

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

Date - Qtr	NRC	INDIAN POINT 2	WESTINGHOUSE or EPRI	OTHER LICENSEES
2000 - 2			W-NSA-00-007 - SG Design Delta-P Issue, 5/5/00	Low radius U-bend history from 6/19/2000 RAI. Dominion Engineering Report L-4021-00-1, April 10, 2000, "Results of U-bend PWSCC Update to Predictions in DEI-519, <u>Steam Generator Tube Life Prediction Analysis for Indian Point 2</u> ," draft.
2000 - 1	February 15 SG tube failure event. NRC letter, Jeffrey Harold to Alan Blind of Con Edison, "Indian Point Nuclear Generating Unit No. 2 (IP2) - Request for Additional Information Re Proposed Steam Generator Tube Examination Program (TAC)	EOC14 Tubes plugged: TSP denting & SCC = 17 (373); hot leg roll = 100 (139); pitting = 300 (735); U-bend PWSCC = 8 (9); PWSCC = (2); other = 170 (662); R2 U-bend preventive 196 (196); Total = 791 (2116) current(cumulative) One probe restriction, 17		
1999 - 4	NRC Safety Evaluation on Tech Spec amendment. Inspection Plan submitted	Plant restarted.	Eddy Current Data Quality Specification for Inspection of Steam Generator Tubes, Vol. 1, Bobbin coil Probe, EPRI document TR-114206-V1, Dec. 1999.	
1999 - 3		Plant shutdown due to Tap Changer Event.		

0  
#

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1999 - 2		IP2 Licensing Amendment 201, revises Tech Specs Section 4.13A.2.a to allow an extension to the SG inspection interval to coincide with the year 2000 refueling outage and Tech Spec 4.13C.1 to remove the requirement of receiving NRC concurrence on the licen		
1999 - 1				
1998 - 4	NRC Draft Regulatory Guide DG-1074, Steam Generator Tube Integrity, Dec 1998.	Indian Point 2 letter form Con Edison, A. Blind, "Proposed Amendment to Technical Specifications Regarding Steam Generator Tube Inservice Inspection Frequency," December 7, 1998.		
1998 - 3	SECY-98-248, Proposed Generic Letter 98-XX, "Steam Generator Tube Integrity"			
1998 - 2				
1998 - 1				
1997 - 4	NRC INR-97-38, Experiences During Recent SG Inspections, 12/16/97 NRC CL 97-05, Steam Generator Tube Inspection Techniques, 12/17/97 NRC CL 97-06, Degradation of Steam Generator Internal			NEI 97-06, "Steam Generator Program Guidelines," December 1997.

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1997 - 3		<p>During EOC13 used new non-rotating probe, CECCO-5, to examine tubes within support plates, tube sheet and sludge pile areas through the first support plate. Probe could identify cracking that bobbin coil probes could miss. In</p>	<p>EPRI Report TIR-106589-V1, "PWR Steam Generator Examination Guidelines, Revision 4, Volume 1 Guidelines," Final report, June 1996. Con Edison member none. EPRI Report TIR-107569-V1-R5, "PWR Steam Generator Examination Guidelines, Revision 5, Volume 1</p>	
1997 - 2	<p>NRC TIR 97-88, "Degradation in Small Radius U-Bend Cracking in SG Tubes," 5/19/97. NRC Memo, Jafferay Harold to Stephen Quinn on "Proposed Steam Generator Tube Examination Program for Indian Point Nuclear Generating Unit No. 2 (ITAC No. M93068)," May 29,</p>	<p>EOC13 Tubes plugged: TSP denting &amp; SCC = 71 (356); hot leg roll = 32 (39); pitting = 20 (435); U-bend PWSCC = 1 (1); PWSCC = (2); other = 49 (492); Total = 173 (1325) current(cumulative) One probe restriction, 12 sludge pile. 100% inspection with CECCO</p>		
1997 - 1		<p>IP2 Licensing Amendment 192, 5/20/97, revised Tech Spec to incorporate commitments made in connection with amendment 183, which authorized installation of laser welded SG sleeves inside defective tubes. IP2 Licensing Amendment 189, 4/9/97, revises Tech S</p>		
1996 - 4				ANO 2, 65 gpd, axial crack (#1H eggcrate)
1996 - 3				Byron 2, 120 gpd, loose part.

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1996 - 2	NRC IN 96-38, Results of SG Tube Examination, 6/21/96			
1996 - 1				
1995 - 4	NRC IN 95-40, Supplemental Information to GL 95-03, Circumferential Cracking of SG Tubes, 9/20/95			"Steam Generator Tube Life Prediction Analysis for Indian Point 2," DEI-442, October 1995, by Dominion Engineering. Draft.
1995 - 3	NRC GL 95-05, Voltage-Based Repair Criteria for Westinghouse SG Tubes Affected By ODSOC, 3/3/95	Secondary water chemistry 1995: - present: ammonia, hydrazine, boric acid, and ETA. See Table in Notes.		
1995 - 2	NRC GL 95-03, Circumferential Cracking of SG Tubes, 4/23/95	IP2 Licensing Amendment 183, 5/19/95, revises Tech Spec Sections 3.1.F and 4.13 to allow the repair of SG tubes by using laser welded sleeves. IP2 Licensing Amendment 180, 3/13/95, revises Tech Spec Sections 3.1.F and 4.13 to allow the repair of SG tubes		
1995 - 1		EOC12 Tubes plugged: TSP denting & SCC = 1 (285); hot leg roll = 2 (7); pitting = 12 (415); PWSCC = 2 (2); other = 4 (443); Total = 21 (1152) current (cumulative). First use of CECCO 5 eddy current probes. 11,909 tubes tested. Removed 2,499 lbs. Tube I		
1994 - 4	NRC Information Notice 94-38, "In-service Inspection Deficiencies Result in Severely Degraded Steam Generator Tubes," Dec 1994			

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1994 - 3	NRC IN 94-62, Operational Experience on SG Tube Leaks and Tube Ruptures, 8/30/94		EPRI NP-104030, Project 2812-15, Final Report, July 1994, "PWSCC Prediction Guidelines."	Sequoia 2 - previously experienced leakage at R1 U-bend due to PWSCC, several Huntington tubes. [Date for recurrence estimated.] Oconee 2, 144 gpd, fatigue. Maine Yankee, 50 gpd, circum crack PWSCC.
1994 - 2	NRC IN 94-46, Determination of P/S SG Leak Rate, 6/10/94			Doel 2 - Row 2 U-bend indication (14.9 EFPY).
1994 - 1				McGuire 1, 100 gpd, leaking sleeve. Oconee 3, 144 gpd, fatigue. South Texas, 160 gpd, leaking plug. Zion 2, 1440 gpd, tubesheet crevice IGA (OD)
1993 - 4				Braidwood 1, 300 gpd, freespan crack between 2 AVBs
1993 - 3	NRC IN 93-52, Draft NUREG-1477, Voltage-Based Interim Plugging Criteria For SG Tubes, 7/14/93			
1993 - 2				Kewaunee, 100 gpd, leaking tubesheet plug. McGuire 1, 185 gpd, sleeve failure.
1993 - 1		EOC11 Tubes plugged: TSP denting & SCC = 0 (284); hot leg roll = 5 (5); pitting = 50 (403); other = 4 (439); Total = 59 (1131) current (cumulative). Used 100, 200, 400, and 600kHz multifrequency bobbin coil. Removed 1,340 lbs. of sludge. Tube leakag		Palo Verde 2, 240 gpm, freespan IGSCC in upper bundle
1992 - 4	NRC IN 92-30, Operation With SG Tubes Seriously Degraded, 12/7/92			McGuire 1, 250 gpd, freespan crack. Trojan, 200 gpd, circum crack at sleeve weld.
1992 - 3			W-INS-40-001, Detection of Intergranular SCC, 7/20/92	
1992 - 2			W-INS-40-001, Fatigue Cracking of SG Tubes with Support, 8/30/91	

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1992 - 1				ANO 2, 360 gpd, circum crack (TS). Prairie Island 1, 144 gpd, axial crack (RTZ).
1991 - 4	NRC IN 91-67, "Problems with the Reliable Detection of Intergranular Stress Corrosion Cracking of SG Tubing," 10/21/91		EPRIReport NP-7498, "Statistical Analysis of Steam Generator Tube Degradation," Sept 1991. EPRIReport NP-7524, "Steam Generator Performance Degradation," Sept 1991	
1991 - 3			WATER INSTEAM, "Sept 28, 1991 Fatigue Cracking of SG Tubes with Support," 8/30/91	Diablo Canyon 1 (3 defects at 5.86 EFPY) experienced PWSCC in R1 and R2 U-bends in Huntington tubing. [Occurred earlier, this date based on 5.86 EFPY from 5/85 to reach 1% UB PWSCC]
1991 - 2	10CFR50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Jun 28, 1991			San Onofre 1, 150 gpd, leaking sleeve joint. Millstone 2, 70 gpd, SCC (U-bend). Millstone 2, 70 gpd, circum crack (TS)
1991 - 1		EOC10 Tubes plugged: TSP denting & SCC = 1 (284); hot leg roll = 0; pitting = 27 (353); other = 12 (435); Total = 40 (1072) current (cumulative). Used 100, 200, 400, and 600kHz multifrequency bobbin coil. Removed 1,334 lbs. of sludge.		
1990 - 4				Oconee 2, 130 gpd, fatigue. Shearon Harris, 50 gpd, loose part. Maine Yankee, 1,440 gpd, PWSCC.
1990 - 3	NRC IN 90-49, "Stress Corrosion Cracking in PWR SG Tubes," 8/6/90	T-hot increased from 574 F to 586 F.		North Anna 2, 40 gpd, cracked plug.
1990 - 2				Millstone 2, cracked plug.
1990 - 1			W-ODTSCC, "Informational Meeting," 2/90	St. Lucie 1, 3 gpd, foreign object. TMI 1, 1440 gpd, fatigue.
1989 - 4				

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1989 - 3			Technical Bulletin 89-05-R0 Minimum Auxiliary Feedwater Flow Rates	Palisades, 432 gpd, IGA/SCC at dented SP.
1989 - 2	NRC Bulletin 89-01-R2, sup. Westinghouse Tube Plug Degradation <sup>10</sup>		Technical Bulletin 89-02-R0 Saline Water for Long Term Cooling of Steam Generator	McGuire 1, 540 gpm, SCC. San Onofre 1, 706 gpd, leaking plug. Beaver Valley 2, 490 gpd, foreign object.
1989 - 1		EOC9 Tubes plugged: TSP denting & SCC = 57 (283); hot leg roll = 0; pitting = 75 (326); other = 12 (423); Total = 144 (1032) current (cumulative). Used 100, 200, 400, and 600kHz multifrequency bobbin coil. Removed 972 lbs. of sludge.		Palisades SG tube leak, 144 gpd, IGA/SCC at dented SP. Zion 2, 446 gpd, PWSCC R1. Kewaunee, 115 gpd, IGA/SCC. North Anna 1, 74 gpm, cracked plug.
1988 - 4	NRC IN 88-99: Detection and Monitoring of Sudden and/or Rapidly Increasing P/S Leakage, 12/20/88			Prairie Island 1 detected R1 U-bend defect in Huntington tube. [Occurred earlier, this date based on 15.28 EPY from 12/73 to reach 1% UB PWSCC.]
1988 - 3	NUREG 0844: "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity", Sept 1988	LKR Tubes plugged: TSP denting & SCC = 19 (226); hot leg roll = 0; pitting = 1 (251); other = 2 (411); Total = 1 (888) current(cumulative)		
1988 - 2	NRC IN 88-06: Foreign Objects in SGs, 2/29/88			
1988 - 1	NRC Bulletin 88-02: Rapidly Propagating Fatigue Cracks in Steam Generator Tubes, 2/5/88 (North Anna 1, high cycle fatigue upper SP)			

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1987 - 4		EOC8 Tubes plugged: TSP denting & SCC = 19 (226); hot leg roll = 0; pitting = 90 (250); other = 2 (411); Total = 111 (887) current (cumulative). Installed sentinel plugs in 2 tubes (13.5 mil hole, 0.35 gpm leak). Used 100, 200, 400, and 600 kHz.	W. Fatigue Cracking, Informational Meeting, 10/87
1987 - 3			EPRI Proceedings Report NP-5498, R. Bandy and D. van Rooyen, "Quantitative Examination of Stress Corrosion Cracking of Alloy 600 in High Temperature Water - Work During 1983," 1986 Workshop on Primary Side Stress Corrosion Cracking of PWR Steam Generator
1987 - 2			
1987 - 1			Technical Bulletin 87-20, EPRI, SC Closures and Pressurizer Manway Installation and Removal Recommendations
1986 - 4			
1986 - 3			
1986 - 2			
1986 - 1		EOC7 Tubes plugged: TSP denting & SCC = 33 (207); hot leg roll = 0; pitting = 76 (160); other = 3 (409); Total = 112 (776) current (cumulative). Used 100, 200, 400, and 600kHz multifrequency bobbin coil. Removed 332 lbs. of sludge. Tube leakage: 8.6	
1985 - 4			
1985 - 3			

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1985 - 2	NRC GL 85-02, Staff Recommended Actions Stemming From NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding SG Tube Integrity, 4/17/85		W/ PWSOC, Informational Meeting
1985 - 1		Four Model 44F replacement steam generators purchased. Thermally treated alloy 600 tubing instead of mill annealed alloy 600 and broached type 405 stainless steel support plates instead of drilled carbon steel support plates. (In monitored storage under	PRR Report NP-3791, "Development of a Model for Predicting Intergranular Stress Corrosion Cracking of Alloy 600 Tubes in PWR Primary Water," Y. S. Garud, January 1985
1984 - 4			
1984 - 3		1984 to Present: Used multifrequency bobbin coil probes as basic inspection tool. All inspections and analyses performed by Westinghouse. Probes with other coil configurations, both rotating and non-rotating, have been used to provide additional inform	
1984 - 2	NRC IN 84-49, Intergranular Stress Corrosion Cracking - Leading to SG Tube Failure, 6/18/84	EOC6 Tubes plugged: TSP denting & SCC = 84 (174); hot leg roll = 0; pitting = 84 (84); other = 0 (406); Total = 168 (664) current(cumulative). Used 100, 200, 400, and 600kHz multifrequency bobbin coil. Removed 1,393 lbs. of sludge.	
1984 - 1		LKR Tubes plugged: TSP denting & SCC = 1 (90); hot leg roll = 0; pitting = 0; other = 0 (406); Total = 1 (496) current (cumulative). Tube leakage: 0.25 gpm, SG 22, TTSH-Pit.	
1983 - 4			

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1983 - 3				
1983 - 2	NRC IN 83-24, Loose Parts in the Secondary Side of SGs at PWRs 4/28/83			Connecticut Yankee has severe denting problems and preventively plugs all R1 and R2 tubes due to hour-glassing.
1983 - 1				
1982 - 4		IP2 Licensing Amendment 81, 10/21/82, modifies Tech Spec to redefine the inspection requirements for the SG tubes.		
	NRC GI 82-32, Potential SG	EOC5 Tubes plugged: TSP denting tubes did not pass the 610 mil probe.	Technical Bulletin 82-07/R3, Carbon	
1982 - 2				
1982 - 1				
1981 - 4				
1981 - 3	Related Generic Requirements 9/26/82	LKR Tubes plugged: TSP denting & SCC = 2 (69); hot leg roll = 0; pitting = 0; U-bend PWSCC = 0; other = 0 (404); Total = 2 (479) current (cumulative). Used 100 and 400kHz bobbin coil. 40	Steel Tube Bulletin	Sequoia 2 - experienced leakage at R1 U-bend due to PWSCC, several Huntington tubes. [Occurred earlier, this date based on 2.46 EFPY from 6/82 to reach 1% UB PWSCC].
1982 - 3				
1981 - 2		LKR Tubes plugged: TSP denting & SCC = 8 (67); hot leg roll = 0; pitting = 0; other = 0 (404); Total = 8 (471) current (cumulative). Unspecified tube leak in SG23, dent 2C.	Technical Bulletin 81-06/R0, Moisture Separator Sludge	
1981 - 1			Technical Bulletin 81-01/R0, Steam Generator Support Bolts	

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE

Revision B, 6/22/2000

1980 - 4		EOC4 Tubes plugged: TSP denting & SCC = 16 (59); hot leg roll = 0; pitting = 0; other = 0 (404); Total = 16 (463) current (cumulative). Used 400kHz bobbin coil. Four tubes did not pass 610 mil probe.		
1980 - 3			Technical Bulletin 80-07-AR0 Radiography of S/C FW/Nozzle to Piping	
1980 - 2				
1980 - 1				
1979 - 4			Technical Bulletin 79-09-AR0, Check valve Slam in Steam Generator Feedwater Lines	
1979 - 3	NRC Bulletin 79-13, Pipe elbow/SG nozzle joint cracking	IP2 Licensing Amendment 58, 9/7/79, based on previous inspection, authorizes operation for up to 16 additional equivalent months before the next inspection of all SGs. IP2 Licensing Amendment 51, 3/19/79, revises Tech Spec concerning SG tube in	Technical Bulletin 79-08-AR0, Water Hammer in Steam Generator Feedwater Lines	
1979 - 2	NRC IN 79-27, SG Tube Ruptures at Two PWR Plants (11/16/71)	EOC3 Tubes plugged: TSP denting & SCC = 23 (43); hot leg roll = 0; pitting = 0; other = 3 (404); Total = 26 (447) current (cumulative). Used 400kHz bobbin coil. Tube leakage: 0.1 gpd, SG22, 11 tubes leaking.		Doel 2 - Row 1 U-bend apex crack - 135gpm (Ovalization), 3.2 EFPY Beznau 2 - Row 1 U-bend PWSCC, 2 Huntington tubes, caused forced outage.
1979 - 1				
1978 - 4		Secondary water chemistry 1978 - 1995: ammonia, hydrazine, and boric acid. See Table in Notes.		
1978 - 3		Addition of 5 - 10 ppm boric acid to secondary side for denting mitigation.		

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1978 - 2		Early 1970's restrictions (denting and constrictions) in tubing observed. Removed 15 inch long section with two rows of tubes and a strongback installed in then cutout. Affected tube stubs plugged. Ligament cracking observed between the flow slots.		
1978 - 1		EOC2 Tubes plugged: TSP denting & SCC = 8 (20); hot leg roll = 0; pitting = 0; other = 14 (401); Total = 22 (421) current (cumulative). Eleven tubes did not pass 700 mil probe. Used 400 kHz bobbin coil.		Beaver Valley 1 experienced PWSCC in R1 and R2 U-bends in Huntington tubing.
1977 - 4				
1977 - 3		IP2 Licensing Amendment 31, 6/28/77, establishes provisions for SG tube inspection that are consistent with the guidance contained in Reg. Guide 1.83, Rev. 1, dated July 1975. IP2 Licensing Amendment 30, 5/13/77, provides additional requirements f		
1977 - 2				
1977 - 1		Secondary water chemistry 1975 - 1978: ammonia and hydrazine. See Table in Notes. T-hot lowered to 574 F or 576 F to mitigate denting.	W-11B No. 77-04, SG Inspection Objectives, 2/25/77.	
1976 - 4		IP2 Licensing Amendment 23, 12/8/76, provides additional requirements for inspection of the SGs.		Surry 1 - 31 tubes removed from Rows 1, 2 & 3. PWSCC cracks on Row 1 tubes. Turkey Pt. 4 - 31 low Row U-bend (15 R1, 15R2, 1R3). PWSCC found only on R1, no through wall.

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE

Revision B, 6/22/2000

1976 - 3		MCO Tubes plugged: TSP denting & SCC = 3 (12); hot leg roll = 0; pitting = 0; other = 3 (387); Total = 6 (399) current (cumulative). Tube leakage: 4 gpm, SG24, dent 6C.	W-IB No. 76-07, Steam Generator Sludge, 6/23/76	Surry 2 - Row 1 U-bend PWSCC apex crack - 330gpm (TSP denting & hourglassing)
1976 - 2			W-IB No. 76-06, SG Tube Support Plate Cracking, 5/14/76	
1976 - 1	Reg. Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," 1976 issued for comment.	EOC1 Tubes plugged: TSP denting & SCC = 0 (9); hot leg roll = 0; pitting = 0; other = 0 (384); Total = 0 (393) current (cumulative)	W-IB No. 75-16, Localized SG Tube Diameter Reductions, 11/17/75	
1975 - 4		1973 - 1982: Primary method of tube exam was single frequency bobbin coil eddy current. Data collected by Con Edison and analysis by Westinghouse and Zetec. B&W performed mechanical profilometry, developed by Con Edison.	W-IB No. 75-12, Occurrence of Denting in SG Tubes, 10/15/75	
1975 - 3		Secondary water chemistry 1973 - 1975: phosphate and hydrazine. See Table in Notes.		
1975 - 2		Tubes plugged: TSP denting & SCC = 9 (9); hot leg roll = 0; pitting = 0; other = 0 (384); Total = 9 (393) current (cumulative). T-hot lowered to 581 F or 579 F to mitigate denting. Single frequency bobbin coil at 3.5, 100 and 400 kHz.		
1975 - 1	Reg. Guide 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes," Rev. 1, 1975	Baseline - Tubes plugged: TSP denting & SCC = 0; hot leg roll = 0; pitting = 0; other = 384; Total = 384 (384) current (cumulative). Converted from phosphate to AVT water chemistry. Used single frequency bobbin coil eddy current at 3.5. Tube leakage: 0		

INDIAN POINT 2 STEAM GENERATOR TUBE FAILURE TIMELINE  
Revision B, 6/22/2000

1973 - 0		During start-up in 1973, the T hot was 593 F or 591 F (design T hot is 650 F).		
----------	--	--	--	--