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W3F1-2017-0044

November 21, 2017

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: 180 Day Steam Generator Tube Inspection Report for the 21st Refueling Outage
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

Attached is the 180 Day Steam Generator Tube Inspection Report for the 21st Refueling Outage for Entergy Operations, Inc. Waterford 3. This report is being submitted in accordance with Technical Specification 6.9.1.5 and provides the complete results of the Steam Generator Tube Inspection conducted during the 21st Refueling Outage.

This letter contains no new commitments.

If you have any questions or require additional information, please contact the Regulatory Assurance Manager, John P. Jarrell, at (504) 739-6685.

Sincerely,

JPJ/mb

Attachments: Waterford 3 Steam Electric Station 180-Day Steam Generator Tube Inspection Report for the 21st Refueling Outage

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Attachment

to

W3F1-2017-0044

Waterford 3 Steam Electric Station
180-Day Steam Generator Tube Inspection Report for the 21st Refueling Outage

Waterford 3 Steam Electric Station (Waterford 3)
180-Day Steam Generator (SG) Tube Inspection Report
for the 21st Refueling Outage (RF21)

During this period of reporting, Waterford 3 had one inspection. In April 2017, Entergy performed the second in-service inspections on the replacement steam generators. These generators were installed during the refuel outage eighteen (RF-18) and were placed in service in January 2013.

Waterford 3 (WF3) Technical Specification (TS) 6.9.1.5 requires Entergy Operations to submit a 180 day report to the NRC that outlines the details of the steam generator (SG) tubing inspections that were performed during the reporting period. The report shall include:

Technical Specification 6.9.1.5

A. The Scope of Inspections Performed on Each Steam Generator

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

DESIGN

The replacement steam generators for Waterford 3 are a Westinghouse Delta 110 design. The tube bundle consists of 8968 U-tubes fabricated from thermally treated Alloy 690. The tubing material complies with the requirements of ASME Section II SB-163, ASME Section III, NB-2000. The nominal outside diameter (OD) of each U-tube is 0.75 in. The nominal tube wall is .044 inches thick for tube rows 1 and 2 and .043 inches thick for all other tube rows (rows 3 through 138). The ends of the tubes are expanded the full depth of the tubesheet and welded to the cladding on the tubesheet primary side.

The tubes are supported on the secondary side by eight (8) tube support plates.
The tube support plate material is stainless steel (ASME SA-240, Type 405). All tube support plates have trefoil-shaped holes arranged on a triangular pitch, produced by broaching, to reduce the potential for tube dry out and chemical concentration in the regions where the tubes pass through the tube support plates.

Five (5) sets of anti-vibration bars (AVBs) are installed to provide support for the U-bend region of the tube bundle. The anti-vibration bar assemblies stiffen the U-bend region of the tube bundle and facilitate proper tube spacing and tube alignment while mitigating tube vibration. The first set of anti-vibration bar assemblies are installed into the U-bend to a depth of, and including, row five (5). The second set of anti-vibration bar assemblies are installed into the U-bend to a depth of, and including, row eighteen (18). The third set of anti-vibration bar assemblies are installed into the U-bend to a depth of, and including, row thirty-four (34). The fourth set of anti-vibration bar assemblies are installed into the U-bend to a depth of, and including, row fifty-five (55). The fifth set of anti-vibration bar assemblies are installed into the U-bend to a depth of, and including, row eighty-four (84), except for one special bar that is inserted to row eighty-three (83). Each anti-vibration bar assembly consists of a “V” shaped, rectangular bar of stainless steel (ASME SA-479, Type 405) and two (2) end caps of thermally treated Alloy 690 (ASME SB-166, Alloy UNS N06690). Each end of each anti-vibration bar assembly is secured to the U-bend peripheral retaining rings of thermally treated Alloy 690 (ASME SB-166, Alloy UNS N06690) by welding the corresponding end cap with SFA-5.14 CL. ERNiCrFe-7 weld metal. Twenty (20) U-shaped retainer bars of chrome plated, thermally treated Alloy 690 (ASME SB-166, Alloy UNS N06690) are installed between several U-tubes. Both ends of the U-shaped retainer bar are welded with SFA-5.14 CL. ERNiCrFe-7 weld metal to the anti-vibration bar retaining ring of each anti-vibration bar set. These retainer bars provide support to the anti-vibration bar assemblies during seismic and postulated steam line break loading conditions.

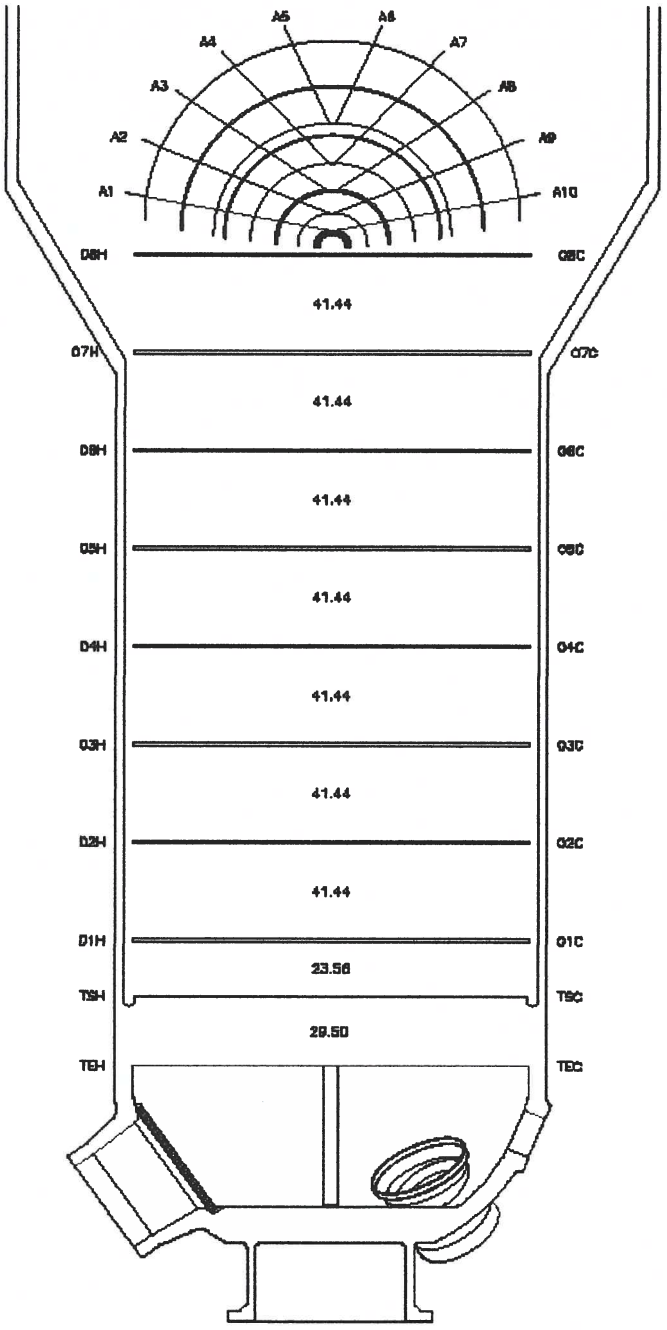

FIGURE 1

Waterford-3 Delta 110
Steam Generator Design

Table 1
Waterford 3 steam Generator Primary Inspection Plan

Outage	Year	Cycle EFPM	SG Cumulative EFPM	Inspection Period EFPM	Sequential Inspection Period	Notes
RF19	2014	14.6	14.6	N/A	N/A	First ISI
RF20	2015	17.1	31.7	17.1	First	No Inspection
RF21	2017	15.8	47.5	32.9	First	Inspect
RF22	2019	(est) 18.8	(est) 66.3	(est) 51.7	First	No Inspection
RF23	2020	(est) 18.4	(est) 84.7	(est) 70.1	First	No Inspection
RF24	2022	(est) 18.0	(est) 102.7	(est) 88.1	First	Inspect

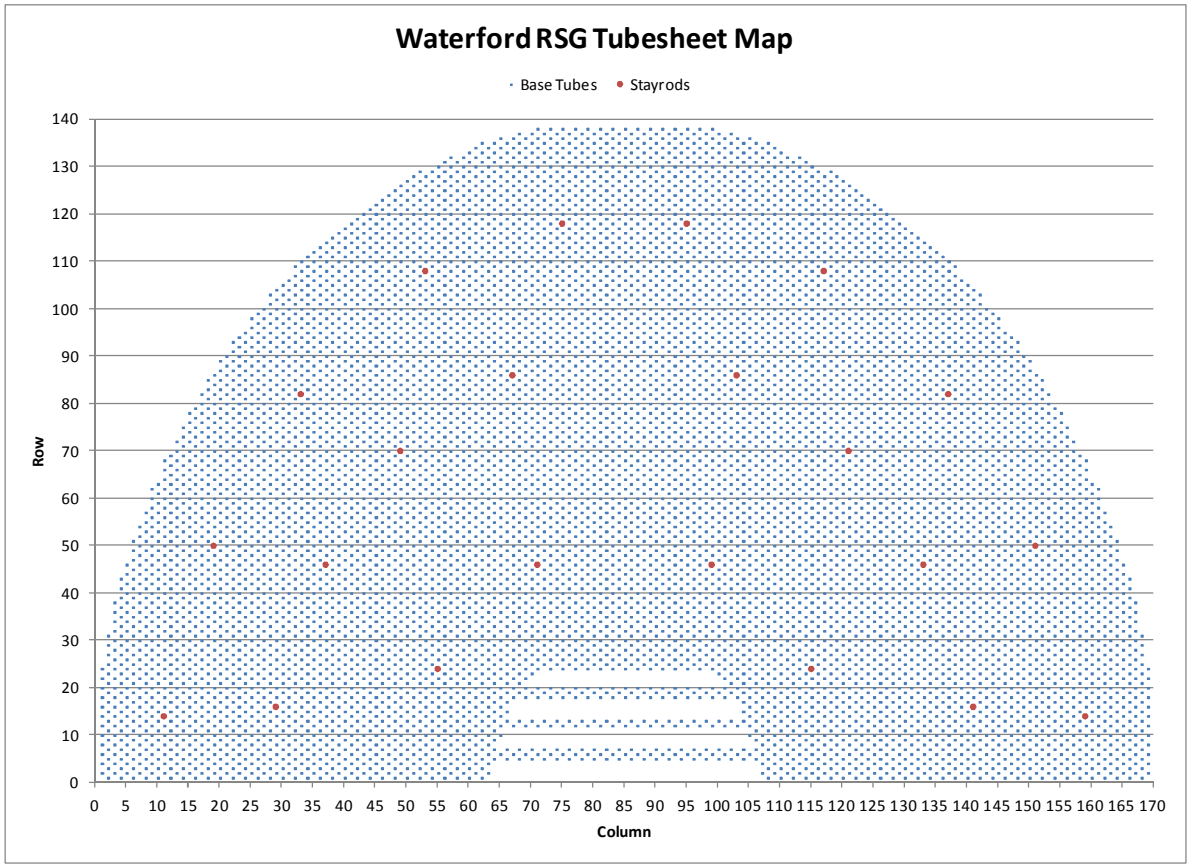

FIGURE 2

Waterford-3 Delta 110
Steam Generator Tubesheet

A. The Scope of Inspections Performed on Each Steam Generator

The RF21 inspection plan included:

- 100% 0.610 inch bobbin coil inspection full length; Rows 11 and above at 80 ips and 100% Rows 10 and below at 24 ips
- +Pt inspection of hot and cold leg TTS (Top of Tube Sheet) +/- 3 inches for detection of PLPs (Potential Loose Parts) (periphery, tube lane, central tube void region)
- +Pt special interest testing as necessary including:
  - Any freespan bobbin I-code
  - Any bobbin I-code at a TSP (Tube Support Plate) intersection
  - Any AVB (Anti Vibration Bar) wear indication >15%TW based on bobbin coil analysis
  - Possible loose parts/foreign object (PLP) signals including a 2-deep pattern of all immediately surrounding tubes until PLP signals are no longer reported (i.e., "boxing")
  - Freespan dings >5V [(1)]
  - TSP dents >2V [(2)]
  - Bulge (BLG) with preferential selection based on bobbin coil 600 kHz signal amplitude >18V
  - Over-expansions (OXP) above the TTS
- Pancake coil RPC (Rotating Pancake Coil) special interest testing of bobbin PRX (Proximity) signals >1V

Tube plug visual inspection

- Channel head bowl visual inspection per NSAL-12-1 including divider plate to channel head juncture

(1) SCC (Stress Corrosion Cracking) at freespan dings is judged non-relevant, similarly, freespan wear is judged non-relevant in the absence of foreign objects. The recommended +Pt inspection of >5V dings is performed to satisfy the full length testing requirement and to establish that foreign objects are not present.

(2) As no industry qualification for the detection of wear in dented TSP intersections is available, the +Pt inspection of dented TSP intersections is performed to establish that no wear is present.

Primary Bowl Examinations

The hot leg and cold leg primary side channel heads in each SG were visually inspected during the RF21 outage. The inspections have been prompted by industry experience where exposure, and in some cases wastage, of the carbon steel channel head pressure boundary has occurred as result of a breach in the stainless steel cladding and/or in the divider plate-to-channel head cladding. The visual inspection results performed during RF21 did not identify any anomalies or degradation of the channel head cladding or associated welds.

The Secondary Side Inspection and FOSAR

The inspection plan was developed to specifically address the areas of potential degradation due to recent industry inspection results. These included:

a. FOSAR of annulus region at the top of the tubesheet

b. Visual inspections of the upper steam drum and support structures

c. Visual inspection of the feed ring, spray nozzles and support structures.

Steam drum region inspections performed at RF21 were quite extensive and included:

Steam outlet nozzle venturis
Mid-deck region
Primary separator ID above swirl vanes
Lower deck region
Spray cans
Feedring ID region
Feedring structural supports
Thermal sleeve to nozzle/pipe welds
Sludge collector internals

The upper steam drum region was inspected in both SG31 and SG32 during Waterford Unit 3 RF21. A total of four (4) foreign objects were identified during the steam drum inspections. The identified foreign objects were entered into Entergy's Corrective Action Program with Condition Reports. All foreign objects identified during the steam drum inspections were removed from the SGs.

The objects identified included a piece of weld slag located in a secondary separator drain cup and a second smaller piece of weld slag located in a feedring spray nozzle of SG31. There were also two small machine curls identified on the outer surface of the feedwater ring in SG32. No structurally significant anomalies which could impact the integrity of the SG tubing were observed during inspection of the components in the upper steam drum regions of SG31 and SG32.

No foreign objects were identified during the FOSAR at the top of the tubesheet in either SG.

Visual inspection of the upper steam drum components identified no anomalies. As the moisture separation equipment is constructed using carbon steels with measurable chrome content or nickel-based alloys, erosion/corrosion of these components is not expected.

The W3 steam generator feedring utilizes a spray can design. The diameter of the holes in the spray cans is slightly less than the minimum tube-to-tube dimension in the pitch direction of 0.28 inch, and can effectively act as foreign material screens. This design feature certainly caused one of the loose parts to remain captured in the feedring.

B. Degradation Mechanisms Found

At RF19 the first Service Induced degradation was identified as wear at the AVBs in both SG31 and SG32. There were four tubes preventatively plugged (PTP) in SG32 which enabled the Cycle 20 and 21 Operational Assessment to successfully analyze a 2 cycle Operating Interval.

At RF21, wear at the TSPs was detected as the second Service Induced degradation mechanism, in addition to wear at the AVBs, in both SG31 and SG32. These indications are provided in Table D-1 for SG31 AVBs, D-2 for SG31 TSPs, D-3 for SG32 AVBs and Table D-4 for SG32 TSPs. There were three (3) tubes plugged in SG31 and twenty four (24) tubes plugged in SG32 which enables the Operational Assessment to successfully analyze a 3 cycle Operating Interval.

C. Nondestructive Examination Techniques Utilized for Each Degradation Mechanism

Summary of SG Tube Degradation Mechanisms and Inspection Requirements: Detection Information: Waterford 3 RF21							
Degradation Mechanism	**Location**	**Probe Type**	**EPRI Technique Sheet (1)**	**Detection Variable**	**Appendix H or I Qualified**	**Inspection Sample Plan**	**Expansion Plan**
Existing Degradation Mechanisms:							
Wear (service induced)	AVBs	0.610 inch Bobbin	ETSS 96004.1 (2)	Phase	Yes	100% full length	No Expansion
		0.610 inch +Pt (confirmation)	ETSS 10908.4	Phase	Yes	Indications ≥15% TW by bobbin and any new indications	No Expansion
Potential Degradation Mechanisms							
Wear (service induced)	TSPs	0.610 inch Bobbin (detection)	ETSS 96004.1 (2)	Phase	Yes	100% full length, both SGs	No Expansion
		0.610 inch +Pt (confirmation)	ETSS 96910.1	Phase	Yes	100% bobbin indications	No Expansion
Wear	Dented AVB and TSP >2V	0.610 inch +Pt	ETSS 10908.4 ETSS 96910.1	Phase	Yes	100%	No Expansion
Volumetric Degradation (not corrosion related) and General Tube Signal Identification	Freespan	0.610 inch Bobbin	ETSS I28413	Phase	Yes	100% full length, both SGs	+Point boxing-in to bound PLPs
		0.610 inch +Pt (confirmation)	See Notes 3&4	Phase	Yes	Any bobbin I-code freespan or at tube supports	No expansion
	Freespan dings ›5V	0.610 inch +Pt	ETSS 22401.1	Phase	Yes	100%	No expansion
PLP Identification and General Tube Signal Identification	TTS (both legs)	0.610 inch +Pt	See Notes 3&4	Phase	Yes	Sampling of peripheral tubes, Hot and Cold Legs TTS +/- 3 inches	+Point boxing-in to bound PLPs and indications
	Freespan, including U-bends	0.610/0.600 inch Bobbin	ETSS I28413	Phase	Yes (5)	100% full length, both SGs	No Expansion
Potential Manufacturing Buff Marks	All	0.610 inch Bobbin	ETSS 96010.1	Phase	Yes	100% full length	No Expansion
		0.580 or 0.610 inch +Pt	See Note 3	Phase	Yes	+Point MBIs	No Expansion

Notes for above Table:

(1): The Acquisition and Analysis Technique Sheets (ACTS and ANTS) detail the plant-specific guidelines for application of the EPRI ETSSs.

(2): ETSS 96004.1 will be applied for detection. Sizing will be performed according to ETSS 96041.1 for AVBs and ETSS 96043.1 for TSPs.

(3): ETSSs 20510, 20511, 21409, 21410, and I228425 are qualified for the detection of axial and circumferential ODSCC and PWSCC. The initial phase setup, initial span setting, and signal analysis methodology of each is consistent. Thus either of these techniques can be used for the resolution of extraneous bobbin indications. As these techniques are qualified for detection of SCC, sensitivity to volumetric degradation will be increased as volumetric degradation will produce larger signal amplitudes for equal depth compared to SCC indications. Analysts should be cautioned to adjust the span setting if a saturated condition is observed.

(4): Depth sizing of foreign object induced tube wear can be accomplished using any of the following ETSSs:

- ETSS 21998.1
- ETSS 27901.2
- ETSS 27902.2
- ETSS 27903.2
- ETSS 27904.2
- ETSS 27905.2
- ETSS 27906.2
- ETSS 27907.2

Each of these ETSSs use peak-to-peak amplitude for the depth sizing curve.

(5): While the various industry ETSSs for bobbin coil in freespan do not exclude small radius U-bends, practical application has been to utilize a supplemental probe (e.g. +POINT probe) for small radius U-bends. The W3 SG Row 1 bend tangent noise is less than Row 5 bend tangent noise in other Westinghouse SGs. Therefore the use of bobbin at a reduced pull speed for small radius U-bends at Waterford will provide an adequate inspection for general tube signal characterization.

Summary of SG Tube Non-flaw Signal Disposition Categories Applicable Inspection: Waterford 3 RF21						
Degradation Mechanism	**Location**	**Probe Type & No.**	**EPRI Technique Sheet**	**Detection Variable**	**Inspection Sample Plan**	**Expansion Plan**
Resolution for Classification of Extraneous Indications						
Dings, Dents, PVN	All	0.610 inch Bobbin Coil	ETSS I28413	Phase	100% full length, both SGs	Expansion according to degradation mechanism confirmed
		0.610/0.580 inch +Pt or Mag Bias +Pt for PVN as needed	ETSS 22401.1 ETSS 22841.1	Phase	100% Dings >5V, 100% Dents › 2V, PVN >1V	
Anomalous Tubesheet Signals	Tubesheet expansion joint	0.610 inch 3-coil +Pt	ETSS 20510.1 ETSS 20511.1	Phase	BLG above TTS, DTI in tubesheet	
Tube-to-Tube Proximity	U-bends	0.610 inch Bobbin Coil	N/A, see Reference (A)	Vertical maximum voltage and phase	100% full length, both SGs	None
		0.580 inch pancake coil	N/A, see Reference (A)	Vertical maximum voltage and phase	Bobbin PRX >1V	None
Tube-to-AVB Proximity (B)	U-bends	0.580 inch pancake coil	N/A, see Reference (A)	Peak-to-Peak voltage	None	Sampling may be performed based on inspection results

Notes for above Table:

(A): LTR-SGMP-12-42, Revision 1, “Waterford RSG Tube-to-Tube and Tube-to-AVB Proximity Testing Summary,” July 2012

(B): This inspection is not planned for RF21 but may be applied in the event that diagnostic testing to examine AVB wear patterns is performed.

D. Location, Orientation (If Linear), and Measured Sizes (if Available) of Service Induced Indications

Table D-1 – SG31 Service Induced Indications – Wear at AVBs

Table D-2 – SG31 Service Induced Indications – Wear at TSPs

Table D-3 – SG32 Service Induced Indications – Wear at AVBs

Table D-4 – SG32 Service Induced Indications – Wear at TSPs

E. Number of Tubes Plugged During The Inspection Outage for Each Degradation Mechanism

Table E-1

Tube Status	SG-31	SG-32
Tubes in Original Steam Generators	8968	8968
Total Number of tubes previously removed from service	0	4
Repair Candidates from RF21:		
Service Induced Wear at AVBs	1	24
Service Induced Wear at TSPs	2	0
Total Candidate Tubes Repaired	**3**	**24**
Total Repair	**SG-31**	**SG-32**
Total Stabilizers Installed – RF21	0	0
Total Tubes Plugged – Post RF21	3	28
Total SG % Plugged – Post RF21	0.03%	0.31%

F. The Number and Percentage of Tubes Plugged to Date, and the Effective Plugging Percentage in Each Steam Generator

Table F-1

Year	Outage	EFPY	SG31 Plugs	SG32 Plugs	Total	Cumulative Plugging
2012	Pre-Service	0	0	0	0	0
2014	RF19	1.20	0	4	4	4
2017	RF21	4.0	3	24	27	27
Total Plugged to Date			**3**	**28**		**31**
Percent Plugged to Date			**0.03%**	**0.31%**		**0.17%**

Table F-1
Effective Plugging Percentage

Generator	# Plugged	% Plugged
SG31	3	0.03%
SG32	28	0.31%

G. The Results of Condition Monitoring, Including the Results of Tube Pulls and In-Situ Testing

Waterford 3 did not perform any tube pulls or in-situ testing during the RF21 inspection. Based on the Waterford 3 RF21 inspection results, no tubes contained indications which represented a challenge to structural or leakage integrity and all condition monitoring requirements are satisfied.

No primary to secondary leakage is predicted for the eddy current indications observed during the inspection in the event of a postulated SLB event.

Waterford 3 has a current Plant Specific Leakage limit of 0.375 gallons per minute for an "accident-induced leakage limit". The predicted leakage is zero, thus the accident-induced leakage limit is met.

OVERALL CONCLUSIONS

During the Waterford 3 second in-service steam generator tube inspection, no indications were found exceeding the structural integrity limits (i.e., burst integrity > 3 times normal operating primary to secondary pressure differential across SG tubes).

Therefore, no tubes were identified to contain eddy current indications that could potentially challenge the tube integrity requirements of NEI 97-06. Similarly, all operational assessment structural and leakage integrity requirements are satisfied. Based on the observed indications, the Waterford 3 SGs are expected to meet all structural and leakage integrity requirements at (End Of Cycle) EOC-24 when the third in-service inspection will be performed.

Table D-1 – SG31 Service Induced Indications – Wear at AVBs

SG	ROW	COL	VOLTS	%	LOCN	INCH	Comment
31	49	8	0.12	8	A09	-0.14	
31	81	66	0.14	8	A04	-0.09	
31	99	66	0.21	11	A07	-0.05	
31	106	71	0.19	10	A07	-0.05	
31	91	72	0.15	10	A08	-0.12	
31	97	72	0.13	9	A06	0.00	
31	64	73	0.15	9	A08	0.15	
31	82	73	0.13	8	A07	0.10	
31	57	74	0.14	9	A07	-0.38	
31	99	74	0.21	11	A05	0.00	
31	99	74	0.16	9	A08	-0.05	
31	99	76	0.23	13	A08	0.09	
31	83	78	0.48	20	A07	-0.08	
31	114	79	0.44	17	A06	0.09	
31	134	79	0.18	11	A08	-0.05	
31	81	80	0.13	8	A07	-0.16	
31	85	80	0.19	10	A05	0.00	
31	95	80	0.16	10	A07	-0.14	
31	105	80	0.33	17	A06	0.00	Plugged
31	105	80	0.09	7	A07	0.00	
31	70	81	0.13	8	A07	-0.08	
31	96	81	0.13	8	A05	0.00	
31	96	81	0.12	7	A06	0.05	
31	97	82	0.15	8	A04	0.05	
31	97	82	0.21	11	A05	0.08	
31	99	82	0.41	17	A06	-0.04	
31	68	83	0.18	11	A07	0.07	
31	78	83	0.17	10	A04	-0.15	
31	92	83	0.26	13	A04	0.00	
31	85	84	0.2	11	A08	-0.18	
31	96	85	0.2	10	A07	-0.14	
31	64	87	0.15	9	A03	-0.14	
31	123	88	0.15	9	A06	-0.06	
31	123	88	0.11	7	A08	-0.15	
31	98	89	0.12	8	A06	0.00	
31	99	90	0.16	9	A04	0.09	
31	109	92	0.13	9	A05	-0.20	
31	94	93	0.14	8	A07	0.03	

31	105	94	0.16	9	A06	-0.16	
31	95	96	0.19	11	A08	0.00	
31	82	153	0.1	7	A08	0.22	
31	48	163	0.13	8	A08	-0.33	
31	43	166	0.2	11	A08	0.21	

Table D-2 – SG31 Service Induced Indications – Wear at TSPs

SG	ROW	COL	VOLTS	%	LOC	INCH	Comment
31	4	1	0.31	7	06C	0.43	
31	4	1	0.24	5	05C	-0.64	
31	4	1	0.2	4	04C	0.40	
31	6	1	0.22	5	05C	-0.48	
31	6	1	0.15	3	04C	-0.45	
31	1	2	0.73	17	07C	0.00	
31	1	2	0.19	4	05C	-0.59	
31	5	2	0.2	4	06C	-0.67	
31	5	2	0.18	4	05C	0.35	
31	1	4	0.36	8	06C	-0.56	
31	1	4	0.53	12	05C	0.00	
31	1	4	0.66	15	04C	0.00	
31	4	5	0.13	3	06C	-0.45	
31	4	5	0.16	3	05C	-0.64	
31	4	5	0.19	4	04C	-0.43	
31	1	6	0.37	8	07C	0.00	
31	1	6	0.91	21	05C	0.00	Plugged
31	1	6	0.34	8	04C	0.00	
31	3	6	0.25	5	06C	0.43	
31	3	6	0.18	4	04C	-0.64	
31	1	8	0.3	7	06C	0.30	
31	4	11	0.18	4	06C	0.40	
31	1	12	0.23	5	06C	0.40	
31	6	13	0.17	4	05C	0.37	
31	1	14	0.19	4	06C	0.38	
31	3	14	0.27	6	06C	0.38	
31	2	15	0.21	5	06C	0.43	
31	80	17	0.22	5	05C	-0.60	
31	8	21	0.19	4	06C	-0.53	
31	4	25	0.37	8	06C	0.43	
31	1	28	0.16	3	03C	-0.51	

31	5	30	0.19	4	06C	0.40	
31	2	31	0.28	6	06C	-0.53	
31	2	31	0.13	3	03C	-0.48	
31	7	34	0.26	6	06C	0.35	
31	2	35	0.27	9	07C	0.00	
31	2	35	0.36	8	06C	0.43	
31	1	36	0.15	3	05C	-0.61	
31	1	44	0.14	3	03C	-0.48	
31	5	52	0.24	5	04C	0.30	
31	6	53	0.23	5	04C	0.53	
31	1	60	0.27	6	06C	0.32	
31	1	62	0.18	4	05C	-0.48	
31	3	62	0.17	4	04C	0.40	
31	4	63	0.27	6	06C	-0.29	
31	15	64	0.19	4	06C	-0.66	
31	136	67	0.22	5	05H	-0.67	
31	5	72	0.16	3	04C	-0.62	
31	6	75	0.29	6	07C	0.00	
31	12	75	0.34	8	07C	-0.63	
31	12	75	0.28	6	06C	0.00	
31	12	75	0.2	4	05C	0.00	
31	136	91	0.36	8	05H	-0.70	
31	18	93	0.33	7	05C	0.43	
31	138	99	0.24	5	05H	-0.69	
31	2	109	0.24	5	03C	0.48	
31	2	109	0.12	2	02C	-0.56	
31	1	112	0.43	10	05C	0.19	
31	1	112	0.43	14	04C	0.00	
31	1	112	0.44	10	03C	-0.16	
31	2	113	0.19	6	06C	-0.11	
31	2	113	0.2	4	04C	0.00	
31	2	113	0.16	5	03C	-0.05	
31	1	114	0.26	14	07C	0.00	
31	1	114	0.51	29	06C	0.00	
31	1	114	1.08	36	05C	0.46	Plugged
31	1	114	1.07	26	04C	0.00	
31	1	114	0.44	17	03C	0.00	
31	2	117	0.19	6	06C	-0.08	
31	6	127	0.23	5	05C	0.35	
31	7	128	0.17	4	05C	0.40	
31	8	129	0.22	5	05C	0.40	

31	4	133	0.28	6	04C	0.35	
31	1	134	0.23	5	06C	0.00	
31	9	134	0.18	4	06C	-0.67	
31	1	138	0.57	13	06C	0.38	
31	1	138	0.21	5	05C	0.43	
31	1	138	0.25	5	04C	0.51	
31	6	139	0.2	4	06C	0.43	
31	7	140	0.23	5	04C	0.40	
31	1	142	0.19	4	04C	0.40	
31	4	143	0.24	5	06C	0.40	
31	1	164	0.35	8	06C	0.30	

Table D-3 – SG32 Service Induced Indications – Wear at AVBs

SG	ROW	COL	VOLTS	PER	LOC	INCH	Comment
32	81	64	0.13	7	A07	0.00	
32	99	68	0.33	13	A05	-0.05	
32	99	68	0.18	9	A06	0.00	
32	99	72	0.22	12	A04	0.00	
32	76	73	0.14	9	A07	0.00	
32	78	73	0.12	8	A07	0.00	
32	92	73	0.11	7	A08	0.00	
32	94	73	0.19	11	A04	0.00	
32	98	73	0.14	9	A06	0.00	
32	110	73	0.12	7	A08	0.00	
32	81	74	0.29	13	A04	0.00	
32	87	74	0.25	12	A05	0.00	
32	99	74	0.19	9	A08	0.00	
32	115	74	0.13	7	A08	0.11	
32	78	75	0.14	7	A07	0.05	
32	84	75	0.12	7	A05	0.00	
32	86	75	0.28	13	A05	-0.12	
32	98	75	0.18	9	A05	0.33	
32	98	75	0.29	13	A06	0.02	
32	110	75	0.14	7	A06	-0.07	
32	110	75	0.26	12	A07	0.00	
32	126	75	0.13	7	A07	0.00	
32	126	75	0.24	11	A08	0.00	
32	130	75	0.27	12	A05	0.00	
32	95	76	0.11	7	A06	0.00	

32	97	76	0.28	14	A07	0.00	
32	101	76	0.13	8	A06	0.00	
32	101	76	0.65	23	A08	0.00	Plugged
32	121	76	0.16	10	A07	0.00	
32	127	76	0.12	8	A05	0.00	
32	76	77	0.1	7	A07	0.00	
32	80	77	0.12	8	A07	0.00	
32	80	77	0.14	8	A08	0.00	
32	92	77	0.2	11	A05	0.00	
32	92	77	0.27	14	A06	0.00	
32	96	77	0.17	10	A04	0.00	
32	98	77	0.17	10	A06	0.00	
32	98	77	0.13	8	A07	0.00	
32	104	77	0.22	12	A05	0.00	
32	112	77	0.27	14	A06	0.00	
32	99	78	0.14	8	A04	0.02	
32	101	78	0.22	11	A05	0.00	
32	103	78	0.88	25	A05	0.00	Plugged
32	105	78	0.19	10	A05	-0.02	
32	107	78	0.41	16	A05	0.00	
32	109	78	0.15	8	A05	0.00	
32	113	78	0.54	19	A05	0.00	
32	113	78	0.84	25	A06	0.00	Plugged
32	113	78	0.3	13	A07	0.00	
32	82	79	0.17	8	A04	-0.06	
32	92	79	0.18	9	A07	0.00	
32	92	79	0.31	14	A08	0.00	
32	94	79	0.19	10	A08	0.03	
32	112	79	0.2	10	A07	0.07	
32	112	79	0.25	11	A08	-0.10	
32	114	79	0.41	16	A07	0.00	
32	114	79	0.54	19	A08	-0.07	
32	124	79	0.19	10	A05	0.00	
32	126	79	0.31	14	A05	-0.05	
32	130	79	0.22	11	A05	0.00	
32	89	80	0.1	7	A04	0.00	
32	91	80	0.2	11	A05	0.00	
32	95	80	0.16	10	A05	0.00	
32	97	80	0.1	7	A09	0.00	
32	99	80	0.66	23	A05	0.39	Plugged
32	99	80	0.54	21	A06	0.24	

32	101	80	0.12	7	A05	0.00	
32	105	80	0.19	11	A06	0.00	
32	107	80	0.16	10	A05	0.00	
32	109	80	0.15	9	A05	0.00	
32	111	80	0.26	14	A05	0.00	
32	115	80	0.24	13	A04	0.00	
32	115	80	0.63	22	A05	0.00	Plugged
32	115	80	0.16	10	A06	0.00	
32	115	80	0.29	14	A07	0.00	
32	115	80	0.11	7	A08	0.00	
32	117	80	0.24	13	A05	0.00	
32	117	80	0.11	7	A06	0.00	
32	117	80	0.67	23	A07	0.00	Plugged
32	123	80	0.13	8	A04	0.00	
32	123	80	0.12	7	A05	0.00	
32	123	80	0.13	8	A06	0.00	
32	123	80	0.12	7	A08	0.00	
32	127	80	0.14	9	A05	0.00	
32	70	81	0.13	8	A07	0.00	
32	86	81	0.18	10	A07	0.00	
32	88	81	0.66	23	A05	0.00	Plugged
32	88	81	0.37	17	A06	0.00	
32	94	81	0.16	9	A05	0.00	
32	94	81	0.2	11	A07	0.00	
32	98	81	0.28	14	A07	0.00	
32	98	81	0.16	10	A08	0.00	
32	104	81	0.15	9	A07	0.00	
32	110	81	0.19	11	A08	0.00	
32	112	81	0.33	15	A07	0.00	
32	114	81	0.16	9	A05	0.00	
32	114	81	0.24	13	A06	0.00	
32	114	81	0.28	14	A08	0.00	
32	118	81	0.12	8	A07	0.00	
32	122	81	0.27	14	A07	0.00	
32	124	81	0.14	8	A06	0.00	
32	91	82	0.25	12	A07	0.10	
32	93	82	0.32	14	A04	0.00	
32	103	82	0.69	22	A08	-0.10	Plugged
32	103	82	0.33	14	A09	0.00	
32	107	82	0.26	12	A07	0.12	
32	113	82	0.13	7	A05	-0.02	

32	117	82	0.13	7	A06	-0.09	
32	117	82	0.28	12	A08	0.00	
32	127	82	0.37	15	A05	0.00	
32	127	82	0.13	7	A06	-0.17	
32	129	82	0.16	8	A05	0.00	
32	129	82	0.66	22	A06	0.00	Plugged
32	129	82	0.19	9	A08	0.00	
32	133	82	0.46	17	A06	-0.22	Plugged
32	84	83	0.15	8	A06	-0.50	
32	88	83	0.17	8	A06	0.00	
32	90	83	0.13	7	A07	-0.10	
32	92	83	0.19	9	A07	-0.13	
32	100	83	0.36	15	A06	0.07	
32	102	83	0.15	8	A05	-0.12	
32	102	83	0.15	8	A08	-0.15	
32	104	83	0.12	7	A04	0.05	
32	106	83	0.21	10	A07	-0.08	
32	112	83	0.13	7	A04	0.19	
32	112	83	0.7	22	A07	-0.18	Plugged
32	114	83	0.21	10	A05	-0.07	
32	116	83	0.14	7	A06	0.10	
32	116	83	0.32	14	A07	-0.10	
32	120	83	0.14	7	A06	0.05	
32	122	83	0.28	12	A06	-0.03	
32	122	83	0.29	13	A07	-0.07	
32	126	83	0.15	8	A04	0.00	
32	126	83	0.19	10	A05	0.00	
32	71	84	0.23	12	A03	-0.17	
32	97	84	0.17	9	A04	0.02	
32	99	84	0.15	9	A05	0.18	
32	101	84	0.19	10	A07	0.15	
32	103	84	0.32	15	A07	0.07	
32	113	84	0.38	16	A05	0.00	
32	115	84	0.42	17	A05	0.00	
32	117	84	0.13	8	A05	0.00	
32	117	84	0.13	8	A08	0.00	
32	119	84	0.14	8	A05	0.00	
32	121	84	0.16	9	A04	0.00	
32	121	84	0.16	9	A05	0.00	
32	121	84	0.75	24	A06	0.00	Plugged
32	121	84	0.26	13	A08	0.03	

32	123	84	0.15	8	A05	0.00	
32	123	84	0.28	14	A06	0.00	
32	123	84	0.29	14	A07	0.00	
32	125	84	0.14	8	A05	0.00	
32	125	84	0.22	12	A06	0.00	
32	131	84	0.18	10	A06	0.00	
32	82	85	0.14	8	A07	0.00	
32	100	85	0.19	10	A07	-0.22	
32	102	85	0.18	10	A04	0.00	
32	108	85	0.56	20	A05	0.00	
32	114	85	0.36	16	A08	0.00	
32	118	85	0.35	16	A05	0.03	
32	122	85	0.14	8	A07	0.00	
32	122	85	0.15	8	A07	0.00	
32	124	85	0.15	8	A08	0.00	
32	73	86	0.12	7	A07	0.00	
32	91	86	0.38	16	A06	0.00	
32	93	86	0.2	10	A04	0.19	
32	93	86	0.12	7	A06	-0.13	
32	93	86	0.17	9	A10	0.00	
32	97	86	0.15	8	A04	-0.11	
32	97	86	0.36	15	A07	-0.17	
32	99	86	0.13	7	A06	-0.26	
32	99	86	0.29	13	A08	0.05	
32	99	86	0.45	17	A09	0.00	
32	99	86	0.16	8	A10	0.00	
32	101	86	0.13	7	A06	-0.36	
32	109	86	0.56	20	A04	0.05	
32	123	86	0.39	16	A06	-0.03	
32	123	86	0.2	10	A07	-0.05	
32	125	86	0.16	9	A08	0.00	
32	131	86	0.86	25	A05	0.00	Plugged
32	131	86	0.8	24	A06	0.00	
32	131	86	0.16	8	A07	-0.10	
32	131	86	0.14	8	A08	0.00	
32	86	87	0.38	16	A07	0.10	
32	102	87	0.14	8	A06	0.15	
32	106	87	0.15	8	A06	0.15	
32	108	87	0.15	8	A06	0.10	
32	110	87	0.12	7	A05	0.00	
32	112	87	0.21	10	A08	0.05	

32	114	87	0.32	14	A06	0.00	
32	116	87	0.44	17	A05	0.03	
32	116	87	0.31	14	A07	0.00	
32	120	87	0.35	15	A05	0.00	
32	122	87	0.17	9	A04	0.02	
32	122	87	0.58	20	A05	0.00	
32	122	87	0.91	26	A06	0.00	Plugged
32	124	87	0.38	15	A04	0.00	
32	124	87	0.7	22	A05	0.06	Plugged
32	124	87	0.31	13	A06	-0.06	
32	128	87	0.48	18	A05	0.00	
32	128	87	0.3	13	A06	0.00	
32	73	88	0.32	15	A07	-0.41	
32	75	88	0.14	8	A07	0.18	
32	79	88	0.13	8	A04	0.00	
32	89	88	0.28	14	A05	0.15	
32	93	88	0.25	12	A07	0.00	
32	97	88	0.11	7	A05	-0.07	
32	97	88	0.25	13	A06	0.00	
32	99	88	0.23	12	A05	0.00	
32	99	88	0.29	14	A06	0.00	
32	101	88	0.29	14	A07	-0.24	
32	107	88	0.18	10	A05	0.00	
32	107	88	0.45	18	A06	0.00	
32	107	88	0.11	7	A07	0.00	
32	111	88	0.23	12	A04	0.00	
32	111	88	0.25	12	A05	0.00	
32	121	88	0.12	7	A05	0.00	
32	123	88	0.13	8	A04	0.00	
32	123	88	0.15	8	A05	0.00	
32	123	88	0.47	19	A08	0.00	Plugged
32	127	88	0.11	7	A03	0.00	
32	127	88	0.46	18	A07	0.00	
32	127	88	0.16	9	A08	0.00	
32	129	88	0.72	23	A05	0.06	
32	129	88	2.58	40	A06	0.00	Plugged
32	129	88	0.37	16	A08	0.00	
32	129	88	0.12	7	A09	0.00	
32	74	89	0.14	8	A07	0.00	
32	80	89	0.16	9	A07	0.00	
32	82	89	0.17	10	A07	0.00	

32	86	89	0.2	11	A04	0.00	
32	88	89	0.15	9	A07	0.00	
32	90	89	0.28	14	A07	0.00	
32	98	89	0.14	8	A06	0.00	
32	98	89	0.14	8	A08	0.00	
32	100	89	0.3	14	A07	0.00	
32	108	89	0.51	19	A05	0.00	
32	110	89	0.25	12	A05	0.00	
32	110	89	0.15	8	A07	0.00	
32	114	89	0.24	12	A04	0.00	
32	114	89	0.16	9	A06	0.00	
32	114	89	0.27	13	A08	0.00	
32	114	89	0.46	18	A09	0.00	
32	118	89	0.18	10	A02	0.00	
32	120	89	0.16	9	A07	0.00	
32	124	89	0.34	15	A05	0.00	
32	87	90	0.32	14	A06	0.00	
32	91	90	0.13	7	A06	0.00	
32	97	90	0.28	13	A04	0.00	
32	97	90	0.14	8	A05	0.00	
32	97	90	0.29	13	A07	0.00	
32	101	90	0.12	7	A04	0.00	
32	103	90	0.28	13	A04	0.02	
32	103	90	0.36	15	A07	0.00	
32	109	90	0.2	10	A07	0.00	
32	115	90	0.16	9	A05	0.00	
32	117	90	0.26	12	A05	0.00	
32	117	90	0.34	15	A08	0.00	
32	119	90	0.31	14	A05	0.00	
32	119	90	0.14	8	A06	0.05	
32	121	90	0.16	9	A06	0.00	
32	121	90	0.16	9	A08	0.00	
32	131	90	0.47	18	A04	-0.09	
32	131	90	0.74	23	A05	0.00	Plugged
32	131	90	0.21	10	A06	0.00	
32	92	91	0.18	9	A04	0.00	
32	92	91	0.33	14	A05	0.00	
32	94	91	0.14	8	A07	0.00	
32	104	91	0.55	20	A06	0.00	
32	104	91	0.26	12	A07	0.00	
32	120	91	0.29	13	A05	0.00	

32	120	91	0.14	7	A07	0.00	
32	122	91	0.13	7	A06	0.00	
32	124	91	0.17	9	A06	0.00	
32	124	91	0.16	8	A07	0.00	
32	126	91	0.22	11	A04	0.03	
32	126	91	0.16	8	A05	0.03	
32	128	91	0.17	9	A08	0.00	
32	77	92	0.16	9	A08	0.08	
32	87	92	0.13	8	A08	0.05	
32	93	92	0.22	12	A07	0.00	
32	95	92	0.19	10	A05	0.00	
32	97	92	0.25	13	A05	0.00	
32	97	92	0.21	11	A06	0.00	
32	103	92	0.86	26	A05	0.00	Plugged
32	103	92	0.66	22	A06	0.00	
32	111	92	0.11	7	A05	0.00	
32	117	92	0.27	13	A04	0.00	
32	117	92	0.26	13	A05	0.00	
32	117	92	0.44	18	A07	0.00	Plugged
32	117	92	0.41	17	A08	0.00	
32	117	92	0.15	9	A09	0.00	
32	121	92	0.28	13	A05	0.00	
32	121	92	1.41	32	A06	0.00	Plugged
32	121	92	0.53	20	A07	0.00	
32	129	92	0.43	18	A05	0.00	Plugged
32	129	92	0.12	7	A06	0.00	
32	129	92	0.31	14	A07	0.00	
32	84	93	0.13	8	A07	0.10	
32	96	93	0.16	9	A07	0.00	
32	98	93	0.15	9	A07	0.00	
32	100	93	0.22	12	A05	0.07	
32	106	93	0.11	7	A04	0.00	
32	108	93	0.16	9	A06	0.00	
32	110	93	0.23	12	A07	0.00	
32	114	93	0.15	9	A06	0.00	
32	114	93	0.27	13	A07	-0.12	
32	116	93	0.24	12	A06	0.00	
32	120	93	0.11	7	A05	0.00	
32	120	93	0.24	12	A07	0.00	
32	124	93	0.21	11	A05	-0.07	
32	124	93	0.25	13	A06	0.00	

32	93	94	0.18	9	A06	0.00	
32	113	94	0.19	10	A06	0.00	
32	121	94	0.12	7	A06	0.00	
32	72	95	0.12	7	A07	0.00	
32	74	95	0.17	9	A07	0.13	
32	76	95	0.17	9	A07	0.13	
32	82	95	0.28	13	A07	0.13	
32	82	95	0.34	14	A08	0.03	
32	98	95	0.15	8	A07	0.07	
32	100	95	0.18	9	A05	0.00	
32	100	95	0.22	11	A06	0.00	
32	104	95	0.24	11	A05	0.00	
32	112	95	0.66	22	A07	0.00	Plugged
32	114	95	0.12	7	A07	0.00	
32	126	95	0.34	14	A06	0.00	
32	81	96	0.15	8	A07	-0.14	
32	87	96	0.12	7	A07	0.00	
32	89	96	0.14	8	A07	0.00	
32	93	96	0.16	9	A03	-0.17	
32	93	96	0.35	15	A05	0.04	
32	93	96	0.38	16	A06	0.00	
32	82	97	0.16	9	A02	0.00	
32	82	97	0.28	13	A03	0.06	
32	126	97	0.15	9	A07	0.00	
32	115	98	0.19	10	A05	0.00	
32	115	98	0.55	20	A06	0.00	Plugged
32	115	98	0.15	8	A07	0.00	
32	94	99	0.16	8	A08	-0.07	
32	99	100	0.12	7	A06	0.00	
32	128	111	0.28	13	A06	0.00	
32	128	111	0.12	7	A07	0.00	
32	35	166	0.14	8	A08	0.00	
32	26	167	0.11	7	A09	0.20	
32	30	167	0.11	7	A02	0.00	
32	30	167	0.23	11	A09	0.15	
32	38	167	0.11	7	A09	0.00	

Table D-4 – SG32 Service Induced Indications – Wear at TSPs

SG	ROW	COL	VOLTS	%	LOC	INCH	Comment
32	15	2	0.24	5	06C	0.40	
32	3	10	0.2	4	07C	0.27	
32	1	18	0.16	3	04C	0.48	
32	1	18	0.15	3	03C	0.43	
32	6	23	0.22	5	05C	-0.51	
32	1	24	0.25	5	05C	0.05	
32	1	24	0.28	9	03C	0.03	
32	5	28	0.23	5	07C	0.35	
32	8	33	0.32	7	05C	-0.62	
32	7	36	0.3	7	05C	-0.65	
32	5	48	0.36	8	05C	-0.57	
32	4	63	0.21	4	05C	-0.62	
32	6	95	0.17	4	03C	-0.56	
32	2	107	0.2	4	05C	0.40	
32	2	117	0.23	5	06C	-0.59	
32	8	123	0.27	6	05C	-0.62	
32	7	130	0.14	3	05C	0.38	
32	2	133	0.46	11	06C	-0.62	
32	1	134	0.18	4	05C	0.40	
32	7	136	0.24	5	04C	-0.59	
32	2	137	0.24	5	05C	0.32	
32	7	138	0.14	3	06C	-0.57	
32	7	138	0.22	5	05C	-0.59	
32	5	150	0.19	4	06C	0.32	
32	2	161	0.12	2	06C	-0.54	
32	3	162	0.14	3	05C	0.35	
32	3	168	0.2	4	05C	0.13	
32	2	169	0.16	3	03C	0.35	