

b. Steam Generator Tubes

Examinations of the steam generator tubes shall be in accordance with the in-service inspection program described herein. The following terms are defined to clarify the requirements of the inspection program.

Imperfection is an exception to the dimension, finish, or contour required by drawing or specification.

Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

% Degradation is an estimated % of the tube wall thickness affected or removed by degradation.

Degraded Tube means a tube contains an imperfection  $\geq 20\%$  of the nominal wall thickness caused by degradation.

Defect means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective.

Tube Inspection means an inspection of the steam generator tube from the point of entry (e.g., hot leg side) completely around the U-bend to the top support of the opposite leg (cold leg).

Tube - the reactor coolant system pressure boundary past the hot leg side of the tubesheet and before the cold leg side of the tubesheet.

Plugged Tube is a tube intentionally removed from service by plugging in the hot and cold legs because it is defective, or because its continued integrity could not be assured.

Repaired Tube is a tube that has been modified to allow continued service consistent with plant technical specifications regarding allowable tube wall degradation, or to prevent further tube wall degradation. A tube without repairs is a nonrepaired tube.

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1. Steam Generator Sample Selection and Inspection - The in-service inspection may be limited to one steam generator on a rotating schedule encompassing the number of tubes determined in TS 4.2.b.2.a provided the previous inspections indicated that the two steam generators are performing in a like manner.

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2. Steam Generator Tube Sample Selection and Inspection - The tubes selected for each in-service inspection shall:

- a. Include at least 3% of the total number of nonrepaired tubes, and 3% of the total number of repaired tubes in all steam generators. The tubes selected for these inspections shall be selected on a random basis except as noted in 4.2.b.2.b.
- b. Concentrate the inspection by selection of at least 50% of the tubes to be inspected from critical areas where experience in similar plants with similar water chemistry indicates higher potential for degradation.
- c. Include the inspection of all non-plugged tubes which previous inspections revealed in excess of 20% degradation. The previously degraded tube need only be inspected about the area of previous degradation indication if their inspection is not employed to satisfy 4.2.b.2.a and 4.2.b.2.b above.
- d. The second and third sample inspections during each inservice inspection may be less than the full length of each tube by concentrating the inspection on those areas of the tube sheet array and on those portions of the tubes where tubes with imperfections were previously found.
- e. If a tube does not permit the passage of the eddy current inspection probe the entire length and through the U-bend, this shall be recorded and an adjacent tube shall be inspected. The tube which did not allow passage of the eddy current probe shall be considered degraded.

The results of each sample inspection shall be classified into one of the following three categories.

<u>Category</u>	<u>Inspection Results</u>
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.

Category

Inspection Results

C-2

One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.

C-3

More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

NOTE: In all inspections, previously degraded tubes must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

3. Inspection Frequencies - The above required in-service inspections of steam generator tubes shall be performed at the following frequencies:
- a. Inservice inspections shall be performed at refueling intervals not more than 24 calendar months after the previous inspection. If two consecutive inspections following service under AVT conditions, not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months.
  - b. If the results of the inservice inspection of a steam generator conducted in accordance with Table 4.2-2 fall in Category C-3, the inspection frequency shall be increased to at least once per 20 months. The increase in inspection frequency shall apply until a subsequent inspection meets the conditions specified in 4.2.b.3.a and the interval can be extended to a 40 month period.
  - c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.2-2 during the shutdown subsequent to any of the following conditions:

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1. Primary-to-secondary tube leaks (not including leaks originating from tube-to-tube sheet welds) in excess of the limits of Specification 3.1.d and 3.4.a.5,
  2. A seismic occurrence greater than the Operating Basis Earthquake,
  3. A loss-of-coolant accident requiring actuation of the engineered safeguards, where the cooldown rate of the reactor coolant system exceeded 100°F/hr, or
  4. A main steam line or feedwater line break, where the cooldown rate of the reactor coolant system exceeded 100°F/hr.
- d. If the type of steam generator chemistry treatment is changed significantly, the steam generators shall be inspected at the next outage of sufficient duration following three (3) months of power operation since the change.
4. Any tube which, upon inspection, exhibits tube wall degradation of 50% or more shall be plugged or repaired prior to returning the steam generator to service. If significant general tube thinning occurs, this criterion will be reduced to 40% wall degradation.

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5. Reports

- a. Following each inservice inspection of steam generator tubes, if there are any tubes requiring plugging or repairing, the number of tubes plugged or repaired shall be reported to the Commission within 30 days. | 70
- b. The results of the steam generator tube inservice inspection shall be included in the Annual Operating Report for the period in which this inspection was completed. This report shall include:
  - 1. Number and extent of tubes inspected.
  - 2. Location and percent of wall-thickness penetration for each indication of a degradation.
  - 3. Identification of tubes plugged.
  - 4. Identification of tubes repaired. | 70
- c. Results of steam generator tube inspection which fall into Category C-3 require prompt (within 4 hours) notification of the Commission consistent with 10CFR50.72(b)(2)(i). A written followup report shall be submitted to the Commission consistent with 10CFR50.73(a)(2)(ii). | 70

Basis:

The plant was not specifically designed to meet the requirements of Section XI of the ASME Code; therefore, 100 percent compliance may not be feasible or practical. However, access for inservice inspection was considered during the design and modifications have been made where practical to make provisions for maximum access within the limits of the current plant design. Where practical, the inspection of ASME Code Class 1, Class 2 and Class 3 components is performed in accordance with Section XI of the ASME Code. If a code required inspection is impractical, a request for a deviation from the requirement is submitted to the Commission for approval.

The basis for surveillance testing of the reactor coolant system pressure isolation valves identified in table T.S. 3.1-2 is contained within "Order for Modification of License" dated April 20, 1981.

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#### Technical Specification 4.2.b

These technical specifications provide the inspection and repair/plugging requirements for the steam generator tubes at the Kewaunee Nuclear Power Plant. Fulfilling these specifications will assure the KNPP steam generator tubes are inspected and maintained in a manner consistent with current NRC regulations and guidelines including the General Design Criteria in 10CFR50, Appendix A.

General Design Criterion (GDC) 14 "Reactor Coolant Pressure Boundary", and GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," require that the reactor coolant pressure boundary have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. Also, GDC 15, "Reactor Coolant System Design," requires that the reactor coolant system and associated auxiliary, control, and protection systems be designed with sufficient margin to ensure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences. Furthermore, GDC 32 "Inspection of Reactor Coolant System Pressure Boundary," requires that components that are part of the reactor coolant pressure boundary be designed to permit periodic inspection and testing of critical areas to assess their structural and leak tight integrity.

The NRC has developed guidance for steam generator tube inspections and maintenance including Regulatory Guides 1.83, and 1.121. Reg. Guide 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes," forms the basis for many of the requirements in this section and should be consulted prior to any revisions. Reg. Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," defines the minimum wall thickness in a steam generator tube, and may be applied to tube sleeves in determining their minimum wall thickness.

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#### Technical Specification 4.2.b.1

If the steam generators are shown to be operating in a like manner it is appropriate to limit the inspection to one steam generator or a rotating schedule. Economic savings as well as reductions in personnel exposure and outage duration can be realized.

#### Technical Specification 4.2.b.2

Periodic inspection of the steam generator tubes allows evaluation of their service condition. As operational experience has become available it is evident that certain types of steam generators are susceptible to generic degradation mechanisms. Site specific steam generator tube degradation has also occurred throughout the industry. The inspection program at Kewaunee is designed to identify both generic and site specific tube degradation mechanisms.

Steam generator tube surveillance at Kewaunee is generally performed using eddy current techniques. Various methods of eddy current (EC) testing are used to inspect steam generator tubes for wall degradation. EC methods have improved considerably since Kewaunee began commercial operation in 1974. Single frequency EC testing with a single probe and X-Y plotter have evolved into multifrequency techniques with assorted probe types and sophisticated software to allow more accurate volumetric tube examinations. Profilometry techniques are also being developed which detect imperfections in a tube's original geometry. WPSC is committed to utilize advancing EC testing technology, as appropriate, to assure accurate determination of the steam generator tubes' service condition.

#### Technical Specification 4.2.b.3

Steam generator tube inspections are generally scheduled during refueling outages at the Kewaunee Nuclear Power Plant. The tubes scheduled for a given inspection are based upon their service condition determined during previous inspections, and operational experience from other plants with similar steam generators and water chemistry. Identification of degraded steam generator tube conditions results in augmentation of the inspection effort as well as increasing the frequency of subsequent inspections. In this manner, steam generator tube surveillance is consistent with service conditions.

These are several operational occurrences or transients that will require subsequent steam generator tube inspections. These inspections are required as a result of excessive primary to secondary leakage or transients imposing large mechanical and thermal stresses on the tubes.



Technical Specificat 4.2.b.4

Steam generator tubes found exceeding the minimum wall thickness criteria determined by analysis, as described in WCAP 7832(1) and (2), must either be repaired to be kept in service or removed from service by plugging.

Steam generator tube plugging is a common method of preventing primary to secondary steam generator tube leakage and has been utilized since the inception of PWR nuclear reactor plants. This method is relatively uncomplicated from a structural/mechanical standpoint as flow is cut-off from the affected tube by plugging it in the hot and cold leg faces of the tubesheet.

Repair by sleeving or other methods have been recognized as a viable alternative for isolating unacceptable tube degradation and preventing tube leakage. Sleeving can isolate unacceptable degradation and extend the service life of the tube, and the steam generator. Design, installation, testing, and inspection of steam generator tube sleeves requires substantially more engineering than plugging, as the tube remains in service. Because of this, the NRC requires approval of the licensee's 10CFR50.59 review prior to sleeve repair of a steam generator tube.

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Technical Specificat 4.2.b.5

Category C-3 inspection results are considered abnormal degradation to a principle safety barrier and are therefore reportable under 10CFR50.72(b)(2)(i) and 10CFR50.73(a)(2)(i).

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References

(1) WCAP 7832: "Evaluation of Steam Generator Tube, Tube Sheet, and Devider Plate Under Combined LOCA Plus SSE Conditions".

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(2) E. W. James, WPSC to A. Schwencer, NRC Stated September 6, 1977

TABLE 4.2-2

STEAM GENERATOR TUBE INSPECTION

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
A minimum of S Tubes per S. G.	C-1	None	N/A	N/A	N/A	N/A
	C-2	Plug or repair defective tubes and inspect additional 2S tubes in this S. G.	C-1	None	N/A	N/A
			C-2	Plug or repair defective tubes and inspect additional 4S tubes in this S.G.	C-1	None
			C-2	Plug or repair defective tubes and inspect additional 4S tubes in this S.G.	C-2	Plug or repair defective tubes
			C-3	Perform action for C-3 result of first sample	C-3	Perform action for C-3 result of first sample
	C-3	Perform action for C-3 result of first sample	N/A	N/A	N/A	N/A
	C-3	Inspect all tubes in this S.G., plug or repair defective tubes and inspect 2S tubes in the other S. G.  Prompt notification of the Commission.*		None	N/A	N/A
			Some S.G.'s C-2 but no additional S.G. are C-3	Perform action for C-2 result of second sample	N/A	N/A
			Additional S.G. is C-3	Inspect all tubes in each S. G. and plug or repair defective tubes. Prompt notification of the Commission.*	N/A	N/A

S = 6%/n Where n is the number of steam generators inspected during an inspection.

\*Note: Refer to Specification 4.2(b)(5)(c)

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