Sequoyah Nuclear Plant (SQN) Unit 1

Pre-Submittal Meeting for License Amendment Request (LAR) Revised Steam Generator (SG) Inspection Intervals

January 27, 2020

Agenda

- Opening Remarks
- Background
- SQN Unit 1 Replacement Steam Generators (RSGs)
- Current Technical Specification (TS) SG Requirements
- Proposed TS Changes
- RSG Inspection History
- RSG Secondary Side
- Operational Assessments
- LAR Schedule Milestones
- Closing Remarks

Opening Remarks

- Purpose of the meeting is to discuss a proposed LAR for a revision to the SQN Unit 1 TS for the SG inspection intervals for the life of the plant.
- TVA is scheduled to perform the next SQN Unit 1 SG tube inspection during the SQN Unit 1 Cycle 24 Refueling Outage (U1R24), scheduled to commence on April 10, 2021.
- Tennessee Valley Authority (TVA) has been involved in the development of Technical Specification Task Force (TSTF)-577, “Performance Based Frequencies for Steam Generator Tube Inspections,” along with meeting between the industry and the Nuclear Regulatory Commission (NRC).

Opening Remarks

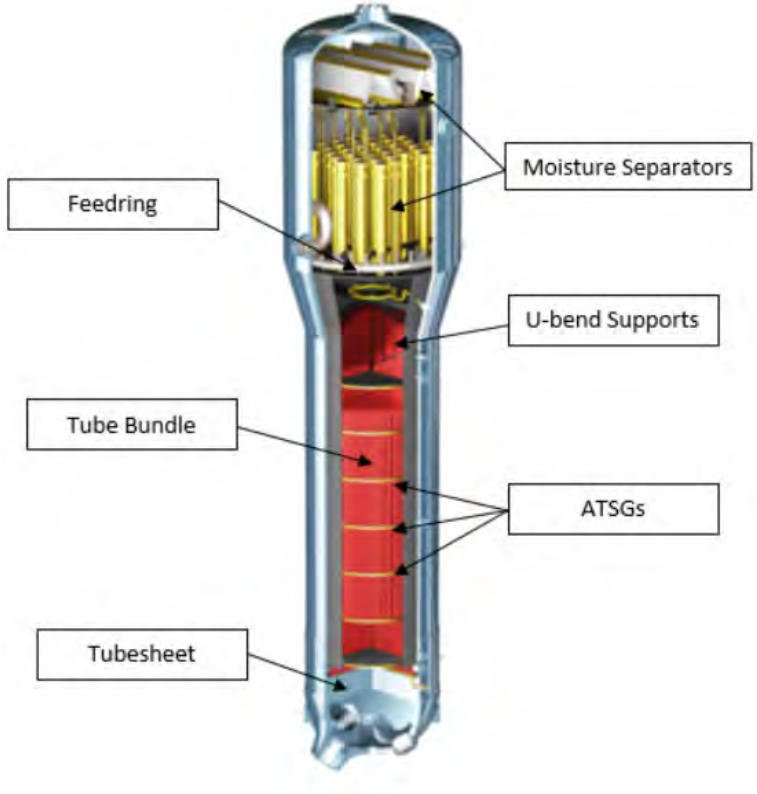
- The operational experience of the SQN RSGs, as described in this presentation, demonstrate that the proposed change to the schedule for the SG inspections is appropriate and will result in a reduction of person-hours, dose to personnel, and risk to the plant.
- TVA plans to follow the guidance in TSTF-577 for future similar LARs.

Background

- SG TS are based on performance of the tube material.
- Current TS inspection intervals developed under TSTF-449 and TSTF-510 with some uncertainty around Alloy 690TT tubing performance.
- Significant experience gained over the course of 15 years of additional Alloy 690TT service.
- TS inspection intervals need to incorporate operating experiences.

Sequoyah Unit 1 RSGs

- Four RSGs per unit
- Replaced U1R12 (spring of 2003)
- Westinghouse Model 57AG
- Recirculating SG design
- 4,983 Alloy 690TT tubes in triangular pitch
- Advanced tube support grid (ATSG) straight leg tube supports
- Ventilated flat bar U-bend tube supports
- Feedring with spray nozzles
- Two stage moisture separator design
- Similar to Unit 2



Current SQN Unit 1 SG TS

- Maximum interval of 72 effective full power months (EFPM) or three refueling outages.
- After the first refueling outage following SG installation, inspect 100% of the tubes during the next 144 EFPM. This constitutes the first inspection period (completed Fall 2016).
- 100% inspection during the next 120 EFPM (second inspection period).
  - SQN Unit 1 is currently in the 120 EFPM sequential period.
  - Two scheduled inspections within period (1R24, 1R27)
- 100% inspection within the next 96 EFPM (third inspection period) and 72 EFPM thereafter.

Proposed TS Change (Markups)

SQN Unit 1 – TS 5.5.7 d. 2, “Steam Generator (SG) Program”

1. Inspect 100% of the tubes in each SG during the first refueling outage following SG installation.

2. After the first refueling outage following SG installation, inspect each SG at least every ~~7296~~ effective full power months ~~or at least every third refueling outage (whichever results in more frequent inspections)~~. In addition, the minimum number of tubes inspected at each scheduled inspection shall be the number of tubes in all SGs divided by the number of SG inspection outages scheduled in each inspection period as defined in a and ~~,~~b~~, c, and d~~ below. If a degradation assessment indicates the potential for a type of degradation to occur at a location not previously inspected with a technique capable of detecting this type of degradation at this location and that may satisfy the applicable tube plugging criteria, the minimum number of locations inspected with such a capable inspection technique during the remainder of the inspection

Proposed TS Change (Markups)

SQN Unit 1 – TS 5.5.7 d. 2. b, c, and d

a) After the first refueling outage following SG installation, inspect 100% of the tubes during the next 144 effective full power months. This constitutes the first inspection period;

~~b)~~ During the next ~~96~~120 effective full power months, inspect 100% of the tubes. This constitutes the second and subsequent inspection periods.

~~c)~~b) ~~During the next 96 effective full power months, inspect 100% of the tubes. This constitutes the third inspection period; and~~

~~d) During the remaining life of the SGs, inspect 100% of the tubes every 72 effective full power months. This constitutes the fourth and subsequent inspection periods.~~

3. If crack indications are found in any SG tube, then the next inspection for each affected and potentially affected SG for the degradation mechanism that caused the crack indication shall not exceed 24 effective full power months or one refueling outage (whichever results in more frequent inspections). If definitive information, such as from examination of a pulled tube, diagnostic non-destructive testing, or engineering evaluation indicates that a crack-like indication is not associated with a crack(s), then the indication need not be treated as a crack.

Proposed TS Change (Markups)

SQN Unit 1 – TS 5.6.6.i, “Steam Generator Tube Inspection Report”

A report shall be submitted within 180 days after the initial entry into MODE 4 following completion of an inspection performed in accordance with the Specification 5.5.7, "Steam Generator (SG) Program." The report shall include:

a. The scope of inspections performed on each SG;

b. Active 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 active degradation mechanism;

f. Total number and percentage of tubes plugged to date;

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

h. The effective plugging percentage for all plugging in each SG.

i. Discuss trending of tube degradation over the inspection interval and provide comparison of the prior operational assessment degradation projections to the as-found condition.

Proposed TS Change (Clean)

SQN Unit 1 – TS 5.5.7 d. 2

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Proposed TS Change (Clean)

SQN Unit 1 – TS 5.5.7 d. 2. a and b

a) After the first refueling outage following SG installation, inspect 100% of the tubes during the next 144 effective full power months. This constitutes the first inspection period;

b) During the next 96 effective full power months, inspect 100% of the tubes. This constitutes the second and subsequent inspection periods.

3. If crack indications are found in any SG tube, then the next inspection for each affected and potentially affected SG for the degradation mechanism that caused the crack indication shall not exceed 24 effective full power months or one refueling outage (whichever results in more frequent inspections). If definitive information, such as from examination of a pulled tube, diagnostic non-destructive testing, or engineering evaluation indicates that a crack-like indication is not associated with a crack(s), then the indication need not be treated as a crack.

Proposed TS Change (Clean)

SQN Unit 1 – TS 5.6.6.i

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Current and Proposed SQN Unit 1 RSG Sequential Periods

SGs Replaced 1R12 S-03	1R13 F-04	1R14 S-06	1R15 F-07	1R16 S-09	1R17 F-10	1R18 S-12	1R19 S-13	1R20 S-15	1R21 F-16	End of 1st Period	1R22 S-18	1R23 F-19	1R24 S-21	1R25 F-22	1R26 S-24	1R27 F-25	1R28 S-27	1R29 F-28	End of 2nd Period
SG EFPY Cumulative	1.3	2.7	4.1	5.4	6.8	8	9.5	11	12.4		13.7	14.9	16.3 est.	17.7 est	19.1 est.	20.5 est	21.9 est.	23.3 est.	
EFPM Within Sequential Period	0	16.8	33.6	49.2	66	80.4	98.4	116.4	133.2		4.8	19.2	36 est.	52.3 est.	69.1 est.	85.9 est	102.7 est.	119.5 est.	
TS Sequential Period	1st ISI	144 EFPM Sequential Period									120 EFPM Sequential Period								
Bobbin Base Scope	100% All SGs	No ECT	54% All SGs	No ECT	No ECT	46% All SGs	No ECT	No ECT	100% All SGs[3]		No ECT	No ECT	50% All SGs[2]	No ECT	No ECT	50% All SGs[2]	No ECT	No ECT	
Inspection Schedule under Proposed Amendment[1] ->											No ECT	No ECT	No ECT	No ECT	100% All SGs[3]	No ECT	No ECT	No ECT	

Notes

1. The schedule under the proposed amendment revise the allowable inspection interval for each SG to at least every 96 EFPM.
2. 50% is the TS minimum required inspection scope determined by dividing 100% by the number of scheduled inspections within the period.
3. The SQN U1R21 inspection consisted of a 100% combination bobbin and array coil inspection of all tubes full length with the exception of the U-bend sections of tube Rows 1 through 4, which were inspected with a singular bobbin probe due to dimensional constraints. This is the planned scope for all scheduled inspections under the proposed amendment.

Current and Proposed SQN Unit 1 RSG Sequential Periods

	End of 2nd Period	1R30 S-30	1R31 F-31	1R32 S-33	1R33 F-34	1R34 S-36	End of 3rd Period	1R35 F-37	1R36 S-39	1R37 F-40	1R38 S-42	1R39 F-43	End of 4th Period
SG EFPY Cumulative		24.7 est.	26.1 est.	27.5 est.	28.9 est.	30.3 est.		31.7 est.	33.1 est.	34.5 est.	35.9 est.	37.3 est.	
EFPM Within Sequential Period		16.3 est.	33.1 est.	49.9 est.	66.7 est.	83.5 est.		4.3 est.	21.1 est.	37.9 est.	54.7 est.	71.5 est.	
TS Sequential Period		96 EFPM Sequential Period						72 EFPM Sequential Period					
Bobbin Base Scope		50% All SGs[2]	No ECT	No ECT	50% All SGs[2]	No ECT		No ECT	50% All SGs[2]	No ECT	No ECT	50% All SGs[2]	
Inspection Schedule under Proposed Amendment[1] ->		No ECT	100% All SGs[3]	No ECT	No ECT	No ECT		No ECT	100% All SGs[3]	No ECT	No ECT	No ECT	

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Benefits of the LAR

- The proposed TS changes will result in:
  - Reduced overall outage dose
  - Reduced number of person-hours
  - Improved focus on essential work
  - Eliminate nuclear plant risk

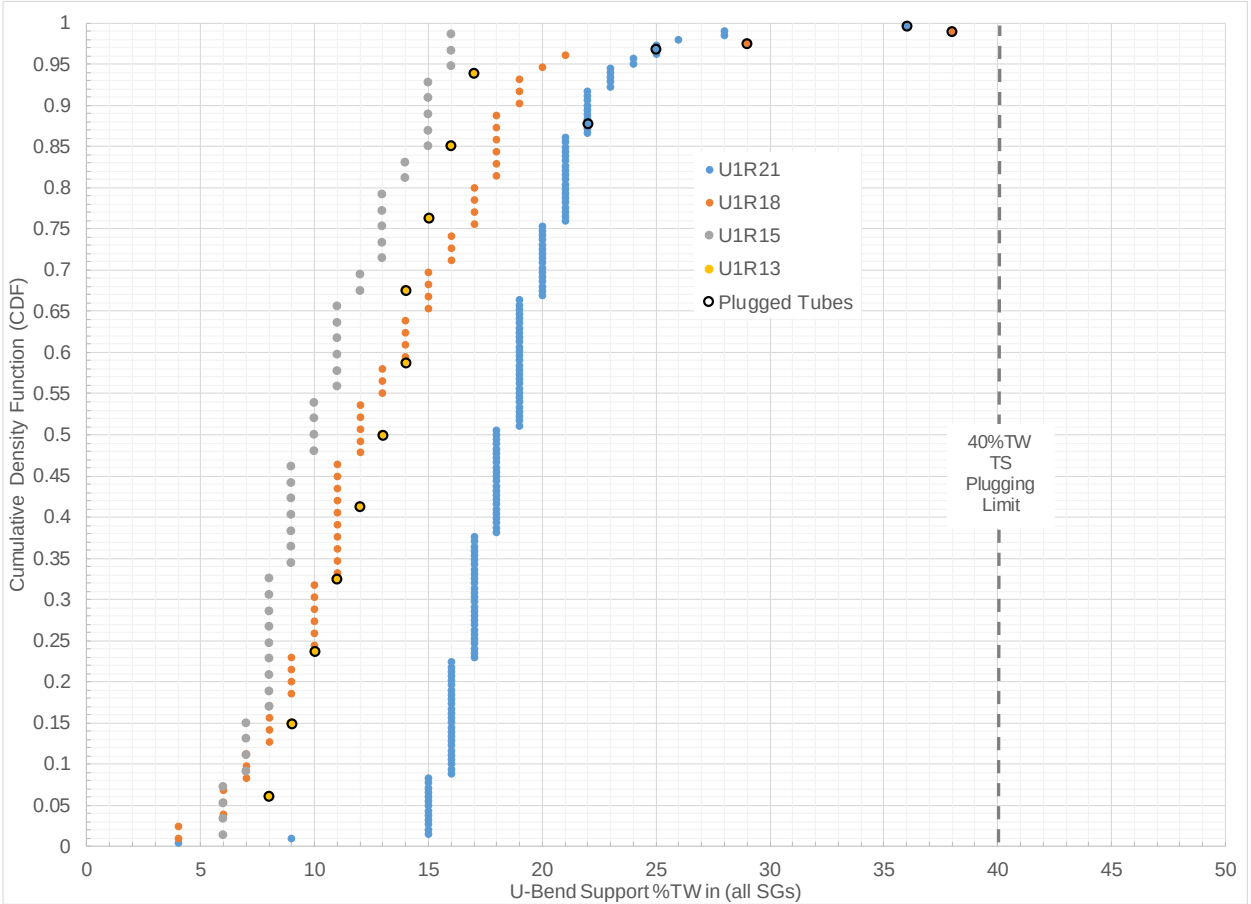
Inspection History

- SQN1 RSGs
  - 100% pre-service inspection
  - Four in-service inspections (1R13, 1R15, 1R18, 1R21)
  - Historical inspections applied bobbin and rotating pancake coil (RPC) probe inspection strategies
  - Most recent inspection was 100% full length combination bobbin and array probe
- Every tube in the SQN1 RSGs has been tested in-service at least three times in 16 years of operation.

RSG Degradation Experience

- Two existing tube degradation mechanisms.
  - Mechanical wear at U-bend supports
  - Mechanical wear at horizontal ATSGs
- Tube plugging to date: 0.17% (34 tubes)
  - 20 tubes plugged pre-service
  - 14 tubes preventively plugged for wear at U-bend supports
  - No tubes plugged for wear at horizontal ATSGs
- No indication has exceeded TS plugging limit of 40% through-wall (TW).

Trending of Existing Degradation Mechanisms



SQN Unit 1 RSG Distribution of U-bend Support Wear Depths

SG Secondary Side

- Tubesheet cleaned every SG inspection since RSG install.
  - Removes secondary deposit buildup and foreign objects
- Foreign object search and retrieval (FOSAR) performed every SG inspection since RSG install.
  - Manual retrieval of identified foreign objects
  - Inspect possible loose part indications from eddy current
- Performed upper internals inspection of all four RSGs at U1R18.
  - Feedring spray can nozzles trap foreign objects

Operational Assessments

- Following U1R21 100% inspection
  - Largest U-bend support wear left in-service is 28%TW
  - Largest ATSG wear left in-service is 22%TW
  - 95th percentile growth rate of 3.7%TW/EFP Years (EFPY)
- OA supports operation for at least 7.5 EFPY (five cycles) while maintaining tube integrity.
- All SQN as-found inspection results have shown margin of >15%TW compared to three cycle OA worst case projected %TW.

Operational Assessments (cont'd)

Examples of conservatism applied in the SQN Unit 1 OAs:

- Tube wear degradation lengths are assumed to be the full length of the tube support intersections.
- Each SQN Unit 1 operating cycle is assumed to be 1.5 EFPY.
- Structural Integrity Performance Criteria (SIPC) of three times normal operating pressure differential is conservatively determined.
  - The value applied does not include pressure drops within the system between the measurement point and the secondary side of the tubing.

LAR Schedule Milestones

- January 27, 2020 – LAR pre-submittal meeting with NRC
- March 10, 2020 – LAR submittal – Request NRC approval within 12 months of submittal
- April 2020 – Teleconference or meeting to discuss any NRC questions
- March 10, 2021 – NRC approval of LAR (Requested). 30-day implementation period
- April 10, 2021 – Scheduled start of SQN U1R24 outage

Summary

- Positive SQN operational performance of Alloy 690TT.
- SQN performs comprehensive RSG inspections.
- Existing SQN1 RSG degradation mechanisms are understood and exhibit predictable behavior.
- Operational assessments accurate and appropriately conservative.
- Proposed TS changes are consistent with performance of Alloy 690TT tube material.
- Degradation trending will be provided to NRC through enhanced reporting.
- Proposed TS changes are intended to be consistent with the proposed TSTF-577.


TVA