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U.S. Nuclear Regulatory Commission
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DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 2
END OF CYCLE 24 STEAM GENERATOR TUBE INSPECTION REPORT

In accordance with Millstone Power Station Unit 2 (MPS2) Technical Specification (TS) 6.9.1.9, Dominion Nuclear Connecticut, Inc. hereby submits the End of Cycle 24 Steam Generator Tube Inspection Report. The report is submitted within 180 days after initial entry into Mode 4 following completion of an inspection performed in accordance with TS 6.26, Steam Generator (SG) Program.

The report includes the following:

a. The scope of inspections performed on each SG,
b. Degradation mechanisms found,
c. Nondestructive examination techniques utilized for each degradation mechanism,
d. Location, orientation (if linear), and measured sizes (if available) of service induced indications,
e. Number of tubes plugged during the inspection outage for each degradation mechanism,
f. The number and percentage of tubes plugged to date, and the effective plugging percentage in each steam generator,
g. The results of condition monitoring, including the results of tube pulls and in-situ testing.

If you have any questions or require additional information, please contact Mr. Jeffry A. Langan at 860-444-5544.

Sincerely,

J. R. Daugherty
Site Vice President – Millstone Power Station

A001
NRR

Enclosures: (1)

Commitments made in this letter: None.

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ENCLOSURE

END OF CYCLE 24
STEAM GENERATOR TUBE INSPECTION REPORT

MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

End of Cycle 24 Steam Generator Tube Inspection Report

The acronyms used in the tables are defined in Attachment 1 of this enclosure.

In accordance with Millstone Power Station Unit 2 (MPS2) Technical Specification (TS) 6.9.1.9, Dominion Nuclear Connecticut, Inc. (DNC) is submitting this 180-day report which describes the results of the End of Cycle (EOC) 24 steam generator (SG) examinations which were performed during the MPS2 Refueling Outage 24 (2R24). Based upon entry into Mode 4 on May 1, 2017, this report is required to be submitted by October 28, 2017.

Background:

MPS2 is a two loop Combustion Engineering pressurized water reactor (PWR) with Babcock and Wilcox replacement SGs. Each SG is designed to contain 8523 U-bend thermally-treated Inconel 690 tubes. The tubing is nominally 0.750 inch outside diameter with a 0.0445 inch nominal wall thickness.

Secondary side tube support structures include seven lattice grid supports on the vertical section of the tubes and 12 fan bar assemblies in the U-bend section of the tubes. All lattice grid supports are full supports. All tube supports were fabricated with 410-series stainless steel.

The MPS2 SGs were replaced during 2R11 (1992). The SGs have accrued approximately 17.8 Effective Full Power Years (EFPYs) of operation as of the EOC 24 (April 2017). Since the first sequential period begins after the first inservice inspection, programmatically the MPS2 SGs have accrued 16.5 EFPYs.

See Attachment 2 of this enclosure, "Millstone Power Station Unit 2 Steam Generator Arrangement," for an illustration of SG component locations.

Report:

TS 6.9.1.9 reporting requirements (in bold text) are provided below, followed by DNC's response:

A report shall be submitted within 180 days after initial entry into MODE 4 following completion of an inspection performed in accordance with TS 6.26, Steam Generator (SG) Program. The report shall include:

a. The scope of inspections performed on each SG,

The MPS2 SG eddy current testing (ECT), conducted at the EOC 24 was completed on April 21, 2017. The examinations, personnel, and equipment conformed to the requirements of NEI 97-06, Rev. 3, Steam Generator Program Guidelines; Electric Power Research Institute Pressurized Water Reactor Steam Generator Examination Guidelines, Rev. 7; and MPS2 TSs.

The EOC 24 ECT inspection is summarized in Table 1. All of the operational tubes in both SGs (a total of 17,014 tubes), were inspected full length with bobbin probes. An augmented sample of 5,325 tube locations was inspected with rotating probe coils (RPCs).

The RPC examination in each SG included a 50% sample of the outer six rows of the hot and cold leg periphery and open tube lane at the top of tubesheet. The primary purpose of this examination was the detection of foreign objects or foreign object wear in the most susceptible regions of the SG. In addition, the RPC examinations included both a pre-planned scope, and 2R24 special interest (SI) emergent scope. The pre-planned scope included historical locations of interest, dents or dings (DNT or DNG), overexpansions or bulges (OXP or BLG), percent through-wall indications (%TW), and a sample of non-quantifiable historical indications (NQH). The emergent scope included 2R24 bobbin coil SI locations such as non-quantifiable indications (NQI), possible loose parts (PLP), and various hot leg and cold leg PLP bounding locations.

In addition to the ECT examinations, primary-side visual examinations were performed in both channel heads of each SG. These visual examinations (as-found/as-left), revealed no degradation of the divider plates, divider plate retaining bars/welds, primary closure rings/welds, or cladding. Visual examinations performed on all previously installed plugs identified no indications of plug degradation, leakage, or misplacement.

Secondary-side visual examinations were performed in both SGs. These examinations included:

- Post-sludge lancing visual examination of the top-of-tubesheet annulus and no-tube lane to assess as-left material condition and cleanliness, and to identify and remove any retrievable foreign objects.

- Visual investigation of accessible locations having eddy current indications potentially related to foreign objects, and removal of retrievable foreign objects.

- Steam drum visual inspections to evaluate the material condition and cleanliness of key components such as moisture separators, drain systems, and interior surfaces.

The results of all secondary-side visual examinations performed were satisfactory, with no degradation detected.

b. Degradation mechanisms found,

Fan bar wear and volumetric wear from foreign objects were the only degradation mechanisms found during the EOC 24 tube examinations. A listing of the flaws detected is provided in Table 3.

Fan Bar Wear

A total of four fan bar wear indications in four tubes were reported during the EOC 24 examinations (two indications in each SG). These four indications had been reported during previous examinations.

Secondary Side Foreign Object Wear

A comprehensive program was developed for detection of foreign objects and foreign object wear. This program consisted of planned examinations for known locations, a 50% examination of the outer six rows with the +Point™ probe, a 100% bobbin coil examination, bounding examinations with +Point™, secondary side inspection (SSI) of the top of tubesheet annulus and bundle periphery, and foreign object search and retrieval (FOSAR), as required. A total of 16 foreign object wear indications were identified.

Per Table 3, SG 1 (or SG 25) had one tube wear location that was newly detected with a wear depth of 23% in tube R92 C143, located approximately 11" above the hot leg tubesheet. A review of previous bobbin data indicates that this wear has been present in this tube since 1997; however, this was the first time that a +Point probe had been used at this location.

Also per Table 3, SG 2 (or SG 26) had 12 previously reported foreign object wear locations with no significant change in depth size from 2R22. SG 2 also reported three new wear locations in R122 C123 (34% TW), in R124 C123 (36% TW) and in R125 C122 (23% TW). None of these locations had an indication of a foreign object and FOSAR found no part at any of these locations.

With no significant change in the historical foreign object wear locations and no parts identified at the new foreign object wear locations, these tubes do not represent a threat to tube integrity over the next three cycles. The combination of the 100% bobbin coil examination of the full tube bundle, the +Point™ examination of the outer six rows of the periphery and open tube lane, and the SSI examination of the tubesheet annulus and periphery, there is reasonable assurance that there are no currently existing parts within the tube bundle high flow region that could threaten tube integrity over the next three cycles.

c. Nondestructive examination techniques utilized for each degradation mechanism,

Table 2 identifies the examination techniques used for each detected degradation mechanism.

d. Location, orientation (if linear), and measured sizes (if applicable) of service induced indications,

A listing of the tube degradation identified during 2R24 is provided in Table 3.

e. Number of tubes plugged during the inspection outage for each degradation mechanism,

No SG tubes were removed from service during 2R24.

f. The number and percentage of tubes plugged to date, and the effective plugging percentage in each steam generator,

Table 4 provides the total number of tubes plugged and the percentages.

g. The results of condition monitoring, including the results of tube pulls and in-situ testing.

No tubes were pulled and no in-situ pressure tests were performed. The condition monitoring assessment concluded that the structural integrity, operational leakage, and accident-induced leakage performance criteria were not exceeded during the operating interval preceding 2R24.

Table 1: Millstone End of Cycle 24 ECT Summary

	SG1	SG2	Total
Number of Installed Tubes	8523*	8523	17046
Number of Tubes In Service Prior to 2R24	8504	8510	17014
Number of Tubes Inspected F/L w/Bobbin Probe**	8504	8510	17014
Previously Plugged Tubes	19*	13	32
Number of Tubes Incomplete w/Bobbin Probe due to Obstruction	0	0	0
Number of Exams with +Point™ (Total)	2623	2702	5325
•Hot Leg Tubesheet TSH +3/-3 Periphery	1256	1269	2525
•Hot Leg Tubesheet PTE	1	0	1
•Hot Leg Tubesheet 01HTSH	3	7	10
•Hot Leg Tubesheet PLP Bounding	18	49	67
•Cold Leg Tubesheet TSC +3/-3 Periphery	1245	1253	2498
•Cold Leg Tubesheet 01CTSC	0	4	4
•Cold Leg Tubesheet TSC +10/-3	11	0	11
•Cold Leg Tubesheet PLP Bounding	22	30	52
•Hot Leg Special Interest	34	39	73
•U-Bend Special Interest	7	5	12
•Cold Leg Special Interest	6	11	17
•Hot Leg Additional RPC	20	22	42
•Cold Leg Additional RPC	0	13	13
Tubes with Max FB Wear ≥ 40 %	0	0	0
Tubes with Max FB Wear ≥20% but <40%	0	0	0
Tubes with Max FB Wear <20%	2	2	4
Tubes with Max SVI / VOL / WAR≥ 40 %	0	0	0
Tubes with Max SVI / VOL / WAR≥20% but <40%	1	13	14
Tubes with Max SVI / VOL / WAR<20%	0	2	2
Total Tubes Plugged as a Result of this Inspection	0	0	0

* One tubesheet location in SG 1 (R57 C156) was not drilled in the cold leg tubesheet. The hot leg hole for this tube was plugged with a welded plug. Although this location was never tubed, it is included in the counts of installed tubes and plugged tubes.

** A number of tubes were examined in hot leg / cold leg segments to achieve full length coverage.

Table 2: Detection and Sizing of Fan Bar and Loose Parts Induced Tube Wear

Classification	Degradation Mechanism	Location	Probe Type
Existing	Wear	Anti-Vibration Bars	Detection and Sizing - Bobbin
Existing	Tube Wear (Foreign Objects)	Freespan and TTS	Detection – Bobbin, +Point™ Sizing - +Point™

Table 3: Location, Orientation (If Linear), and Measured Sizes (If Applicable) of Service Induced Indications

SG	Row	Col	Location	ETSS	Axial Length (in)	Circ Length (in)	Maximum Depth 2R24	Depth Reported Prior Outage	Initially Reported	Signal Present Prior to Current Outage?	Cause	Foreign Object Remaining?	In-Situ Tested?	Plugged & Stabilized?
25	40	155	F06 - 1.76"	96041.3	3.15*	N/A	13% TW	12% TW 2R23	2R14	Yes	Fan Bar Wear	N/A	No	No
25	140	93	F08 - 0.66"	96041.3	3.15*	N/A	19% TW	14% TW 2R23	2R14	Yes	Fan Bar Wear	N/A	No	No
25	92	143	TSH + 10.91"	27901.1	0.24	0.37	23% TW	NDD 2R23	2R24	Yes	Foreign Object Wear	No	No	No
26	28	5	TSC + 21.65"	27901.1	0.28	0.43	25% TW	27% TW 2R22	2R15	Yes	Foreign Object Wear	No	No	No
26	29	4	TSC + 22.2"	27901.1	0.27	0.43	26% TW	25% TW 2R22	2R18	Yes	Foreign Object Wear	No	No	No
26	37	120	F07 - 0.83"	96041.3	3.15*	N/A	12% TW	8% TW 2R22	2R15	Yes	Fan Bar Wear	N/A	No	No
26	44	5	TSC + 17.91"	27902.1	0.43	0.38	10% TW	11% TW 2R22	2R20	Yes	Foreign Object Wear	No	No	No
26	59	10	TSC + 17.33"	27901.1	0.38	0.43	23% TW	24% TW 2R22	2R15	Yes	Foreign Object Wear	No	No	No
26	98	143	TSH + 8.76"	27901.1	0.33	0.37	20% TW	20% TW 2R22	2R18	Yes	Foreign Object Wear	No	No	No
26	99	80	F06 + 1.28"	96041.3	3.15*	N/A	13% TW	15% TW 2R22	2R15	Yes	Fan Bar Wear	N/A	No	No
26	118	41	TSH + 12.81"	27902.1	0.48	0.37	12% TW	12%TW 2R22	2R18	Yes	Foreign Object Wear	No	No	No
26	119	42	TSH + 12.97"	27903.1	0.38	0.43	29% TW	24% TW 2R22	2R18	Yes	Foreign Object Wear	No	No	No
26	122	123	TSH + 2.53"	27901.1	0.33	0.54	34% TW	NDD 2R22	2R24	No	Foreign Object Wear	No	No	No
26	123	46	TSH + 18.15"	27903.1	0.23	0.37	25% TW	22% TW 2R22	2R15	Yes	Foreign Object Wear	No	No	No
26	124	45	TSH + 19.27"	27903.1	0.38	0.32	31% TW	26% TW 2R22	2R18	Yes	Foreign Object Wear	No	No	No
26	124	123	TSH + 1.77"	27901.1	0.38	0.43	36% TW	NDD 2R22	2R24	No	Foreign Object Wear	No	No	No
26	125	48	TSH + 19.53"	27903.1	0.33	0.43	36% TW	32% TW 2R22	2R15	Yes	Foreign Object Wear	No	No	No
26	125	122	TSH + 1.36"	27902.1	0.53	0.37	23% TW	NDD 2R22	2R24	No	Foreign Object Wear	No	No	No
26	126	49	TSH + 19.97"	27903.1	0.49	0.48	39% TW	34% TW 2R22	2R15	Yes	Foreign Object Wear	No	No	No
26	128	107	TSH + 0.06"	27901.1	0.28	0.37	26% TW	29% TW 2R22	2R20	Yes	Foreign Object Wear	No	No	No

* Conservative assumed length

Table 4: Current Tube Plugging Status

	SG 1	SG 2
Tubes Plugged Prior to 2R24	19	13
Tubes Plugged During 2R24	0	0
Total Plugged Following 2R24	19	13
Percentage Plugged	0.22	0.15
Overall Percentage Plugged	0.19	

Since no sleeving has been performed in the MPS2 SGs, the effective plugging percentage is the same as the actual plugging percentage.

Attachment 1

Acronyms

B&W	Babcock & Wilcox
BLG	Bulge
CHN	Channel
C	Column
CM	Condition Monitoring
CMOA	Condition Monitoring and Operational Assessment
COL	Column
DEG	Degrees
DEP	Deposit
DNG	Ding
DNT	Dent
ECT	Eddy Current Testing
EFPY	Effective Full Power Years
ELEV	Elevation
EPRI	Electric Power Research Institute
ETSS	Examination Technique Specification Sheet
FB	Fan Bar
F/L	Full Length
FOSAR	Foreign Object Search and Retrieval
IGA	Intergranular Attack
LPI	Loose Part Indication
MBM	Manufacturing Burnish Mark
MPS2	Millstone Power Station Unit 2
NDD	No Degradation Detected
NDE	Non-Destructive Examination
NQH	Non-Quantifiable Historical Indication
NQI	Non-Quantifiable Indication
ODSCC	Outer Diameter Stress Corrosion Cracking
OXP	Over Expansion
PLP	Possible Loose Part
POD	Probability of Detection
PTE	Partial Tubesheet Expansion
PWSCC	Primary Water Stress Corrosion Cracking
%TW	Percent Through-Wall
R	Row
RPC	Rotating Probe Coil
SCC	Stress Corrosion Cracking
SG 1	Steam Generator Number 1
SG 2	Steam Generator Number 2
SI	Special Interest
SLG	Sludge
SSI	Secondary Side Inspection
SVI	Single Volumetric Indication
TEC	Tube End Cold-leg
TEH	Tube End Hot-leg
TSC	Top of Tube Sheet Cold-leg
TSH	Top of Tube Sheet Hot-leg
VOL	Volumetric Indication
WAR	Wear Indication

Attachment 2
Millstone Power Station Unit 2 Steam Generator Arrangement