEG FILE NUMBER	36 INCH C.A.R. LINE	Description / Notes
01	D	Looking upstream at bottom of 90degree elbow. Note surface tiger striping and previous surface grinding on bottom plates in elbow and in HAZ of weld from pipe to elbow. Some surface roughness on bottom half of horizontal run.
02	D	Same as 01 above rotated 90 degrees. Note small area adjacent to weld to elbow and longitudinal weld in horizontal pipe.
03	D	Looking downstream at right side of horizontal pipe upstream of manway. General surface roughness on pipe and at weld at manway.
04	D	Looking downstream at right side and top of horizontal pipe upstream of manway. General surface roughness on top of pipe and at weld at manway.
05	D	Looking downstream at center of Herzog cone at inlet to MS-1-1D.
06	D	Close-up of welds on Herzog cone at inlet to MS-1-1D.
07	D	Close-up of welds on Herzog cone at inlet to MS-1-1D.
08	D	Close-up of welds on Herzog cone at inlet to MS-1-1D.
09	D	Looking downstream at bottom right side adjacent to weld to MS 1D inlet. Note previous welds overlay and surface grinding.
10	D	Looking downstream at bottom left side in bore of inlet nozzle to MS 1D inlet. Note extent of previous surface corrosion and previous surface grinding.
11	D	General surface condition on bottom of horizontal pipe upstream of manway. Note roughness.
12	D	General surface condition on left side of horizontal pipe upstream and opposite of manway. Note roughness.
13	D	Looking downstream at left side in bore of inlet nozzle to MS-1-1D. Note extent of previous surface corrosion, previous surface grinding, and localized areas of previous attack.
14	D	Looking downstream at left side of pipe and in bore of inlet nozzle to M-1-1D. Note extent of previous surface corrosion, previous surface grinding, and localized areas of previous attack. Also general surface condition of pipe.
15	C	Looking upstream from manway. Note FME in bottom of pipe from HP turbine modifications. Material was vacuumed out of pipe and CR written to document condition.
16	C	Same as 015 above rotated 90 degrees. Note area of surface roughness along left side of pipe.
17	C	Looking upstream from manway. FME in bottom of pipe from HP turbine modifications was removed. Note area of surface roughness and previous surface grinding along left side of pipe and along bottom longitudinal weld in extrados of elbow.
18	C	Looking downstream from manway. Note area of surface roughness and previous surface grinding along right side of pipe and on extrados of mitered elbow at inlet to MS-1-1C.
19	C	Looking upstream at elbow. Note area of surface roughness and previous surface grinding along left side of pipe and left bottom plate of elbow.
20	C	Looking upstream at elbow. Note area of surface roughness and previous surface grinding on right bottom plate of elbow.
21	C	Looking upstream, close-up of bottom of elbow. Note area of surface roughness and previous surface grinding. Crown of longitudinal weld on extrados of elbow and to downstream pipe has no corrosion surface film.
22	C	Looking upstream, close-up of upper right side plate in 90 degree elbow (intrados). Note area of surface tiger striping along weld to turning vane and at weld to horizontal pipe.
23	C	Looking upstream, close-up upper right side of horizontal pipe downstream of weld to 90 degree elbow. Note extent of localized area of surface roughness.
24	C	Looking upstream, close-up upper trailing edge of turning vane and bottom (extrados) of elbow.

XX in JPEG FILE NUMBER	36 INCH C.A.R. LINE	Description / Notes
25	C	Looking downstream from manway. Note area of surface roughness and previous surface grinding along right side of pipe and welds and on extrados of mitered elbow at inlet to MS-1-1C.
26	C	Close up of extrados of mitered elbow. (right side of horizontal run). Note area of surface roughness below the equator and previous surface grinding along longitudinal weld and circumferential weld on upstream end of mitered elbow.
27	C	Close up of extrados of mitered elbow. (right side of horizontal run). Note area of surface roughness above the equator on extrados of elbow and on bore of inlet nozzle to MS-1-1C.
28	B	General surface condition on bottom of horizontal pipe upstream of manway. Note roughness.
29	B	Looking upstream, close-up of bottom of 90 degree elbow. Note Previous tiger striping and previous surface grinding over entire area of left side bottom plate (extrados) in elbow.
30	B	Looking upstream, close-up of right side of weld at 90 degree elbow to horizontal pipe. Note surface roughness on upper right side plate in elbow (intrados) and on downstream pipe.
31	B	Looking upstream, close-up of bottom of pipe at weld at 90 degree elbow. Note previous area of surface attack immediately upstream of to horizontal pipe. Note surface roughness on bottom surface of pipe.
32	B	Looking upstream, close-up of hole bored in left side of horizontal pipe downstream of 90 degree elbow. Hole is for small bore nozzle used in turbine performance testing. Note general surface condition of pipe.
33	B	Looking upstream, close-up of top left half (intrados) of 90 degree elbow. Note extent of surface tiger striping over entire area of the top left side plate (intrados) in elbow. Also surface roughness on upper surface of turning vane.
34	B	Looking upstream to vertical drop, in intrados of 90 degree elbow (go into top half of elbow). Note local area of surface corrosion on upper left side of intrados adjacent to the longitudinal weld.
35	B	Looking downstream on left side of horizontal pipe just opposite and upstream from manway. Localized area of previous surface corrosion and previous surface grinding along longitudinal weld on left side of pipe.
36	B	Looking downstream on right side of horizontal pipe upstream from manway. Localized area of previous surface corrosion and previous surface grinding along longitudinal weld on right side of pipe.
37	B	Same area described in photo 35 above.
38	B	Looking downstream in horizontal pipe upstream from manway. Localized area of previous surface roughness opposite manway above equator. Note PPE for on large engineer for future inspections (PCs, Safety harness, ropes and oxygen monitor. Knee pads are recommended).
39	B	Looking into 12 inch diameter connection for line 12"-ES-1B. 12 inch piping is chrome-moly. Note fit up miss-match at bottom of 12 inch pipe for future inspections.
40	B	Looking downstream in horizontal pipe opposite from manway. Localized area of previous surface roughness and surface grinding.
41	B	Looking downstream of horizontal pipe bottom surface upstream of inlet to MS-1-1B. Localized area of previous surface roughness and surface grinding at bottom center and along circumferential weld at mitered elbow.
42	B	Looking downstream at right side of horizontal pipe and intrados of mitered elbow at equator of pipe. Note localized area of previous surface corrosion and surface grinding upstream of weld from pipe to elbow.
43	B	Looking downstream at right side of horizontal pipe and intrados of mitered elbow below equator of pipe. Note localized area of surface roughness.
44	A	Looking upstream at right side of horizontal pipe upstream of manway. Note extent of previous internal weld repairs and surface grinding on pipe and upstream elbow.

ATTACHMENT 4: CATALOG OF PHOTOS FROM INTERNAL INSPECTION OF 36 INCH DIAMETER CROSS AROUND PIPING

XX in JPEG FILE NUMBER	36 INCH C.A.R. LINE	Description / Notes
45	A	Looking upstream at right side of horizontal pipe and 90 degree elbow. Note extent of previous internal weld repairs and surface grinding on pipe. Also note extent of previous surface grinding in elbow at bottom extrados and both top and bottom right side plates.
46	A	Looking upstream into 12 inch diameter connection for line 12"-ES-1A. 12 inch piping is chrome-moly EXCEPT for C.S. pup piece approx. 5 inches long shown between welds in photo. Note fit up miss-match at bottom and left side of 12 inch pipe for future inspections. Also note previous weld repair and surface grinding at left side of 12 inch opening and general surface condition of 36 inch pipe.
47	A	Looking downstream at top left side of entrance to MS-1-1A. Note localized area of previous surface corrosion and surface grinding in bore of nozzle and general condition of circumferential weld.
48	A	Looking downstream at right side of pipe at entrance to MS-1-1A. Note previous weld repair and surface grinding.
49	A	Looking downstream at top of pipe at entrance to MS-1-1A. Note previous surface grinding and general condition of piping upstream of circumferential weld.
50	A	Looking downstream at bottom left side of Herzog cone at inlet to MS-1-1A. Note condition of fillet welds.

Notes:
1. Pictures are in JPEG format. File names on CD are "RFO24picturexx.JPG" where "xx" is in column 1 above.
2. In descriptions above, directions for orientation are given looking downstream (i.e. left side of pipe means looking downstream on left side on interior surface.
3. Reference VY drawings 5920-0150 Sheets 1 & 2 for piping arrangement. And 5920-6841 Sheet 1 of 2 for spool piece details.

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ATTACHMENT 9.3 TECHNICAL REVIEW COMMENTS AND RESOLUTION FORM

Entergy

ENN Site Applicability: ☐ IP1 ☐ IP2 ☐ IP3 ☐ JAF ☐ PNPS ☒ VY

Engineering Report
Technical Review Comments and Resolutions Form

Engineering Report Number:	VY-RPT-04-00010	Rev. 0	Title: Vermont Yankee Piping Flow Accelerated Corrosion Inspection Program (PP 7028), 2004 Refueling Outage Inspection Report (RFO 24 – Spring 2004)
Quality Related: ☒ Yes ☐ No		Special Notes or Instructions: None	

Comment Number	Section/ Page No.	Review Comment	Response/Resolution	Responsible Engineer's Accept Initials
1	5.1/6	Percentages of components	Incorp'd.	JCPHZ
2	Attach. 1	Inspect. No. 2004-09 adjust Tpred.	Incorp'd.	JCPHZ
3	Attach. 1	Notes, 17.9 equivalent cycles	Incorp'd.	JCPHZ
4	Attach. 2	Inspect. No. 04-SB06, adjust Cycles to Tmin.	Incorp'd.	JCPHZ
5	Attach. 2	Inspect. No. 04-SB09, adjust Tmeas.	Incorp'd.	JCPHZ

Reviewed/ Verified By:	T. M. O'Connor	Date:2-15-05
Site/Department:	VY/MSD	Phone:x3092