

Delivering the Nuclear Promise

Top Innovative Practice



December 16, 2022

DNP-TIP-2022-07

Steam Generator Inspection Frequency Extension

2022 Top Innovative Practice Winner

Summary

Sequoyah Nuclear Plant (SQN) requested and received approval from the NRC for a reduced frequency of Steam Generator (SG) inspections for Unit 1. The NRC approval of the SQN Unit 1 Inspection Frequency License Amendment Request (LAR) establishes the first greater than three cycle SG inspection interval in the industry. TVA participated in an EPRI-led initiative to revise SG technical specifications (TS). TVA was the first to submit a license amendment request to the NRC that utilizes EPRI's Steam Generator Management Program's Operational Assessment (OA) methodologies. EPRI's Integrity Assessment Guidelines provides the technical bases to ensure the industry is performing SG inspections at the appropriate intervals. The technical bases rely, in part, on extensive industry performance data.

The prior TS SG inspection interval requirements were developed when there was uncertainty around the performance of the Alloy 690TT tube material. Significant experience has been gained over the course of 30 years of service of this tube material type. The SQN Unit 1 Replacement Steam Generators (RSGs) are a second-generation evolutionary design, which benefits from industry-operating experience. The RSGs have been inspected in-service by eddy current techniques four separate times over an operating period of greater than 14.9 Effective Full Power Years since installation. Through these inspections, every tube in each RSG has been tested full length at least three times with techniques qualified for detection of all existing and potential degradation mechanisms.

The SQN RSG degradation mechanisms have been proven to be well understood and exhibit predictable behavior. As such, the OAs performed to date have been both accurate and appropriately conservative.

Figure 1 shows the SQN Unit 1 RSG, Westinghouse Model 57AG.

Innovation

The development, submittal, and subsequent NRC approval of the SQN Unit 1 Inspection Frequency License Amendment Request (LAR) establishes the first greater than three cycle SG inspection interval in the industry. This is a first of a kind submittal to the NRC that utilizes OA methodologies to ensure we are performing SG inspections at the appropriate intervals based on industry standard methodologies and decades of SG performance data.

TVA considers the TS change to the SG tube inspection frequency of 100% of the SG tubes every 96 Effective Full Power Month (EFP) period based on the OA to be a more efficient and effective inspection approach. Relative to the prior requirement, this results in more frequent inspections per tube. Full bundle

data collection, or 100% scope, can be achieved in an overall shorter period with no impact to safety or operation. This change minimizes person-hours and dose and reduces risk to the plant and personnel.

Safety

Radiological Safety

The extended frequency will result in two fewer instances of SG inspections through the current life of the plant while still accomplishing the 100 percent inspection of the tubing within a 96 EFPM period. Typical dose values for SG inspections can vary depending on outage scope and activities. During the Unit 1 Refueling Outage 21 SG inspection, the associated activities accounted for 22.6 person-rem, which was approximately 22% of the total site outage dose. Assuming that the same dose would occur in future SG inspection outages, the avoided dose for SQN Unit 1 personnel under the approved amendment and SG inspection schedule would be at least 45.2 person-rem over the current life of the plant.

Industrial Safety

Many of the evolutions performed for SG inspections pose an increased risk to the plant and personnel (e.g., heavy lifts and confined space activities). An example of plant configuration improvement and risk reduction as a result of not performing an SG inspection is the elimination of the need for a plant mid-loop hold for installation of SG nozzle dams. This evolution is performed by personnel in a confined space internal to the SG channel head under a high radiation environment with the plant at a reduced primary water inventory. Personnel performing the nozzle dam installations are outfitted with a bubble suit which has an independent air supply adding another industrial safety challenge since air tubing can have complications or become blocked. For SG inspections, there are heavy lifts associated with moving equipment onto the refuel floor, into containment, and to the SG platforms. The primary and secondary manways (over 600 lbs. each) must also be removed by a manway handling device and installed back on the RSGs. Personnel performing these activities could potentially be working in a locked high radiation area. Working in the upper internals of the RSGs also requires putting personnel inside a confined space. The new approved frequency will reduce 11,690 manhours of outage labor on SG support activities over the current life of the plant.

Nuclear Safety

Plant configuration improvement and risk reduction is achieved by the elimination of the need for a plant mid-loop hold for installation of SG nozzle dams. The plant configuration required for mid-loop is typically an ORANGE outage risk window. This increased risk configuration will be avoided during two outages for the remaining current life of SQN Unit 1. Inspection of the SGs on the new approved frequency will reduce opportunities for human performance issues that could impact SG performance and overall nuclear safety.

While risk is minimized as much as possible through plant processes and procedures, performing 100% SG inspection scope in a 96 EFPM sequential period will reduce the total number of outages between subsequent 100% tube inspections and improve overall plant risk due to more frequent individual tube inspections.

Cost Savings

The SQN Unit 1 Steam Generator Inspection Frequency Extension will reduce the number of SG inspections by two full inspections over the current remaining life of the plant. The vendor and support cost avoidance associated with this reduction is estimated to be approximately \$16 million. This includes vendor contract cost, TVA internal labor and material costs. Additional cost savings is attributed to reduced Outage Critical Path time. Typically, SG Inspections are on critical path during the core empty time period. An approximate Outage Critical Path savings of 24 hours will be realized for the current remaining life of SQN Unit 1. Accordingly, the dose avoidance of approximately 45.2 person-rem will be realized over the life of the plant. Additional cost savings could also be realized through increased flexibility in scheduling of activities during refueling outages. These savings will be further increased if subsequent license renewal is submitted and

approved.

Productivity/Efficiency

SG inspections are outage labor intensive, so by extending the frequency to match with the OA and not perform the inspections as frequently, outage labor can be committed to work tasks that have a greater impact on nuclear safety and equipment reliability.

SG inspections require significant commitment of plant and contract skilled and experienced labor, planners and schedulers, and radiation protection field support. The update to the SG inspection frequency will allow the reallocation of skilled and experienced labor to other high priority and high safety significant outage work scope to improve nuclear safety margins and equipment reliability. Burden to planners, schedulers, radiation protection and outage coordination will be significantly reduced. Limited experienced vendor personnel will not be committed to unnecessarily frequent inspections and will be available to support industry peer outages.

Transferability

This SQN Unit 1 LAR is a precedent for other PWR utilities to submit similar LARs or submit under TSTF-577. TVA has already submitted a similar LAR for the Watts Bar Unit 1 RSGs.

Team Members

- Jeremy Mayo, Steam Generator Program Manager (TVA)
- Jesse Baron, Steam Generator Engineer (TVA)

Figure 1 – Sequoyah Unit 1 Replacement Steam Generator – Westinghouse Model 57AG

Figure 1

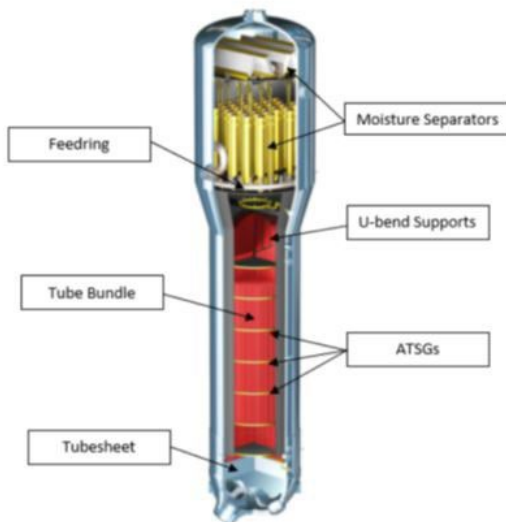


Figure 1: SQN Unit 1 RSG - Westinghouse Model 57AG