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SUBJECT: Notifies NRC staff that next scheduled insp of plant SG tubes will occur on or about 981024.

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October 22, 1997

U.S. Nuclear Regulatory Commission
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Ladies/Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Planned Steam Generator Tube Inspection for the Kewaunee Nuclear Power Plant

Reference: Letter from M.L.Marchi (WPSC) to U.S. Nuclear Regulatory Commission (NRC) dated July 1, 1997.

The purpose of this letter is to notify the NRC staff that the next scheduled inspection of the Kewaunee Nuclear Power Plant (KNPP) steam generator (SG) tubes will occur on or about October 24, 1998. The prior SG in-service inspection was completed on October 18, 1996, which will result in an inspection interval of just over 24 calendar months. However, with the recent extended outage and the de-rated operation of the KNPP, this corresponds to an actual inspection interval of 15.5 effective full power months (EFPMs).

An inspection interval of up to either 15.5 EFPMs, or 25 calendar months, is in accordance with our current licensing basis and will also provide reasonable assurance of adequate SG tube integrity at the end-of-the planned operating cycle. The current requirements for SG tube inspection frequency are covered in Technical Specification (TS) 4.2.b.3.b, which stipulates an inspection frequency of at least once per 20 months if the SGs are in the C-3 category, and TS 4.0.b which allows an extension of not to exceed 25% of the specified surveillance interval. We recognize the NRC staff position provided in Generic Letter 91-04 (Changes in Technical Specification Surveillance Intervals to Accommodate a 24-Month Fuel Cycle) excludes applying the 25% extension frequency to SG tube inspections which fall into the C-3 category; however, this requirement is not a part of the KNPP licensing basis and based on the recent extended KNPP outage is not directly applicable to our current situation. More importantly, our end-of-cycle tube integrity assessment demonstrates the acceptability of this inspection interval.

A047

A summary of the end-of-cycle tube integrity assessment based on a planned October 18, 1998 shutdown is provided as an attachment to this letter for your information. If you have any questions or comments please call a member of my staff.

Sincerely,

Mark L. Marchi
Manager-Nuclear Business Group

SLB

Attach.

cc: US NRC Senior Resident Inspector
US NRC Region III

ATTACHMENT

Letter from M. L. Marchi (WPSC)

To

Document Control Desk (NRC)

Dated

October 22, 1997

Summary of End-of-Cycle Tube Integrity Assessment

INTRODUCTION

The purpose of this assessment is to demonstrate with a reasonable degree of assurance that the end-of-cycle 22 (Summer 1997 to Fall 1998) steam generator tubing conditions will satisfy structural and accident leakage integrity requirements. This assessment was performed by projecting the as-left condition of the SG tubing over the course of the planned operating cycle. Information used to perform this assessment includes; the cycle 22 operating conditions; prior cycle in-service inspection (ISI) data; results of testing performed on tubes removed from the KNPP SGs; and in-situ pressure testing performed at a similar plant.

BACKGROUND

The KNPP has two Westinghouse model 51 SGs with 7/8-inch OD tubing constructed of mill-annealed inconel 600 partially depth rolled for a length of 1.5 to 2.5 inches into the tubesheet. The KNPP SGs have been experiencing tube wall degradation attributed to outside diameter intergranular attack and outside diameter stress corrosion cracking (ODSCC). As a result of this degradation, significant tube plugging and sleeving has been required. During the 1988 and 1989 outages a large scale sleeving program was implemented in the hot leg tubesheet crevice region. All of the sleeves installed were Westinghouse mechanical hybrid expansion joint (HEJ) sleeves. Additional sleeving occurred in 1991 using HEJs and in 1992 with the Combustion Engineering (CE) welded slecves. As a result of these sleeving programs a total of 2195 HEJs and 12 CE sleeves were installed in SG A, and 2133 HEJs and 4 CE sleeves were installed in SG B.

During the 1994 refueling outage the upper HEJs were inspected using the I-coil, a motorized rotating probe developed for the sleeved tube inspections. A total of 77 circumferential crack-like indications were detected in the parent tubes; i.e., PTIs. Sixty-six of the indications were within the pressure boundary as defined in TSs and removed from service by plugging the tube. During the 1995 refueling outage the upper HEJs were examined using the +point probe. During this inspection 753 PTIs were detected; 657 within the pressure boundary that were removed from service by plugging the tube.

On September 21, 1996, the KNPP was shutdown for cycle 21/22 refueling and SG tube in-service inspection (ISI) outage. The SG ISI scope consisted of a 100% bobbin coil examination of non-sleeved tubing with supplemental MRPC, and a 100% +point inspection of the upper sleeve joints. In addition, a total of 16 tubes were removed from the KNPP SGs; one tube with two tube support plate location indications for analysis in accordance with NRC Gencric Letter 95-05; eight HEJ sleeved tubes with PTIs to perform structural and leakage testing; six laser weld repaircd HEJs to determine the cause of the weld failure, and to determine structural and leakage integrity of the welded joint; and one re-sleeved tube to confirm weld acceptability. Full tube in-situ pressure testing was also performed on 16 laser weld repaired tubes and a secondary pressure test was performed prior to placing the SG back in-service after all of the sleeve repairs were completed.

The ISI was completed on October 18, 1996, with the inspection results placing the SGs in the C-3 category in accordance with TS 4.2.b.2.g. The complete ISI results, including number of tubes plugged and repaired, were reported to the NRC in License Event Report 96-006-01. During this inspection over 1400 new PTIs were detected. This population of sleeved tubes with new PTIs, in addition to a number of HEJ sleeved tubes that were unplugged in a recovery effort, resulted in approximately 1900 HEJ sleeved tubes that required repair or plugging prior to placing the SGs back in service. A number of difficulties were encountered with the original efforts to perform a laser welded repair. Following the laser weld repair campaign, a number of the tubes with failed laser welds were re-sleeved. This effort had a much higher success rate, but was also a very time consuming process. As result of all the repair work required, the outage was extended from the originally planned 6 weeks, to 37 weeks. The plant was returned to service on June 12, 1997. The plant is currently operating at 97% of full rated power due to the number of tubes plugged and sleeved. Provided below is a table listing the present SG tubing conditions.

	SG A	SG B
Total number of tubes	3388	3388
Number of open tubes	880	978
Number of HEJs; NDD >7 mil ΔD	777 73	1277 52
Number of laser weld repaired tubes	381	292
Number of plugged tubes	839	785
Number of CE re-sleeves	366	0
Number of CE sleeves	72	4
Equivalent tubes plugged	26.89%	25.25%

The next planned refueling shutdown is scheduled to start on October I8, 1998, with the tube ISI starting on or about October 24, 1998. This will result in an inspection interval of approximately twenty-four calendar months. Taking into account the extended outage time and de-rated operation, this corresponds to an actual intcrval of 15.5 effcctive full power months. Provided below is an assessment which demonstrates with reasonable assurance that tube integrity will be maintained over the planned operating cycle.

ASSESSMENT OF END-OF-CYCLE SG TUBE INTEGRITY

The purpose of this assessment is to demonstrate with reasonable assurance that the following performance criteria will not be exceeded at the end of the current operating cycle (cycle 22) which is scheduled to end on October 18, 1998. The three performance criteria used for evaluation are:

- Structural Integrity
- Accident Leakage Integrity
- Operational Leakage Integrity

The performance criteria on operational leakage integrity is implemented in accordance with KNPP TS 3.1.d.2 which requires a plant shutdown if the primary-to-secondary leakage in any one SG exceeds 150 gpd. Following is an evaluation of the structural and accident leakage integrity critcria.

This evaluation considered the following areas of known degradation in the KNPP SGs:

- Low row U-bend stress corrosion cracking (SCC),
- Anti-vibration bar (AVB) wear,
- Hot leg tubesheet crevice and top of tubesheet region ODSCC in unsleeved tubes,
- Hot leg and cold leg tube support plate intersection ODSCC, and
- Parent tube primary-side water SCC in HEJ sleeved tubes.

These degradation mechanisms have been characterized using state-of-the-art non-destructive examination techniques. The latter three forms of degradation have also been confirmed with pulled tubes and destructive examination. The ISI also monitors for free span indications, cold leg thinning and welded sleeve joint in-service degradation. Thus far no active degradation has been reported in these regions. Also of interest is the performance of the laser weld repaired performed on a number of the HEJs during the 1996/1997 outage. Analysis work was done to justify the operability of these repairs; this information is contained in WCAP-14685, Revision 2, Addendum 1, "Laser Welded Repair of Hybrid Expansion Joint Sleeves for Kewaunee Nuclear Power Plant Addendum 1: Evaluation of Weld Repaired HEJ Sleeved Tubes." Baseline ISI of the laser weld repaired HEJs and CE sleeves and re-sleeves was performed in 1997; therefore, this inspection interval will be within the 20 months specified in TS 4.2.b.3.b.

The data to support the evaluation of structural and accidcnt leakage integrity is based on cycle 22 plant operating conditions; prior cycle ISI data; the results of tests done on tubes removed from KNPP; and in-situ pressure testing performed at a similar plant. The operating conditions for cycle 22 are nearly identical to those of the prior operating cycle, cycle 21, i.e., the same cycle length in EFPMs, and no changes in operating temperature or chemistry. Each degradation mode is discussed below.

Low Row U-Bend SCC

The U-bend region of the lower row tubes (i.e., row 3 and lower) has been inspected since 1990 using MRPC. During the 1990, 1991, 1993 and 1994 inspections no indications of degradation were detected in the low row U-bends. In 1992 one indication was detected in SG B, in 1995 one indication was detected in SG A, and in 1996 two indications were detected in SG A. In all cases the U-bend indications were plugged on detection.

An engineering evaluation was performed for the two indications reported in 1996 to determine the acceptability of the as-found tubing condition. The engineering review concluded that the indication were not through-wall (conservatively determined to have an avcrage depth ranging from 6% to 40% through-wall) and the calculated burst pressures significantly exceeded the recommendations of Regulatory Guide (RG) 1.121. Based on the prior cycle ISI data, which has detected very few new indications each cycle, and no changes in cycle 22 operating conditions that could contribute to an increase in the number of new indications or growth rate; it is reasonable to conclude that the EOC-22 tube intcgrity criteria will be satisfied in the low row U-bend region.

AVB Wear

The upper tube bundle in the vicinity of the AVBs has been inspected since 1983 paying particular attention to indication of wear. In 1983, 21 tubes were plugged for suspected AVB wear. From 1983 to present no additional tubes have required plugging for this mechanism. Based on past inspection data which has shown no increase in degradation since 1983, and no changes in cycle 22 operating conditions that could contribute to an increase in the number of new indications or growth rate, it is reasonable to conclude that the EOC-22 tube integrity criteria will be satisfied in the upper region of the tube bundle potentially affected by AVB wear.

Hot Leg Tubesheet Crevices and Top of Tubesheet Region ODSCC (in unsleeved tubes)

During both the 1995 and 1996 ISI's, 100% of the hot leg crevice region and top of tubesheet in unsleeved tubes were inspected using MRPC. In 1995 a total of 78 new indications of axially-oricnted ODSCC were detected in the tubesheet crevice and in 1996, 52 new indications were detected. The indications were all plugged or repaired on detection. All of the indications were confined to within the tubeshcet crevice and no indications of circumferential cracking were found. Since all of the indications were confined to within the tubesheet, tube burst is not an issue and the structural integrity performance criteria is inherently satisfied.

An engineering assessment was performed to demonstrate that the accident leakage criteria would be satisfied. Although there is not a qualified NDE sizing technique for axially-oriented ODSCC within the tubesheet, a review of the MRPC data showed that the flaws were rclatively short in axial length when compared to axially-oriented ODSCC indications reported at the Zion plant during their last inspection using the same inspection technique. A number of the larger (i.e., longer) flaws at Zion were either in-situ pressure tested, or pulled and subjected to laboratory leakage testing. None

of the flaws located within the tubesheet crevice region leaked under the various pressure test conditions. Due to the similarity of SG design and degradation mechanism, this data can be used to conservatively bound the indications found in the Kewaunee SGs. Based on no tube leakage during pressure testing of the Zion tubes, it is reasonable to conclude that the accident leakage criteria is satisfied for the conditions at KNPP.

Based on the results of the last two inspections which has shown no increase in the number of new indications, and no changes in cycle 22 operating conditions that could contribute to an increase in the number of new indications or growth rate, it is reasonable to conclude that the EOC-22 tube integrity criteria will be satisficd.

Hot Leg and Cold Leg Tube Support Plate Intersection ODSCC

A voltage-based repair criteria has been approved for use by the NRC for the tube support plate intersections that are affected by ODSCC. The Cycle 22 Alternate Repair Criteria 90-day report was submitted to the NRC on September 3, 1997. Using the NRC probability of detection of 0.6, the EOC-22 tube leakage under steam line break conditions was projected to be 2.9 gpm for SG B (the limiting SG) and the probability of burst was projected to be 8.6 E-05. These results meet the Kewaunee site allowable tube leak limit and the NRC guideline of 1.0 E-02 for tube burst probability.

Parent Tube PWSCC in HEJ Sleeved Tubes

During the 1994, 1995, and 1996 ISIs, 100% of the upper HEJs were inspected, results of which are reported in the Background section. There are currently 777 HEJ sleeved tubes in SG A, and 1277 HEJ sleeved tubes in SG B that are in service with no detectable degradation, and 73 HEJs in SG A, and 52 HEJs in SG B that are in service based on the ΔD criteria. A projection of the last three operating cycle of data predicts that there will be 653 HEJs with new PTI in SG A and 690 new PTIs in SG B at the end of cycle 22.

During both the 1995 and 1996 outages a number of HEJ sleeved tubes with PTIs were removed for structural and leakage testing. The samples bounded the indications found; i.e., samples with 0 mil ΔD and large voltages PTIs, as well as a few samples with a 2 to 3 mil ΔD. One sample had a complete 360 degree throughwall crack with a visible parent tube separation of 0.005 to 0.010 inch. All of the tubes that were tensile tested exceeded the RG 1.121 guidance of 3 times normal operating pressure differential. (The results of the 1995 removed HEJ testing were reported to the NRC as a part of the TS amendment request to relocate the pressure boundary, approved TS amendment 128, and the 1996 removed tube data was presented to the NRC staff in a meeting on December 17, 1996.)

Using a very conservative bounding assessment, the projected EOC tube leakage under SLB conditions was calculated by applying the leakage value of 0.025 gpm (from TS 4.2.b.4.b.1) to each new indication and the indications left in-service based on the ΔD criteria.

SG A: (73+653)*0.025 gpm=18.15 gpm

SG B: (52+690)*0.025 gpm=18.55 gpm

The projected accident leakage in the limiting SG (SG B) is still under the site allowable limit when combined with the projected tube support plate intersections. In addition the assigned leak rate value is very conservative. The value of 0.025 gpm was derived from using simulated flaws; the actual leak rate data from HEJs removed from KNPP ranged from no leakage, to a worst case of 0.008 liters per hour (0.0005 gpm.)

Since the upcoming operating cycle (cycle 22) will be nearly identical to the last operating cycle; i.e., no increase in cycle length or operating temperature or chemistry, it is reasonable to assume that the structural and accident leakage criteria will be satisfied throughout the operating cycle.