4.16 INSERVICE INSPECTION OF STEAM GENERATOR TUBING

APPLICABILITY: Applies to the inservice inspection and sampling selection for steam generator tubing.

OBJECTIVE: To monitor the integrity of the steam generator tube primary boundary and provide guidance for corrective action when imperfections are observed.

SPECIFICATION: A. GENERAL STEAM GENERATOR TUBE SELECTION

The steam generators shall be inspected when shutdown by selecting steam genertor tubes on the following basis: 44 10/31/78

1. Tubes for the inpsection shall be selected on a random basis except where experience at San Onofre Unit 1 or experience in similar plants indicates critical areas to be inspected.

2. Each inspection shall include at least 3% of the total number of tubes in each steam generator to be inspected.

3. Inservice inspections may be limited to one steam generator on a rotating schedule encompassing 3% of the total tubes of steam generators in the plant if the results of previous inspections indicate that all steam generators are performing in a like manner.

4. Every inspection shall include all non-plugged tubes in the steam generators to be inspected that previously had detected imperfections greater than 20%, except as specified in Specification C.1.

B. SUPPLEMENTARY INSPECTIONS

If the inspections in Specification A indicate imperfections, additional inspections shall be required as follows:

1. If any of the tubes inspected pursuant to Specification A.3 have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, inspect 3% of the tubes in one of the uninspected steam generators.

2. If more than 10% of the tubes inspected in a steam generator have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, or one or more of the tubes inspected have an imperfection in excess of the plugging limit, inspect an additional 3% of the tubes in that steam generator, concentrating on tubes in those areas of the tube sheet array where tubes with imperfections were found and on that length of tube where the imperfections were found. In addition, the rest of the steam generators shall be inspected in accordance with Specification A.2. 44 10/31/78

3. If the additional inspection in Specification B.2 indicates that more than 10% of the additionally inspected tubes have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, or one or more of the additionally inspected tubes have an imperfection in excess of the plugging limit, inspect an additional 6% of the tubes in that steam generator in the area of the tubesheet array where tubes with imperfections were found and through that length of tube where the imperfections were found.

C. SPECIAL STEAM GENERATOR TUBE INSPECTIONS

In addition to the general steam generator tube inspections performed in Specifications A and B, every inspection shall include the following special inspections:

1. Every inspection shall include all nonplugged tubes in one of the steam generators that previously had been noted as having discretely quantifiable imperfections greater than 30% at antivibration bar (AVB) intersections, and all non-plugged tubes in that steam generator that previously had been noted as having imperfections at AVB intersections which were not discretely quantifiable but which were identified during previous inspections as being in the 30 to 50% range.

2. At each steam generator inspection, all previously identified restricted tubes in either steam generator A or C shall be gauged by using eddy current probes to determine restriction sizes.

D. INSPECTION FREQUENCY

The inspections in Specifications A and B above shall be performed at the following frequencies:

1. Inservice inspections shall be not less than 10 nor more than 24 calendar months after the previous inspection.

2. If two consecutive inspections indicate that less than 10% of the tubes inspected have either (a) new imperfections greater than 20% or (b) previous imperfections that have increased more than 10% since their last inspection, the inspections shall be not less than 10 nor more than 40 calendar months after the previous inspection.

3. Unscheduled inspections shall be conducted in accordance with Specification A in the event of primary-to-secondary leaks exceeding Specification 3.1.4.C, a seismic occurrence greater than an operating basis earthquake, a loss-of-coolant accident requiring actuation of engineered safeguards, or a major steam line or feedwater line break. 44 10/31/78

E. ACCEPTANCE CRITERIA

1. As used in this specification:

   a. Imperfection means an exception to the dimensions, finish, or contour required by drawing or specification.

   b. Defect means an imperfection of such severity that the tube is unacceptable for continued service.

   c. Plugging limit means the imperfection depth at or beyond which plugging of the tube must be performed. The plugging limit is equal to or greater than 50% of the nominal tube wall thickness, except where sleeves are installed, in which case the plugging limit is equal to or greater than 40% of the nominal sleeve wall thickness. 60 6/8/81

2. If, in the inspections performed under Specification A,

   a. Less than 10% of the total tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, and

   b. No tube inspected exceeds the plugging limit, plant operation may resume.

3. If, in the inspections performed under Specification B,

   a. Less than 10% of the total tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, and 44 10/31/78

   b. No more than 3 of the tubes inspected exceed the plugging limit,

   plant operation may resume after performance of the corrective action in Specification F.

4. If, in the inspections performed under Specification B,

   a. More than 10% of the tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, or

   b. More than 3 of the tubes inspected exceed the plugging limit,

   the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action. 91 11/14/85

5. If in the inspections performed under Specification C.1, wear rates are observed at AVB intersections which are inconsistent with the 50% plugging criterion, the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action. 91 11/14/85

6. If in the inspections performed under Specification C.2 progression of the denting process is observed to be recurring, the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action. 91 11/14/85

F. CORRECTIVE ACTION

All leaking tubes, defective tubes, and tubes with imperfections exceeding the plugging limit shall be repaired or plugged.

<u>BASIS</u>:

The Surveillance Requirements for inspection of the steam generator tubes ensure that the structural integrity of this portion of the Reactor Coolant System will be maintained. The program for inservice inspection of steam generator tubes is based on Regulatory Guide 1.83, Revision 1. Inservice inspection of steam generator tubing is essential in order to maintain surveillance of the conditions of the tubes in the event that there is evidence of degradation due to design, manufacturing errors, or inservice conditions that lead to corrosion. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken. 44 10/31/78

The plant is expected to be operated in a manner such that the secondary coolant will be maintained within those chemistry limits found to result in negligible corrosion of the steam generator tubes. If the secondary coolant chemistry is not maintained within these limits, localized corrosion may likely result in stress corrosion cracking. The extent of cracking during plant operation would be limited by the limitation of steam generator tube leakage between the primary coolant system and the secondary coolant system (primary-to-secondary leakage = .3 gallons per minute per steam generator). Cracks having a primary-to-secondary leakage less than this limit during operation will have an adequate margin of safety to withstand the loads imposed during normal operation and by postulated accidents. Operating plants have demonstrated that primary-to-secondary leakage of .3 gpm per steam generator can readily be detected by radiation monitors of steam generator blowdown. Leakage in excess of this limit will require shutdown during which the leaking tubes will be located and plugged and additional inspections performed. 44 10/31/78

If a defect should develop in service, it will be found during scheduled inservice steam generator tube examinations. Plugging will be required for all tubes with imperfections exceeding the plugging limit of 50% of the tube nominal wall thickness, except where sleeves are installed, in which case the plugging limit is 40% of the nominal sleeve wall thickness. A plugging limit of 50% for tubes and 40% for sleeves ensures that defects will not occur between inspection intervals. 60 6/8/81

The results of tube ID gauging and dent detection conducted in San Onofre Unit 1 steam generators demonstrate that the denting process has been arrested. Continuing assurance of this condition can be provided by performing a program of limited tube ID gauging and dent detection in either steam generator A or C on a refueling outage frequency. Adequate surveillance of denting related tube restrictions can be maintained at refueling intervals by noting any new restrictions during the conduct of general surveillance and AVB inspections and by gauging tubes which have previously been noted as being restricted. Progression of denting can also be monitored in either steam generator A or C by evaluating third and fourth support plate denting data obtained from the general surveillance and AVB inspections as well as from the ID gauging program and comparing these results with those of previous inspections. 44 10/31/78

The results of AVB area inspections conducted in San Onofre Unit 1 steam generators demonstrate that AVB modifications installed during the Cycle VI refueling outage were successful in eliminating significant growth of tube wall penetration indications at AVB locations. Continuing assurance of this condition can be provided by performing U-bend inspections at refueling outage intervals of tubes having wall penetration indications in excess of 30% at AVB locations.

4.16 INSERVICE INSPECTION OF STEAM GENERATOR TUBING

APPLICABILITY: Applies to the inservice inspection and sampling selection for steam generator tubing.

OBJECTIVE: To monitor the integrity of the steam generator tube primary boundary and provide guidance for corrective action when imperfections are observed.

SPECIFICATION:

A. GENERAL STEAM GENERATOR TUBE SELECTION

The steam generators shall be inspected when shutdown by selecting steam generator tubes on the following basis:

1. Tubes for the inspection shall be selected on a random basis except where experience at San Onofre Unit 1 or experience in similar plants indicates critical areas to be inspected.

2. Each inspection shall include at least 3% of the total number of tubes in each steam generator to be inspected.

3. Inservice inspections may be limited to one steam generator on a rotating schedule encompassing 3% of the total tubes of steam generators in the plant if the results of previous inspections indicate that all steam generators are performing in a like manner.

4. Every inspection shall include all non-plugged tubes in the steam generators to be inspected that previously had detected imperfections greater than 20%.

B. SUPPLEMENTARY INSPECTIONS

If the inspections in Specification A indicate imperfections, additional inspections shall be required as follows:

1. If any of the tubes inspected pursuant to Specification A.3 have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, inspect 3% of the tubes in one of the uninspected steam generators.

2. If more than 10% of the tubes inspected in a steam generator have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, or one or more of the tubes inspected have an imperfection in excess of the plugging limit, inspect an additional 3% of the tubes in that steam generator, concentrating on tubes in those areas of the tube sheet array where tubes with imperfections were found and on that length of tube where the imperfections were found. In addition, the rest of the steam generators shall be inspected in accordance with Specification A.2.

3. If the additional inspection in Specification B.2 indicates that more than 10% of the additionally inspected tubes have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration since their last inspection, or one or more of the additionally inspected tubes have an imperfection in excess of the plugging limit, inspect an additional 6% of the tubes in that steam generator in the area of the tubesheet array where tubes with imperfections were found and through that length of tube where the imperfections were found.

C. INSPECTION FREQUENCY

The inspections in Specifications A and B above shall be performed at the following frequencies:

1. Inservice inspections shall be not less than 10 nor more than 24 calendar months after the previous inspection.

2. If two consecutive inspections indicate that less than 10% of the tubes inspected have either (a) new imperfections greater than 20% or (b) previous imperfections that have increased more than 10% since their last inspection, the inspections shall be not less than 10 nor more than 40 calendar months after the previous inspection.

3. Unscheduled inspections shall be conducted in accordance with Specification A in the event of primary-to-secondary leaks exceeding Specification 3.1.4, a seismic occurrence greater than an

operating basis earthquake, a loss-of-coolant accident requiring actuation of engineered safeguards, or a major steam line or feedwater line break.

D. ACCEPTANCE CRITERIA

1. As used in this specification:

   a. Imperfection means an exception to the dimensions, finish, or contour required by drawing or specification.

   b. Defect means an imperfection of such severity that the tube is unacceptable for continued service.

   c. Plugging limit means the imperfection depth at or beyond which plugging of the tube must be performed. The plugging limit is equal to or greater than 50% of the nominal tube wall thickness, except where sleeves are installed, in which case the plugging limit is equal to or greater than 40% of the nominal sleeve wall thickness.

2. If, in the inspections performed under Specification A,

   a. Less than 10% of the total tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, and

   b. No tube inspected exceeds the plugging limit, plant operation may resume.

3. If, in the inspections performed under Specification B,

   a. Less than 10% of the total tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, and

   b. No more than 3 of the tubes inspected exceed the plugging limit,

   plant operation may resume after performance of the corrective action in Specification E.

4. If, in the inspections performed under Specification B,

    a. More than 10% of the tubes inspected have imperfections greater than 20% that were not detected during the previous inspections or have previously detected imperfections that have increased more than 10% wall penetration, or

    b. More than 3 of the tubes inspected exceed the plugging limit,

    the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action.

E. CORRECTIVE ACTION

All leaking tubes, defective tubes, and tubes with imperfections exceeding the plugging limit shall be repaired or plugged.

<u>BASIS</u>: The Surveillance Requirements for inspection of the steam generator tubes ensure that the structural integrity of this portion of the Reactor Coolant System will be maintained. The program for inservice inspection of steam generator tubes is based on Regulatory Guide 1.83, Revision 1. Inservice inspection of steam generator tubing is essential in order to maintain surveillance of the conditions of the tubes in the event that there is evidence of degradation due to design, manufacturing errors, or inservice conditions that lead to corrosion. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken.

The plant is expected to be operated in a manner such that the secondary coolant will be maintained within those chemistry limits found to result in negligible corrosion of the steam generator tubes. If the secondary coolant chemistry is not maintained within these limits, localized corrosion may likely result in stress corrosion cracking. The extent of cracking during plant operation would be limited by the limitation of steam generator tube leakage between the primary coolant system and the secondary coolant system (primary-to-secondary leakage = .3 gallons per minute per steam generator). Cracks having a primary-to-secondary leakage less than this limit during operation will have an adequate margin of safety to withstand the loads imposed during normal operation and by postulated accidents. Operating plants have demonstrated that primary-to-secondary leakage of .3 gpm per steam generator can readily be detected by radiation monitors of steam generator blowdown. Leakage in excess of this limit will require shutdown during which the leaking tubes will be located and plugged and additional inspections performed.

If a defect should develop in service, it will be found during scheduled inservice steam generator tube examinations. Plugging will be required for all tubes with imperfections exceeding the plugging limit of 50% of the tube nominal wall thickness, except where sleeves are installed, in which case the plugging limit is 40% of the nominal sleeve wall thickness. A plugging limit of 50% for tubes and 40% for sleeves ensures that defects will not occur between inspection intervals.

The results of tube ID gauging and dent detection conducted in San Onofre Unit 1 steam generators demonstrate that the denting process has been arrested. Continued assurance of this condition will be provided by monitoring for dent progression as part of the general steam generator tube inspection in accordance with Specification A. Progression of denting is adequately monitored in either steam generator A or C by reviewing required eddy current probe size reductions during the performance of this inspection scope.

The results of AVB area inspections conducted in San Onofre Unit 1 steam generators demonstrate that AVB modifications installed during the Cycle VI refueling outage were successful in eliminating significant growth of tube wall penetration indications at AVB locations. Continuing assurance of this condition can be provided by performing U-bend inspections as part of the Specification A inspection scope at refueling outage intervals of tubes having wall penetration indications in excess of 20% at AVB locations.

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STEAM GENERATOR TUBE/ANTIVIBRATION BAR WEAR AND TUBE DENTING EVALUATION SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1

INTRODUCTION

San Onofre Nuclear Generating Station Unit 1 (SONGS-1) began commercial operation on January 1, 1968. Beginning in 1972, eddy current inspections have been conducted on SONGS-1 steam generators during scheduled refueling outages, unscheduled steam generator tube leak outages, and NRC mandated outages. Two major problems identified during these eddy current inspections were tube denting at the first and second support plates in A and C steam generator and tube/antivibration bar (AVB) wear. A brief history of tube denting and tube/AVB wear in the SONGS-1 steam generators is presented below:

- In 1972, eddy current testing identified that tube denting at the tube support plate and wear at the tube/AVB intersection had occurred at SONGS-1.

- A special steam generator denting inspection in 1976 revealed that SONGS-1 did not have any of the conditions that led to a steam generator tube failure at Surry Unit 2. Also, in 1976 to arrest tubing wear at the AVBs, additional, redesigned AVBs were installed.

- In September 1977, following 142 effective full power days (EFPD) of operation from the previous 1976 special denting inspection, the steam generators were inspected to assess the progression of denting, and to monitor the AVB fix. The results of this inspection indicated that no significant increase in tube denting had occurred and the tube/AVB wear had been arrested.

- In April 1978, an NRC mandated steam generator denting inspection program was conducted. The results of this inspection indicated that tube denting was not progressing.

- Subsequent SONGS-1 steam generator inspections in 1980, 1982, 1984 and 1985 have confirmed that steam generator tube denting is not progressing and growth of tube wear indications at the AVBs is not occurring.

A proposed change to the technical specifications that was consistent with the recommendations of Regulatory Guide 1.83, Revision 1, was submitted to the NRC in July 1978. This proposed change was later revised to include special inspection and reporting requirements to monitor tube denting and tube/AVB wear. The special inspection requirements that were incorporated into the SONGS-1 operating license as Specification 4.16.C, "Special Steam Generator Tube Inspection", were as follows:

1. Every inspection shall include all non-plugged tubes in one of the steam generators that previously had been noted as having discretely quantifiable imperfections greater than 30% at AVB intersections, and all non-plugged tubes in that steam generator that previously had been noted as having imperfections at AVB intersections which were not discretely quantifiable, but which were identified during previous inspections as being in the 30 to 50% range.

2. At each steam generator inspection, all previously identified restricted tubes in either steam generator A or C shall be gauged by using eddy current probes to determine restriction sizes.

The reporting requirements in Specification 4.16.E.5 and 6 for these two special inspections were as follows:

5. If in the inspections performed under Specification C.1, wear rates are observed at AVB intersections which are inconsistent with the 50% plugging criterion, the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action.

6. If in the inspections performed under Specification C.2, progression of the denting process is observed to be recurring, the situation shall be reported to the Commission in accordance with Technical Specification 6.6 for approval of the proposed remedial action.

The purpose of this evaluation is to determine if Technical Specification 4.16, "Inservice Inspection of Steam Generator Tubing," should be revised to delete the inspection and reporting requirements for the dent gauging program and incorporate the inspection and reporting requirements for monitoring tube/AVB wear into Section A.4.

DENTING EVALUATION

Denting Operating History

Denting was first evidenced in the SONGS-1 steam generators in January 1972. The tube denting was discovered as a result of a tube leak investigation in C steam generator. The leaking tube restricted the smallest probe available, 0.480 inch diameter, corresponding to at least a 0.160 inch dent at the first tube support plate (nominal tube inner diameter is 0.640 inch). Eddy current testing of 650 tubes around the leaking tube revealed each tube was dented at the first and second support plates. These dents were estimated to indicate less than a 0.005 inch diameter reduction and were attributed to possible loads imposed during shipping and handling, since the corrosion induced denting phenomenon had not yet been identified. There were no dent indications at the third or fourth support plates.

Again in October 1972, the plant was shut down to investigate a tube leak in A steam generator. Subsequent eddy current testing of 130 tubes revealed 19 tubes which restricted passage of a 0.540 inch diameter probe, 69 tubes with dent indications at the first and second support plates, and no denting at the third or fourth support plates. In January 1973, the plant was shut down to investigate a third tube leak, again in A steam generator. Of 37 tubes inspected, 7 were reported as restricting the 0.540 inch diameter probe and all were reported as having dent indications at the first and second support plates with no indications at the third or fourth support plates. Subsequent denting inspections conducted in June 1973, October 1973, April 1974, March 1975, June 1975, and October 1976 yielded consistent results, i.e., every tube which was inspected in the A and C steam generator hot legs, was dented at the first and second support plates. Some minor dent indications were observed at the third and fourth support plates. The only dented tubes observed in B steam generator were a limited number of peripheral tubes documented in 1966 prior to initial plant startup. These dents resulted from loads imposed on the tube bundle during shipment and handling.

The October 1976 steam generator inspection included a special denting inspection. The purpose of this inspection was to ascertain the extent of the denting problem and to provide a baseline to allow monitoring of dent progression in future outages. A photographic and videotape examination of the support plate flowslots and eddy current testing was conducted in all three steam generators. Deformation, hourglassing, and cracking were visible in the bottom two tube support plates in A and C steam generators. No evidence of deformation, hourglassing, or cracking existed in the upper two support plates in A and C steam generators or any of the four support plates in B steam generator. Results from the eddy current inspection indicated a correlation between the flowslot deformation and denting at the first and second support plates in A and C steam generators. Further, there was no denting in the third and fourth support plates in A and C steam generators and no denting at any of the tube support plates in B steam generator.

Utilizing this denting inspection baseline in each subsequent outage (September 1977, April 1978, September 1978, May 1980, February 1982, April 1984 and December 1985) the denting inspection results were compared to the previous inspection results to establish if denting was progressing. This results comparison yields the conclusion that, since this baseline inspection in October 1976, there has been no indicated progression of denting. This conclusion is illustrated in a tabulation of the A and C steam generator denting inspection (tube gauging) results, which are shown in Tables 1 through 4. The results in Tables 1 through 4 show some tubes which were more restricted than in previous inspections. These results are within the expected variability of the gauging process and are not attributable to a significant progression of the denting process. Therefore, it is concluded that steam generator tube denting, as compared to previous inspection results, is not progressing at San Onofre Unit 1.

Denting Mechanism

Denting of steam generator tubing is caused by the corrosion of tube supports or the tubesheet. This denting process is presently well understood. Corrosion products and other impurities present in the steam generator feedwater are transported to and concentrated in a crevice (e.g., between the tube and tube support or tubesheet) by boiling heat transfer (alternate wetting and drying of the surface). The chlorides concentrated in the crevice initiate the chemical reactions (corrosion of the tube support/tubesheet). The anodic reaction, caused by chlorides, creates an acidic environment, oxidizes the iron contained in the tube support plate or tubesheet into magnetite, releases hydrogen gas, and also releases electrons which are used by copper and/or oxygen to sustain the overall corrosion reaction. The overall corrosion reaction forms magnetite which is approximately twice the volume of the iron consumed in the corrosion process. As the corrosion reaction continues, the growth of magnetite within the crevice eventually results in stresses on the tube and tube support structure, causing tube denting and support structure ligament fracturing. Therefore, denting is caused by chloride and copper/oxygen ingress, the creation of an acidic environment, and corrosion of the tube support plate or tubesheet.

Denting Mechanism Initiated

Examination of the operational history of the plant indicates that the above conditions that cause denting existed during November 1970 to April 1971. During this period the plant had copper condenser and feedwater tubing, frequent saltwater inleakage due to condenser tube leaks (average chloride levels were between 10 to 15 ppm), and no feedwater phosphate additions. Phosphate treatment of feedwater was changed to all volatile treatment during this period in an attempt to control chemistry related to the unequal moisture carryover. However, due to the significant blowdown required to control saltwater concentrations, the plant was returned to phosphate control in April 1971. Therefore, it is concluded that denting of the SONGS-1 steam generators occurred during this time frame and was arrested when phosphate chemistry was restored.

Current Chemistry Performance

The performance of the SONGS-1 steam generators has significantly improved. The SONGS-1 secondary water chemistry control guidelines have evolved utilizing input from industry experience, unit specific experience, and information from the EPRI Steam Generator Owners Group. Current secondary side water chemistry limits at SONGS-1 are as follows:

Steam Generator	
pH	9.4-10.2
Conductivity	$\leq$ 125uS/cm
Chloride	$\leq$ 500 ppb
Phosphate	15-30 ppm
Na/PO4	2.3-2.6
Condensate	
Oxygen	$\leq$ 10 ppb

Based on experience at SONGS-1 and other PWRs it is believed that by maintaining chemistry within these limits, denting will not progress in the SONGS-1 steam generators.

Denting Summary and Conclusions

In summary, denting has not progressed in the SONGS-1 steam generators since 1972. Denting occurred during a brief period of time (6 months) when phosphate chemistry was discontinued. Further, if denting was to progress, inspections conducted in accordance with Specification 4.16.A would identify the problem by noting new restrictions to eddy current probes that had previously passed. Therefore, in order to reduce personnel radiation exposure, inspection costs, and eliminate unwarranted inspections, the requirement for special dent gauging inspections should be deleted from Technical Specification 4.16.

AVB EVALUATION

AVB Inspection History

The SONGS-1 steam generators were manufactured with round, carbon steel AVBs. Fretting wear of tubes at many of these AVB intersections led in 1976 to the installation of square, chrome plated, Inconel AVBs between and adjacent to the originally installed AVBs as depicted in Figure 1. The additional AVBs are considered to have substantially impeded, if not eliminated, the fretting and wear processes. This conclusion is based on operating experience and eddy current examination results since their installation.

AVB inspection results (Table 5) show that the installation of the square AVBs has apparently arrested the fretting/wear process by tightening the upper bundle and restraining tubes against flow induced vibration. Therefore, the AVB indications of primary concern are those associated with the original round bars. The shapes of flaws at round AVB intersections, as evidenced by U-bend specimens removed from SONGS-1, are dish-like with axial and circumferential extents on the order of the AVB diameter (1/4") and with varying depths. Specimens of round AVB bars removed, show that the bars themselves are worn in dish-like patterns to varying extents at areas of contact with tubes. Thus, there are probably as many different combinations of flaws and worn AVBs at tube/AVB intersections, as there are intersections. Compounding these possibilities is the varying degree to which the round AVBs may or may not be in contact with tubes. Depending on factors such as the extent of AVB and tube wear, the size of the gap between tubes created by the square AVBs, tube pitch alignment in the upper bundle, etc., the degree of contact between round AVBs and tubes can range from intimate contact to a sizable gap between tube and AVB. Finally, due to tube bundle expansion and contraction during steam generator heat-up and cool-down, relative motion may occur between AVBs and tubes at some intersections resulting in axial offset of tube/AVB intersections in cold conditions versus operating conditions.

These possible variations in configuration of tube/AVB intersections are reflected in the eddy current responses. For example, assuming a flaw of given depth, the phase response of a single frequency, differential test, varies dependent on the extent of the flaw in relation to coil width and spacing and upon the degree of AVB contact. Since the flaws are typically dished or tapered and of the same or larger axial extent as the nominal differential coil set (.2"-.3"), the phase response of the differential coil may be distorted and nondiscrete when traversing an AVB flaw. The proximity of the AVB bar also influences the phase and amplitude of the eddy current indication.

<u>Previous AVB Indication Interpretation Guidelines</u>

In 1977, a technique was developed by Westinghouse to interpret AVB indications based upon the inherent available characteristics of AVB wear and utilizing single frequency information. Defects resulting from AVB induced tube wear create a situation wherein only two combinations of defect volume and depth are possible. The tube wall may contain defects on either one or two sides of the tube. If a defect of a given depth occurs on one side of the tube only, the volume of the defect is a minimum and the corresponding amplitude of the defect signal is a minimum. The maximum signal amplitude for a given defect depth would result from the presence of equal defect depths on both sides of a tube. Thus, for any given defect depth as determined by phase angle measurements, there is a corresponding minimum and maximum signal amplitude. Signal amplitudes outside this range of minimum to maximum signal amplitudes cannot be due to defect depths as suggested by phase angle measurement alone, but must be associated with lesser or greater defect depths, respectively.

This interpretation technique resulted in many AVB indications that were not discretely quantifiable. Further, because of the low signal amplitude of AVB indications less than 30 percent through wall, these indications could not be quantified. Therefore, in order to monitor the AVB wear, special AVB inspection criteria were included in the technical specification change submitted in 1978.

<u>Current AVB Indication Interpretation Guidelines</u>

Beginning in 1984, both multifrequency eddy current testing techniques and an AVB standard (Figure 2) were utilized at SONGS-1 to discretely quantify AVB wear indications. Mixing techniques, amplitude analysis and the use of the absolute mode were utilized to minimize the inherent ambiguity in the examination of AVB wear indications. In the test itself, both the ASME standard with carbon steel support ring and the AVB standard are used. Usually, only differential phase vs. depth analysis is done with the ASME standard, while absolute and/or differential amplitude vs. depth analysis, as well as phase analysis, is done with the AVB standard.

Utilizing these new techniques, AVB wear indications are now quantifiable in the same range (greater than 20 percent through wall) as other defect indications. At SONGS-1, all previous AVB wear indications have been inspected in all three steam generators and have been given a discretely quantifiable defect depth (if greater than 20 percent through wall).

AVB Summary and Conclusions

In summary, AVB wear indication evaluation methods, prior to the introduction of multifrequency eddy current testing, could not quantify AVB defects that were less than 30 percent through wall. Now, using multifrequency eddy current techniques and an AVB standard, AVB indications greater than 20 percent through wall are quantifiable. Therefore, the requirement for special AVB inspections should be deleted and the AVB indications that are greater than 20 percent through wall will be inspected in accordance with Technical Specification 4.16 Section A.4.

CONCLUSION

Denting of SONGS-1 steam generators occurred during a six month period in 1971 and 1972. Since that time, it has been demonstrated that denting is not progressing. Further, because of improved station operation and the resulting improved secondary water chemistry, it is highly unlikely that denting at SONGS-1 will progress. Therefore, the special requirement for denting gauging of A and C steam generator should be deleted.

Improved steam generator tubing eddy current testing and evaluation techniques have allowed AVB wear indications to be quantified in the same manner as other defect indications (greater than 20 percent through wall). Further, all previously non-quantifiable indications in each steam generator have been inspected, evaluated and assigned discrete defect depths. On this basis, the special inspections for AVB wear indications should be deleted and all AVB wear indications that are greater than 20 percent through wall will be inspected in accordance with Technical Specification 4.16 Section A.4.

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" OUTLET

TUBE NO.		2/72	11/73	4/74	6/75	10/76	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D.	
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E	DECREASE	COMMENTS
1	33															1	1				1	2	0		1	2	0		NO	
1	34																1	0			1	0			1	0			NO	
1	41															1	0				0				0				NO	
1	49															1	1	0			1	0			1	0			NO	
2	49																1	0			1	0			1	0			NO	
36	19											0				4	0				0				0				NO	
36	20											0				4	4	0			4	0			0				NO	
36	21											0				4	0				4	0			0				NO	
37	21											0				4	4	0			0				0				NO	
37	22											0				4	0				0				0				NO	
37	80											0				4	0				0				0				NO	
37	81											4	0			4	4	0			4	0			0				NO	
37	82											4	0			4	4	0			4	0			4	0			NO	
38	21											4	0			4	4	0			4	0			4	0			NO	
38	80											4	0			4	4	0			0				4	0			YES	
38	81											4	0			4	4	4	0		4	4	0		4	4	0		NO	
39	21											0				4	4	0			4	0			4	0			NO	
39	30											4	0			4	4	0			4	0			4	0			NO	
44	30															2	0				0				0				NO	
44	32															2	2	0			2	0			2	0			NO	

NOTES: 1. A - .580" DIAMETER PROBE
B - .560" DIAMETER PROBE
C - .500" DIAMETER PROBE
D - .460" DIAMETER PROBE
E - .400" DIAMETER PROBE

2. 0 - PROBE NOT RESTRICTED AT ANY LEVEL
1 - PROBE RESTRICTED AT FIRST SUPPORT LEVEL
2 - PROBE RESTRICTED AT SECOND SUPPORT LEVEL
3 - PROBE RESTRICTED AT THIRD SUPPORT LEVEL
4 - PROBE RESTRICTED AT FOURTH SUPPORT LEVEL

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO. ROW	TUBE NO. COL.	2/72	11/73	4/74	6/75	10/76	9/77	4/78 B	4/78 C	4/78 D	4/78 E	9/78 B	9/78 C	9/78 D	9/78 E	5/80 A	5/80 B	5/80 C	5/80 D	5/80 E	2/82 B	2/82 C	2/82 D	2/82 E	12/85 B	12/85 C	12/85 D	12/85 E	EVIDENCE OF I.D. DECREASE	COMMENTS
1	1							1	0			1	0			1	1	0			1	0			[illegible]	0			NC	
1	15															4	0				0				0				NO	
1	17															2	0				0				0				NO	
1	19							1	0			1	0			1	1	0			1	0			1	0			NO	
1	19															2	0				0				1	0			YES	
1	21							1	0			0				0					0								NO	
												2	0			2	2	0			0				0				NC	
1	24															2	0				0				0				NO	
1	26															2	0				0				0				NO	
1	28															1	0				0				0				NO	
								2	0			0					0				0								NO	
1	29															2	0				0				0				NO	
1	30															1	0				0				0				NO	
1	33							1	0			1	0			1	1	0			1	0			1	0			NO	
[illegible]	74							1	0			1	0			1	1	0			1	0			1	0			NO	
1	35															1	0				0				1	0			YES	
1	41															2	0				0				0				NO	
1	43															2	0				0				0				NO	
1	44															2	0				0				0				NO	
1	45							1	0			1	0			1	1	0			2	0							NO	
1	46															1	0				0				0				NO	
1	47															1	0				0				0				NO	
1	49							1	0			1	0			1	1	0			1	0			1	0			NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO. ROW	COL.	2/72	11/73	4/74	6/75	10/76	9/77	4/78 B	C	D	E	9/78 B	C	D	E	5/80 A	B	C	D	E	2/82 B	C	D	E	12/85 B	C	D	E	EVIDENCE OF I.D. DECREASE	COMMENTS
1	52															1	0				0				0				NO	
1	53															1	0				0				0				NO	
1	54															1	0				0				0				NO	
1	55															1	0				0				0				NO	
1	57															1	0				0				0				NO	
1	58															1	0	0			0				0				NO	
					>.500(2)			2	0			0					0	0			0								NO	
1	59															1	0				0				0				NO	
					>.500(2)			2	0			0					0				0								NO	
1	60															1	0	0			0				0				NO	
					>.500(2)			2	0			0					0	0			0				0				NO	
1	61															1	0	0			0				0				NO	
					>.500(2)			2	0			0					0	0			0								NO	
1	62							1	0				0			1	0				0								NO	
												2	0				2	0			2	0			0				NO	
1	63															1	0	0			0				0				NO	
					>.500(2)			2	0			2	0				0	0			0								NO	
1	64			>.500(1)			<.500(1)	1	0			1	0			1	1	0			1	0			1	0			NO	
1	65															1	0				0				0				NO	
1	66															1	0				0				0				NO	
1	70		>.500(1)					1	0			0				1	0	0			0				0				NO	
1	71			>.500(2)			<.500(2)	0				0				1	0	0			0				0				NO	
1	72							1	0			1	0			1	1	0			1	0			1	0			NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO.		2/72	11/73	4/74	6/75	10/75	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF T.D.	COMMENTS
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E	DECREASE	
1	73															1	0	0			0				0				NO	
							(.540(2)	2	0			0					0	0			0				0				NO	
1	74															2	0				0				0				NO	
1	75							2	0			2	0			2	2	0			2	0			2	0			NO	
1	76							2	0			0				2	0	0			0				0				NO	
1	87							1	0			0				0	0				0				0				NO	
2	1							2	0			2	0				2	0			2	0			2	0			NO	
2	10																0				0				0				NO	
2	17															1	1	0				0				0			NO	SLEEVE
								2	0			0						0				0				0			NO	
2	18															1	0					0				0			NO	SLEEVE
2	20							1	0			0					0					0							NO	SLEEVE
												2	0				2	0				0				0			NO	
2	21							2	0			0				0						0				0			NO	SLEEVE
2	23							2	0			0					2	0				0				0			NO	SLEEVE
2	24							2	0			0					2	0				0				0			NO	SLEEVE
2	27															1	1	0				0				0			NO	SLEEVE
2	42															1	0					0				0			NO	SLEEVE
2	43															1	0					0				0			NO	SLEEVE
								2	0			2	0				2	0				0				0			NO	SLEEVE
2	44							1	0			1	0				1	0				0				0			NO	SLEEVE
2	45															1	0					0				0			NO	SLEEVE
2	47							1	0			1	0			1	1	0				0				0			NO	SLEEVE

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO. ROW	TUBE NO. COL.	2/72	11/73	4/74	6/75	10/76	9/77	4/78 B	4/78 C	4/78 D	4/78 E	9/78 B	9/78 C	9/78 D	9/78 E	5/80 A	5/80 B	5/80 C	5/80 D	5/80 E	2/82 B	2/82 C	2/82 D	2/82 E	12/85 B	12/85 C	12/85 D	12/85 E	EVIDENCE OF I.D. DECREASE	COMMENTS
2	50					.500-.540(1)	<.540(2)	1	0			1	0			1	1	0				0				0			NO	SLEEVE
2	51					<.500(1)	<.500(1)	1	1	0		1	1	0		1	1	1	0			1	0			1	0		NO	SLEEVE
2	56	.340-.580(1)						1	0			1	0			1		0				0							IPD	SLEEVE
2	60	.340-.580(1)			.500-.580(1)	.500-.580(1)		0				0				1	0					0							IPD	SLEEVE
2	61				.500-.580(1)	.500-.580(1)		0				0				1	0													PLUG
2	62				.500-.580(1)	.500-.580(1)		0				0				1	0													PLUG
2	63				.500-.580(1)	.500-.580(1)		0				0				1	0													PLUG
2	65			>.500(2)		.500-.540(2)		2	0			2	0				2	0												PLUG
2	66			>.500(2)			<.540(2)									1	0													PLUG
2	68			>.500(1)		.500-.540(1)		1	0			1	0			1	1	0												PLUG
							<.540(2)		0				0					0												
2	69			>.500(1)				1	0			0				1	0													PLUG
2	71			>.500(1)				1	0			1	0			1	1	0												PLUG
2	72						<.540(2)	0				0				1	0													PLUG
2	88							1	0			1	0				1	0			0				0				NO	
2	89							1	0			1	0			1	1	0			1	0			1	0			NO	
3	1							2	0			2	0				2	0			2	0			2	0			NO	
3	12							1	0			1	0			1	0					0				0			NO	SLEEVE
3	24															1	0					0				0			NO	SLEEVE
3	26															1	0					0				0			NO	SLEEVE
								2	0			0					2	0				0				0			NO	
3	27							2	0			2	0				2	0				0				0			NO	SLEEVE
3	44							2	0			2	0				2	0				0				0			NO	SLEEVE

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO.		2/72	11/73	4/74	6/75	10/75	5/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D.	
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E	DECREASE	COMMENTS
3	45															1	0					0							IPD	SLEEVE
								2	0			0					2	0				0				0			NO	
3	46							1	0			0	0			1	0					0							NO	SLEEVE
												2	0				0					0				0			NO	SLEEVE
3	47															1	0					0				0			NO	SLEEVE
3	50							1	0			0				1	1	0				0				1	0		YES	SLEEVE
3	51							1	0			0				1	1	0				0				0			NO	SLEEVE
3	57															1	0					0				0			NO	SLEEVE
								2	0			0					2	0				0							NO	
3	61				.500-.580(1)	.500-.580(1)		0				0				1	0	0				0				0			NO	SLEEVE
3	62				.500-.58)(1)	.500-.590(1)		0				0				1	0					0				0			NO	SLEEVE
3	75							1	0			1	0			1	1	0				0				0			NO	SLEEVE
3	76															1	0					0				0			NO	SLEEVE
4	10							1	0			0					0				0				0				NO	
4	25							2	0			2	0				2	0				0				0			NO	SLEEVE
4	27															2						0				0			NO	SLEEVE
4	40															1						0				0			NO	SLEEVE
4	43															1	0					0				0			NO	SLEEVE
								2	0			2	0				0					0							NO	
4	50				.500-.580(1)	.500-.580(1)		1	0			1	0			1	1	0				0				0			NO	SLEEVE
4	61				.500-.580(1)	.500-.550(1)		1	0			1	0			1	1	0				0				0			NO	SLEEVE
4	74															1	0									0			NO	SLEEVE
5	26							1	0			0				1	1	0								0			NO	SLEEVE

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO. ROW	COL.	2/72	11/73	4/74	6/75	10/76	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D. DECREASE	COMMENTS
								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E		
5	27											2	0				2	0				0				0			NO	
5	28											0					2	0				0				0			NO	
5	41															1	0					0				0			NO	SLEEVE
5	42							2	0			0					2	0				0				0			NO	SLEEVE
5	59															1						0							IPD	SLEEVE
5	60				.500-.580(2)	.500-.580(2)		2	0			0					2	0				0				0			NO	SLEEVE
5	75															1						0				0			NO	SLEEVE
6	26							1	0			0				1	1	0				0				0			NO	
6	27																1	0				0				0			NO	
6	57															1	0					0				0			NO	SLEEVE
6	60				.500-.580(1)	.500-.580(1)		0				0				1	1	0				0				0			NO	SLEEVE
7	74															1						0				0			NO	SLEEVE
8	2							1	0			1	0			1	1	0			0				2	0			YES	
9	2															1	0				0				0				NO	
[illegible]	[illegible]																2	0			0				4	0			YES	
11	2							4	0			0					4	0			0				0				NO	
11	3							4	0			0					4	0			4	0			4	0			NO	
11	4							4	0			4	0				4	0			0				4	0			YES	
12	4							0				4	0				4	0			4	0			4	0			NO	
13	4						.500-.560(1)	0				0				1	0				0				0				NO	
13	5															1	0				0				0				NO	
14	3						.500-.560(1)	1	0			1	0			1	0				1				1	0			NO	
14	4						.500-.560(1)	0				0					0				0				0				NO	

TUBE NO.		2/70	11/73	4/74	6/75	10/76	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E		
27	9							2	0			2	0				2	0			0				0				NO	
28	91							1	0			1	0				0				1	0			0				NO	
29	11							1	0			1	0			1	0				0				1	0			YES	
						.500-.540(2)	.500-.540(2)		0				0					0			0					0			NO	
29	90					<.500(1)	.460-.500(1)	1	1	0			1	0		1	1	1	0		1	1	0		1	1	0		NO	
30	12					>.540(1)		1	0			1	0			1	1	0				0			1	0			NO	
							.500-.540(2)		0				0					0				0				0			NO	
30	59					<.500(1)	.460-.500(1)	1	1	0		1	1	0		1	1	1	0		1	1	0		1	1	0		NO	
31	13							2	0			0				2	0				0				0				NO	
31	88							1	0			0					0				0				0				NO	
31	89							1	0			0					0				0				0				NO	
33	45															1	0					0				0			NO	SLEEVE
37	20							4	0			4	0			4	4	0			4	0							IPD	
37	21															4	4	0			0				0				NO	
38	21					>.540(2)		2	0			0	0			2	0				0				0	0			NO	
						.500-.540(4)			0			4	0				4	0			4	0			4	0			NO	
38	91							2	0			2	0			2	2	0			0				2	0			YES	
37	21						.500-.540(1)	1	0			0				1	0				0				0	0			NO	
						<.500(2)	.460-.500(2)		2	0		2	2	0			2	2	0		2	2	0		2	2	0		NO	
39	22															1	0				0				0				NO	
37	23															2	0				0				0				NO	
39	77															2	0				0				0				NO	
39	80							2	0			0					2	0			0				0				NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO. ROW	TUBE NO. COL.	2/72	11/73	4/74	6/75	10/76	9/77	4/78 B	4/78 C	4/78 D	4/78 E	9/78 B	9/78 C	9/78 D	9/78 E	5/80 A	5/80 B	5/80 C	5/80 D	5/80 E	2/82 B	2/82 C	2/82 D	2/82 E	12/85 B	12/85 C	12/85 D	12/85 E	EVIDENCE OF I.D. DECREASE	COMMENTS
40	23						.500-.540(1)	1	0			1	0			1	1	0			1	0			1	0			NO	
						.500-.540(2)			0				0					0				0				0			NO	
40	24						.500-.540(1)		0				0			0					0								NO	
						.500-.540(2)		2	0			2	0			2	2	0			4	0			2	0			NO	
40	25															2	0				0				0				NO	
40	78							1	0			0				1	0	0			0				0				NO	
									0				0				2	0			0				0				NO	
40	79							2	0			2	0			2	2	0			2	0			2	0			NO	
41	24															1	0				0								NO	
						.500-.540(2)		2	0			2	0				2	0			2	0			2	0			NO	
41	25							2	0							2	0	0			0				0				NO	
41	33							1	0			1	0			1	1	0			1	0			1	0			NO	
41	77							1	0			0				0	0	0			0								NO	
												2	0			2	2	0			2	2	0		2	0			NO	
42	31							1	0			0					0				0				0				NO	
42	32							1	0			0					0				0				0				NO	
43	30															2	0				0				0				NO	
43	31							2	0			2	0				2	0			2	0			2	0			NO	
43	32					<.540(1)	.500-.540(1)	1	0			1	0			1	1	0			1	0			1	0			NO	
43	75															2	0				0				0				NO	
44	30							1	0			1	0			1	1	0			1	0			1	0			NO	
44	32					<.540(1)		1	0			1	0			1	1	0			1	0			1	0			NO	
44	32						.460-.500(2)	2	0			2	0				2	0			2	0			2	0			NO	

TUBE NO.		2/72	11/73	4/74	6/75	10/76	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E		
44	33															2	2	0			2	0			2	0			NO	
44	35															2	0				0				0				NO	
45	34							1	0			1	0			1	1	0			0				0				NO	
45	35				<.540(1)	<.540(1)	.500-.540(1)	1	0			1	0			1	1	0			1	0			1	0			NO	
46	34				<.540(1)	<.540(1)	.500-.540(1)	1	0			1	0			1	1	0			2	0			1	0			NO	
46	35							1	0			1	0			1	1	0			1	0			1	0			NO	
46	36						.500-.540(1)	1	0			1	0			1	1	0				0							NO	
					<.540(2)	<.540(2)			0				0					0			2	0			2	0			NO	
46	37							2	0			2	0			2	2	0			0				2	0			YES	
46	38															2	0				0				0				NO	
46	39															2	0				0				0				NO	
46	47											2	0			2	2	0			2	0			2	0			NO	
46	63							2	0			2	0				2	0			0				0				NO	
46	64						.500-.540(1)		0				0					0				0				0			NO	
						<.540(2)		2	0			2	0			2	2	0				0			2	0			NO	
46	65					<.540(2)	.500-.540(2)	0				2	0			2	2	0			2	0			2	0			NO	
[illegible]	66							1	0			1	0			1	1	0			1	0			1	0	0		NO	
						<.540(2)	.400-.540(2)		2	0			2	0				2	0			2	0			2	0		NO	
47	37															2	0				0				0				NO	
[illegible]7	38							2	0			2	0			2	2	0			2	0			2	0			NO	
47	39															2	0				0				0				NO	
47	62						.500-.540(1)	1	0				0			1	0				0				0				NO	
						.450-.540(2)						2	0				2	0			0				2	0			YES	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "C" INLET

TUBE NO.		2/72	11/73	4/74	6/75	10/76	9/77	4/78				9/78				5/80					2/82				12/85				EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.							B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E	B	C	D	E		
47	63						<.560(2)	2	0			2	0			2	2	0			0				2	0			YES	
47	64															2	0				0				0				NO	
48	41															2	0				0				0				NO	
48	42															2	0				0				0				NO	
48	43															2	0				0				0				NO	
48	44															2	0				0				0				NO	
48	45								0			0				1	0				0				0				NO	
						>.540(2)		2	0			0					0				0				0				NO	
48	49															1	0				0				0				NO	
48	58															2	2	0			0				0				NO	
48	59															2	0				0				0				NO	

NOTES: 1. ">" - TUBE I.D. IS GREATER THAN PROBE SIZE SHOWN

2. "<" - TUBE I.D. IS LESS THAN PROBE SIZE SHOWN

3. A RANGE INDICATES THAT TUBE I.D. IS BETWEEN PROBE SIZES SHOWN

4. A - .580" DIAMETER PROBE
B - .560" DIAMETER PROBE
C - .500" DIAMETER PROBE
D - .460" DIAMETER PROBE
E - .400" DIAMETER PROBE

5. IPD - INSUFFICIENT PREVIOUS DATA

6. 0 - PROBE NOT RESTRICTED AT ANY LEVEL
1 - PROBE RESTRICTED AT FIRST SUPPORT LEVEL
2 - PROBE RESTRICTED AT SECOND SUPPORT LEVEL
3 - PROBE RESTRICTED AT THIRD SUPPORT LEVEL
4 - PROBE RESTRICTED AT FOURTH SUPPORT LEVEL

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" OUTLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
2	25																1	0				P								PLUGGED
2	26																1	0				P								PLUGGED
3	25																1	1	1	0		1	0						NO	
4	25																1	1	0			1	0						NO	
3	27																1	0											IPD	
4	27																1	0											IPD	
2	32																1	0				1	0						YES	
																		2	2	0			0						NO	
1	33																	1	1	0		P								PLUGGED
																				2	2	P								
2	33																1	1	0			1	0						NO	
																			2	0			0						NO	
2	34																1	0				0							NO	
																		2	0			2	0						NO	
2	35																1	0				0							NO	
																		2	2	0			2	0					NO	
2	36																1	0				0							NO	
																		2	2	0		2	2	0					NO	
2	37																1	1	0			1	0						NO	
2	38																	2	0			2	0						NO	
1	39																	2	0			2	0						NO	
4	39																	1	1	0		1	0						NO	
5	39																1	0											IPD	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" OUTLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
4	40																	1	0			1	0						NO	
5	40																1	1	0			1	0						NO	
6	40																1	0											IPD	
4	41																	1	0			1	0						NO	
5	41																1	0											IPD	
4	42																	1	0			1	0						NO	
6	42																1	0											IPD	
5	45																1	0											IPD	
1	46																1	0											IPD	
1	49																	2	2	0		2	0						NO	
1	50																1	0											IPD	
2	50																1	0				0							NO	
																		2	0			2	0						NO	
3	50																1	0											IPD	
12	50																1	0											IPD	
2	51																	1	0			1	0						NO	
																			2	0			0						NO	
12	51																1	0											IPD	
2	52																	1	0			1	0						NO	
2	55																1	0											IPD	
13	57																1	0											IPD	
5	58																1	0											IPD	
																		2	0			2	0						NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" OUTLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D.	
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E				DECREASE	COMMENTS
4	59																	1	0			1	0						NO	
																		2	0				0						NO	
5	59																1	0				0							NO	
																		2	0			2	0						NO	
7	59																1	0											IPD	
13	59																1	0											IPD	
5	60																	1	0			1	0						NO	
6	60																1	1	0			1	0						NO	
15	60																1	0											IPD	
5	61																1	0				0							NO	
																		2	0			2	0						NO	
42	67																	1	1	1	1	P								PLUGGED
43	70																	1	0			1	0						NO	
44	70																1	1	1	0		1	0						NO	
44	71																	1	1	0			1	0					NO	
4	74																1	0											IPD	
4	75																1	0											IPD	
3	75																1	0											IPD	
5	77																	2	0			2	0						NO	
3	78																	1	0			1	0						NO	
4	78																1	1	0			1	0						NO	
2	79																	1	0			P								PLUGGED
[illegible]	79																1	0											IPD	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" OUTLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84								EVIDENCE OF I.D.	
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					DECREASE	COMMENTS
2	80																	2	0			2	0							NO	
3	80																	1	0			1	0							NO	
2	81																	2	0			P									PLUGGED

NOTES: 1. A-.580" DIAMETER PROBE
B-.560" DIAMETER PROBE
C-.500" DIAMETER PROBE
D-.460" DIAMETER PROBE
E-.400" DIAMETER PROBE

2. IPD - INSUFFICIENT PREVIOUS DATA

3. 0 - PROBE NOT RESTRICTED AT ANY LEVEL
1 - PROBE RESTRICTED AT FIRST SUPPORT LEVEL
2 - PROBE RESTRICTED AT SECOND SUPPORT LEVEL
3 - PROBE RESTRICTED AT THIRD SUPPORT LEVEL
4 - PROBE RESTRICTED AT FOURTH SUPPORT LEVEL

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/75	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
1	1																1	0											IFD	
2	1								1	0			1	0			1	1	0			1	0						ND	
3	1																1	0											IPD	
2	2								2	0			2	0			2	2	0			2	0						ND	
1	3																2	0											IFD	
11	3																4	0											IPD	
13	3																1	0											IPD	
2	4																2	0											IPD	
12	4		<.540(1)	<.540(1)			.500-.540(1)		1	0			1	0			1	1	1	0		1	0						ND	
14	4		<.540(1)	<.540(1)			.500-.540(1)	.500-.560(1)	1	0			1	0			1	1	0			1	0						ND	
																		2	0				0						ND	
15	4								1	0			1	0			1	1	0			1	0						ND	
13	5						.500-.540(1)		1	0			1	0			1	1	0			1	0						ND	
17	5								1	0			1	0			1	0				0							ND	
																		2	0			2	0						ND	
14	5							.500-.560(1)	1	0			1	0			1	1	0			1	0						ND	
15	5																1	0											IPD	
18	5																1	0											IPD	
12	6								2	0			2	0			1	0											ND	
1	9																2	0											IPD	
3	10																1	0											IPD	
26	10																1	0											IPD	
29	11							.500-.560(1)	1	0			1	0			1	1	0			1	0						ND	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
30	12								1	0			1	0			1	1	1	0		1	0						NO	
							.500-.540(2)	.500-.560(2)		0				0					0				0						NO	
31	12								1	0			1	0			1	1	0			1	0						NO	
							.500-.540(2)	.500-.540(2)		0				0					0				0						NO	
30	13																1	0											IPD	
31	13						.500-.540(1)	<.540(1)	1	0			1	0			1	1	1	0		1	0						NO	
32	13								1	0			1	0			1	1	0			1	0						NO	
1	14																	2	0										IFD	
30	14																	2	0										IFD	
31	14																	2	0										IPD	
1	16																	2	0										IPD	
2	16																	2	0										IPD	
1	17						>.500(2)		2	0			2	0			2	2	2	0		2	2	0					NO	
2	17						.500-.540(1)		1	1			1	0			1	1	1	0		P							YES	PLUGGED
							.500(2)			2	0			2	0					0		P							NO	
2	18								1	0			1	0			1	1	0			P							NO	PLUGGED
1	19																2	0											IPD	
2	20																1	0											IFD	
39	21						>.540(1)	.500-.560(1)	1	0			1	0			1	0											NO	
39	22																2	0											IPD	
40	22																1	0											IFD	
2	23																2	0											IPD	
39	23																1	0											IPD	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D.	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E				DECREASE	
49	23						>.540(1)		1	0			1	0			1	1	0			1	0						NO	
1	24																1	0											IPD	
2	24								2	0			2	0			2	2	0			P							NO	PLUGGED
39	24																2	0											IPD	
40	24																2	0											IPD	
41	24																1	0											IPD	
5	25																1	0											IPD	
1	31																2	0											IPD	
2	31																1	0											IPD	
1	33						<.500(2)		1	0			1	0			1	1	1	0		P							YES	PLUGGED
										0				2	0					0		P							NO	
2	33						>.500(1)		1	0			1	0			1	1	0				0						NO	
				<.540(2)						0				0					0				0						NO	
45	33																1	0											IPD	
2	34								1	0			1	0			1	1	0				0						NO	
							.500-.540(2)			0				0					0				0						NO	
46	34						>.540	.500-560(1)	1	0			1	0			1	1	0			1	0						NO	
2	35																1	0											IPD	
46	35																1	0											IPD	
2	36																1	0											IPD	
46	36			<.540(1)			.500-.540(1)	<.540(1)	1	0			1	0			1	1	1	0		1	0						NO	
2	37																2	0											IPD	
46	37						>.540(1)	.500-.560(2)	1	0			1	0			1	1	0			1	0						NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D.	
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E				DECREASE	COMMENTS
46	37									0				0					0				0						NO	
47	37						>.540(1)	.500-.560(1)	1	0			1	0			1	2	0			1	0						NO	
2	38								0				0				1	0											IPD	
47	38						>.540(1)	<.560(1)	1	0			1	0			1	1	0			1	0						NO	
45	38																1	0											IPD	
46	39						>.540(1)	.500-.560(1)	0				0				1	0				0							NO	
									2	0			2	0				2	0			2	0						NO	
47	39																1	0											IPD	
1	40																2	0											IPD	
4	40																1	0											IPD	
45	40																1	0											IPD	
4	41																1	0											IPD	
6	41																1	0											IPD	
4	42																1	0											IPD	
5	42																1	1	0				0						NO	
3	43								2	0			2	0			2	0											NO	
2	44																1	0											IPD	
2	45																1	0											IPD	
1	46																1	0											IPD	
2	46								1	0			1	0			1	1	0				0						NO	
2	47								1	0			1	0			1	1	0				0						NO	
1	47						>.500(1)		1	0			1	0			1	0											NO	
1	50												2	0				0											NO	

RESTRICTED TUBES DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/81								EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E						
2	50						>.500(1)	>.540(1)	0				0				1	0												NO	
							<.540(2)		0				0					0												NO	
2	51								1	0			1	0			1	1	0				0							NO	
48	51																2	0												IPD	
1	52								1	0			1	0			1	1	0			1	0							NO	
2	52								1	0			1	0			1	1	0				0							NO	
1	54																2	0												IPD	
2	54								1	0			1	0			1	1	0				0							NO	
42	54																2	0												IPD	
2	55																2	0												IPD	
43	55																2	0												IPD	
1	58																2	2	0			0								NO	
3	58																1	0												IPD	
5	59																1	0												IPD	
4	59																1	0												IPD	
6	59																1	0												IPD	
5	61																1	0												IPD	
42	62																2	0												IPD	
43	62																2	0												IPD	
44	62																2	0												IPD	
46	62																1	0												IPD	
47	62																2	0												IPD	
54	63																2	0												IPD	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
45	67																2	0											IPD	
46	63						>.540(1)		0				0				0					0							NO	
								.500-.560(2)	2	0			2	0			2	2	0			0							NO	
47	63																2	0											IPD	
1	64																2	0											IPD	
2	64																1	0											IPD	
45	64																2	0											IPD	
2	65						.500-.540(1)		1	0			1	0			1	1	1	0			0						NO	
45	65																2	0											IPD	
46	65					.500-.520(1)			1	0			1	0			1	1	0			1	0						NO	
		<.540(2)		<.540(2)	.500-.540(2)		.500-.540(2)			0				0					0				0						NO	
1	66								1	0			1	0			1	1	0			1	0						NO	
45	66						>.540(1)	>.560(1)	0				0				0					0							NO	
									2	0			0				2	2	0			0							NO	
46	66					.500-.520(1)			0				0				1	0				0							NO	
		<.540(2)			.500-.540(2)		.500-.540(2)		2	0			2	0				2	2	0		2	0						NO	
2	67			<.540(1)			.500-.540(1)		1	0			1	0			1	1	1	0			0						NO	
1	68						<.500(1)		1	1	0		1	1	0		1	1		0		1	1	0					NO	
41	[illegible]								1	0			0				1	0											NO	
41	[illegible]																2	0											IPD	
1	69																1	0											IPD	
2	69						.500-.540(1)		1	0			1	0			1	1	1	0			0						NO	
41	[illegible]																1	0											IPD	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/79				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
43	69	<.540(1)		<.540(1)	.500-.540(1)	.500-.520(1)	.500-.540(1)	.500-.560(1)	1	0			1	0			1	1	0			1	0						NO	
43	69			<.540(1)		.500-.520(1)		>.500(1)	0				0				1	0				0							NO	
		<.540(2)			.500-.540(2)		.500-.540(2)	<.560(2)	2	0			2	0				2	2	0		2	0						NO	
2	70						.500-.540(2)	.470-.500(2)	0				0				1	0					0						NO	
									2	0			2	0				2	2	0			0						NO	
43	70			<.540(1)	.500-.540(1)			.500-.560(1)	1	0			1	0			1	1	0			1	0						NO	
2	71								1	0			1	0			1	1	0				0						NO	
2	72																2	0											IFD	
3	72																2	0											IFD	
2	74								2	0			2	0			2	2	0				0						NO	
4	74																1	0											IFD	
1	75																1	0											IFD	
40	75																1	0											IFD	
[illegible]	76																2	0											IFD	
1	77																1	0											IFD	
38	77																1	0											IFD	
39	77						>.540(1)	.500-.560(1)	0				0				1	0				0							NO	
									2	0			2	0				2	0			2	0						NO	
40	77						>.540(2)	.500-.560(2)	2	0			2	0			2	2	0			2	0						NO	
38	78																2	0											IFD	
39	78			<.540(1)	.500-.540(1)	.500-.520(1)		.500-.560(1)	1	0			1	0			1	1	0			0							NO	
							.500-.540(2)			0				0					2	0		2	0						NO	
40	78			<.540(1)	.500-.540(1)	.500-.520(1)	.500-.540(1)	.500-.560(1)	1	0			1	0			1	1	0			1	0						NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	5/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E					
40	78				.540(2)					0				0					0				0						NO	
38	79			.500-.600(1)	>.500(1)			.500-.560(1)	0				0				1	0											NO	
39	79			.500-.600(1)	>.500(1)			.500-.560(1)	1	0			1	0			1	1	0			1	0						NO	
38	80			.500-.600(1)	>.500(1)			>.560(1)	0				0				2	0											NO	
39	80			.500-.600(1)	>.500(1)			.500-.560(1)	1	0			1	0			1	1	0			1	0						NO	
39	81			.500-.600(1)	>.500(1)			>.560(1)	0				0				1	0											NO	
37	82			.500-.600(1)	>.500(1)			>.560(1)	0				0				0												NO	
2	83																2	0											IPD	
37	83						>.540(1)		0				0									P							NO	PLUGGED
37	83							.500-.560(2)	2	0			2	0				2	0			P							NO	
1	84						>.500(1)		1	0			1	0			1	1	0			1	0						NO	
																			2	0			0						NO	
36	84																2	0											IPD	
2	85						.500-.540(2)		0				0				1	0					0						NO	
									2	0			2	0				2	2	0			0						IPD	
2	86																2	0											IPD	
2	87																1	0											IPD	
29	87																2	0											IPD	
30	87																1	0											IPD	
32	87																1	0											IPD	
29	88																1	0											IPD	
30	88								1	0			0				1	0				0							NO	
													2	0				2	0			2	0						NO	

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84								EVIDENCE OF I.D. DECREASE	COMMENTS
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E						
31	88						.500-.540(1)	.500-.540(1)	1	0			1	0			1	1	0			1	0							NO	
										0				0					2	0			0							NO	
26	89																2	0												IFD	
28	89																2	0												IFD	
29	89																1	0												IFD	
30	89			<.540(1)			<.500(1)		1	1	0		1	1	0		1	1	1	0		1	1	0						NO	
								.460-.540(2)			0				0					0				0						NO	
26	90							.500-.560(1)	0				0				0													NO	
									2	0			2	0			2	0												NO	
29	90						>.540(1)	.500-.560(1)	1	0			1	0			1	1	0			1	0							NO	
4	91																1	0												IFD	
25	91																2	0												IFD	
27	91						>.540(1)	.500-.560(1)	0				0				1	0												NO	
28	91																2	0												IFD	
6	92																1	0												IFD	
26	92							.500-.560(1)	0				0				2	0												NO	
27	92						>.540(1)	.500-.560(1)	0				0				1	0												NO	
12	95						.500-.540(1)		1	0			1	0			1	1	1	0		1	0							NO	
								.460-.500(2)		0				0						0			0							NO	
13	95								0				0				1	0				0								NO	
13	95								2	0			2	0				2	0			0								NO	
11	96			.500-.600(1)					0				0				0													NO	
12	96			.500-.600(1)			.500-.540(1)		1	0			1	0			1	0				0								NO	

RESTRICTED TUBE DATA
SAN ONOFRE UNIT 1
STEAM GENERATOR "A" INLET

TUBE NO.		10/72	1/73	6/73	4/74	4/75	10/76	9/77	4/78				9/78				5/80					4/84							EVIDENCE OF I.D.	
ROW	COL.								B	C	D	E	B	C	D	E	A	B	C	D	E	B	C	D	E				DECREASE	COMMENTS
12	96																	2	0			2	0						NO	
14	96			.500-.600(1)					0				0				0												NO	
11	97			.500-.600(1)					0				0				1	0											NO	
12	97	>.480(1)		.500-.600(1)			.500-.540(1)	.460-.540(1)	1	0			1	0			1	1	0			0							NO	
14	97	>.480(1)		.500-.540(1)			.500-.540(1)	.460-.560(1)	1	0			1	0			1	0				0							NO	
																		2	2	0		2	0						NO	
11	98								0				0				1	0				0							NO	
									2	0			2	0				2	0			2	0						NO	
2	99																2	0											IPD	
2	100	>.480(1)			>.500(1)		>.500(1)	.500-.540(1)	1	0			1	0			1	1	0			1	0						NO	
								<.500(2)		0				0					0				0						NO	
3	100	>.480(1)		<.540(1)	>.500(1)		>.500(1)		1	0			1	0			1	1	0			1	0						NO	
4	100								0				0				1	0				0							NO	
									2	0			2	0				2	0			2	0						NO	

NOTES: 1. ">" - TUBE I.D. IS GREATER THAN PROBE SIZE SHOWN
2. "<" - TUBE I.D. IS LESS THAN PROBE SIZE SHOWN
3. A RANGE INDICATES TUBE I.D. IS BETWEEN PROBE SIZES SHOWN

4. A-.580" DIAMETER PROBE
B-.560" DIAMETER PROBE
C-.500" DIAMETER PROBE
D-.460" DIAMETER PROBE
E-.400" DIAMETER PROBE

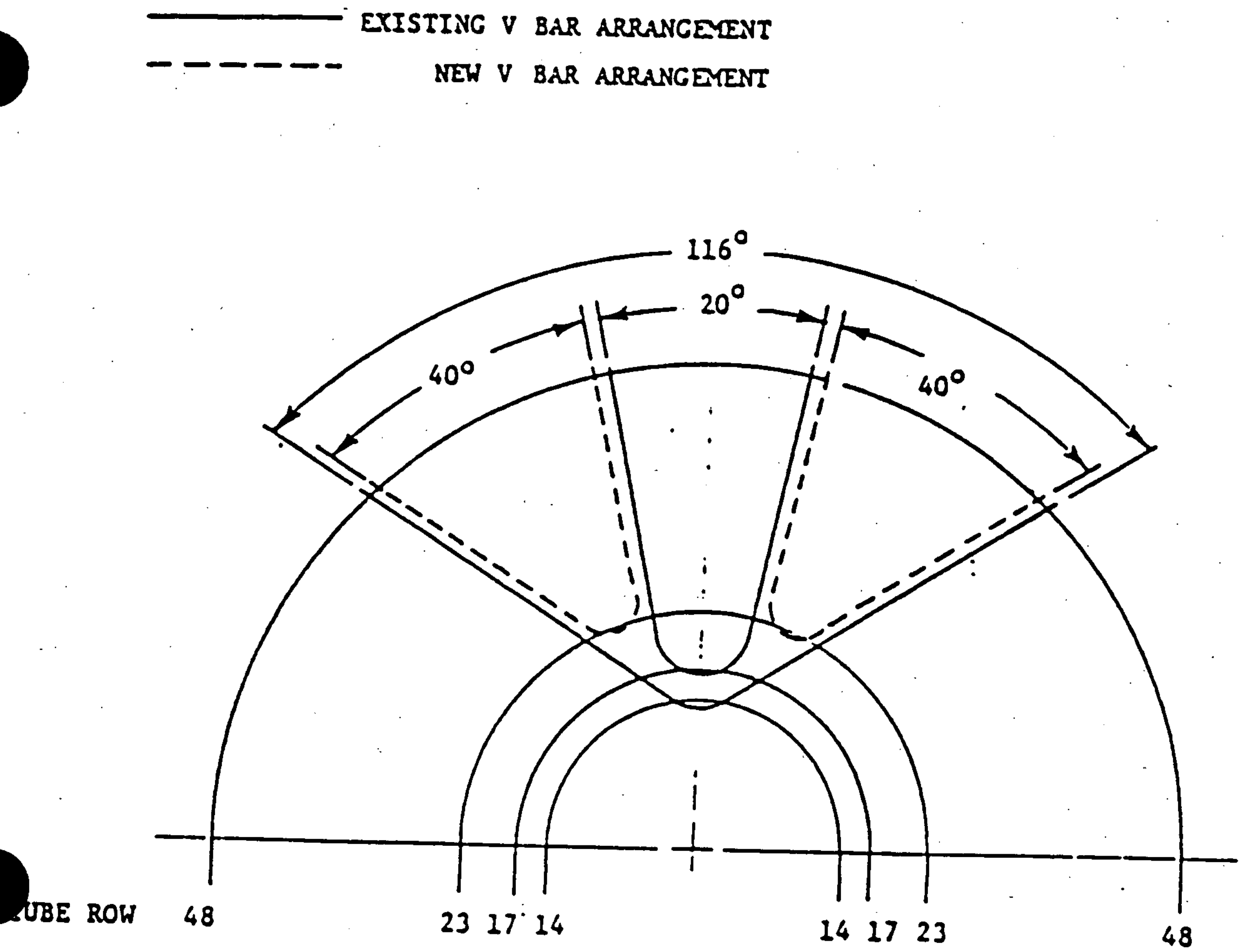
5. IPD - INSUFFICIENT PREVIOUS DATA

6. 0 - PROBE NOT RESTRICTED AT ANY LEVEL
1 - PROBE RESTRICTED AT FIRST SUPPORT LEVEL
2 - PROBE RESTRICTED AT SECOND SUPPORT LEVEL
3 - PROBE RESTRICTED AT THIRD SUPPORT LEVEL
4 - PROBE RESTRICTED AT FOURTH SUPPORT LEVEL

TABLE 5

AVB INSPECTION RESULTS

Inspection Interval	Number of Indications Compared	Calculated Main Growth (%)	EFPM	Calculated Mean Growth (%) per EFPM
10/76 - 9/77	55	0.98	4.7	0.21
9/77 - 9/78	650	-1.30	9.7	-0.13
9/78 - 5/80	803	-1.75	15.1	-0.12
5/80 - 2/82	373	-2.00	4.3	-0.47

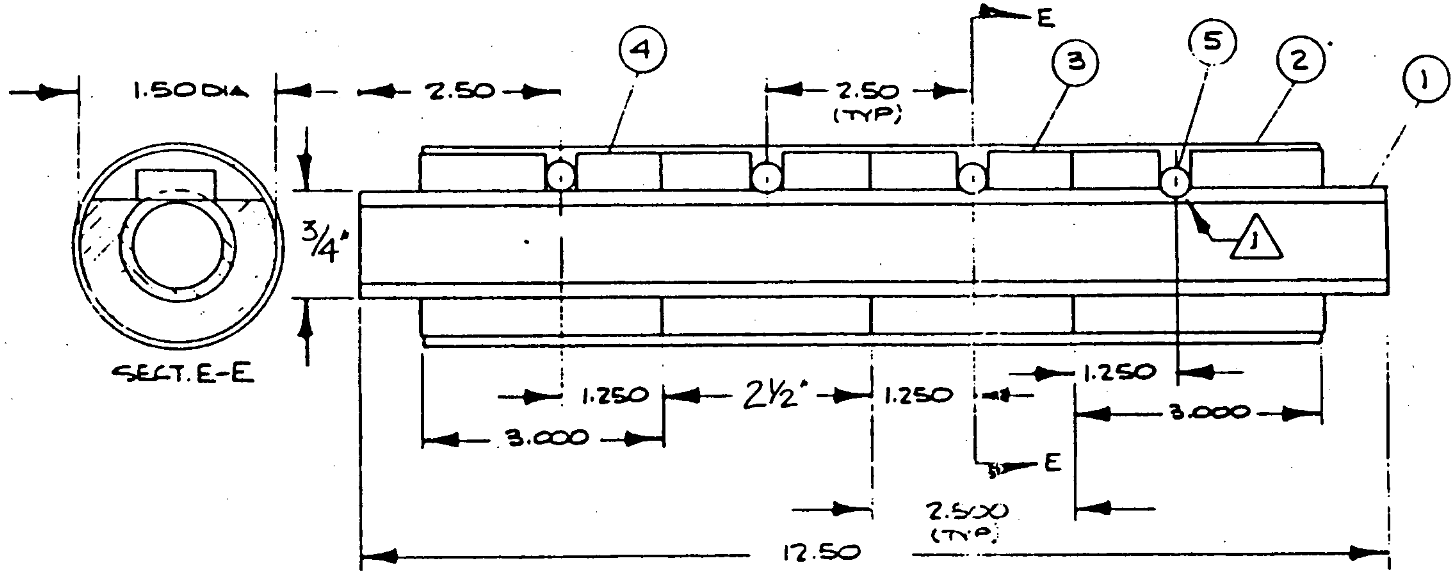


NEW ARRANGEMENT : Add V Bars Between Existing V Bars and Attach to Existing Retainer Ring

NOTE: The modification affects tubes in columns 18 through 83 inclusive.

FIGURE 1

LOCATION	A	B	C	D
MAX. MEASURED DEPTH IN %	0%	23%	45%	63%



A.V.B. MATERIAL CARBON STEEL
TUBE MATERIAL INCONEL 600
AVERAGE MEASURED WALL THK. .056"
NOMINAL WALL THK. .055
HEAT LOT NO. 1958
SERIAL NO. Z-3018
DATE 11-19-85
RECORDED ON REEL NO. 25
BY M. Chin
CUSTOMER ALLEN NUCLEAR & ASSOCIATES
P.O. NO. 1170
RELEASE NO. N/A
QUALITY REL NO N/A

1 THRU WALL INDICATORS ARE TO BE MACH. IN A CIRCULAR FORM TO MATCH ROUND STOCK

QTY	PART NO	DESCRIPTION
	5	ROUND STOCK
	4	DELRIN SPACER 1.500 O.D. x 3.00L
	3	DELRIN SPACER 1.500 O.D. x 2.50L
	2	HEAT SHRINK TUBE 1.5 I.D. x 11.0L
	1	TUBE - INCONEL

EXCEPT AS NOTED
DIMENSIONS IN INCHES
TOLERANCES
.XXX ±.003 ANGLES
.XX ±.010 ±
.X ±.030

ZETEC INC

TITLE A.V.B. NOTCH STANDARD ASSY.

SCALE NONE | DWG NO 2-4065 | 1 | 1 | DATE 4-11-8

FIGURE 2

DESCRIPTION OF PROPOSED CHANGE AND SAFETY ANALYSIS OF
PROPOSED CHANGE NO. 172 TO THE TECHNICAL SPECIFICATIONS
PROVISIONAL OPERATING LICENSE DPR-13

This is a request to revise Section 3.1.4 "LEAKAGE" and to add a Section 4.1.13, "LEAKAGE AND LEAKAGE DETECTION SYSTEMS" of Appendix A Technical Specifications for San Onofre Nuclear Generating Station, Unit 1.

DESCRIPTION

Technical Specification 3.1.4, "LEAKAGE" currently requires that the reactor coolant system (RCS) be monitored for evidence of leakage. The scope of this specification includes both identified and unidentified sources of RCS leakage. The specification also provides plant operation related action levels for various levels of RCS leakage. However, the specification does not specify the methods and systems to be used for RCS leakage detection, and, accordingly, it does not define Limiting Conditions for Operation (LCOs) and surveillance requirements for these systems. The need for definition of LCOs and surveillance requirements was noted as part of the NRC's review in this area as part of SEP Topic V-5, Reactor Coolant Pressure Boundary Leakage Detection. It is the purpose of Proposed Change No. 172 to propose revisions that will provide appropriate Limiting Conditions for Operation (LCOs) and Surveillance Requirements for the RCS leakage detection systems at San Onofre Unit 1.

Proposed Change No. 172 would revise Specification 3.1.4, "LEAKAGE" to include an LCO for each of three RCS leakage detection systems. These systems are associated with the containment atmosphere radiation, the sphere sump, and the steam generator blowdown. The sphere sump level control and sump level monitoring systems have the best sensitivity for leak detection and the containment atmosphere radiation monitors are slower response time backups to the sump monitor. The steam generator blowdown monitor is the primary to secondary intersystem leakage detection system. Other systems are available that are redundant to these systems, but these three systems are the most accurate and have the best response times for RCS leakage detection and, therefore, closer compliance with Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," May 1973. The San Onofre Unit 1 compliance with this regulatory guide has been reviewed as part of the NRC review performed under SEP Topic V-5, Reactor Coolant Pressure Boundary Leakage Detection for San Onofre Unit 1. The LCOs are similar, to the extent possible with NUREG-0452, "Standard Technical Specifications for Westinghouse Pressurized Water Reactors, Revision 4 (STS)." However, in the case of the containment atmosphere radiation monitors and the steam generator blow down effluent monitor, the proposed operability requirements allow for grab samples in lieu of monitor operability. The grab samples are required at a 12 hour frequency, which is commensurate with the importance and time requirements for leakage detection. Accordingly, there is no impact on the margin of safety. In the event that there is a reduction in the number of leakage detection methods from three to two, the action is to perform the surveillance RCS water inventory balance at an increased frequency for up to 30 days. This action provides assurance that RCS leakage will be a closely monitored operational parameter.

Proposed Change No. 172 also defines other minor changes that would more clearly define the mode applicability of the specification, define the specification for allowable RCS leakage and an associated ACTION statement. Currently, since there is no clear "ACTION," operating personnel must defer to Specification 3.0.3, which allows 1 hour. However, the specification as proposed as ACTION A would allow 4 hours for action to reduce leakage to within the specification limits. The proposed revisions to Specification 3.1.4, "LEAKAGE," including the inclusion of specification regarding mode applicability and allowance for action time, are similar to the extent possible, with those provided in the STS.

Proposed Change No. 172 would also add a new Specification 4.1.13, "LEAKAGE AND LEAKAGE DETECTION SYSTEMS" in order to add appropriate surveillance requirements for monitoring RCS leakage and the RCS leakage detection systems required to be operable by the revised Specification 3.1.4, "LEAKAGE AND LEAKAGE DETECTION SYSTEMS." These specifications are similar, to the extent possible, to those provided in the STS. The specification of reactor coolant system water inventory balance every 72 hours increases the existing 7 day frequency described in the San Onofre Unit 1 Final Safety Analysis. The specification of the surveillance requirements for the radiation monitors refers to the surveillances and frequencies of Technical Specification 4.1.2, 4.1.3 and 4.1.5. This proposed method of referring to the Section 4.1.2, 4.1.3 and 4.1.5 surveillances is consistent with other specifications which do not duplicate existing surveillance requirements and instead refer to other sections for the appropriate test requirements and frequencies.

EXISTING TECHNICAL SPECIFICATIONS

See Attachment 1.

PROPOSED TECHNICAL SPECIFICATIONS

See Attachment 2.

SAFETY EVALUATION

The proposed change as discussed above shall be deemed to constitute a significant hazard consideration if positive findings are made in any of the following areas:

1. Will operation of the facility in accordance with this proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

Response: No

The revisions to the technical specifications contained in this proposed change require the operability and the performance of surveillance for systems that are currently necessary to meet technical specification requirements but do not have explicit operability and surveillance requirements. The imposition of these additional requirements merely formalizes what is now an informal requirement, and provide actions to be performed in the event of the systems' unavailability. The requirement to perform a reactor coolant system water inventory balance already exists, the proposed change merely increases the required frequency. The allowance of 4 hours to reduce leakage to within the specifications allows personnel a reasonable amount of time to locate and mitigate a leak. This increased time for action does not involve a significant increase in system failure probability and is consistent with the STS provisions. The remaining changes are only clarifying in nature and do not affect the specification content. Therefore, it is concluded that this proposed change will not cause a significant increase in the probability or consequences of an accident previously evaluated.

2. Will operation of the facility in accordance with this proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

Response: No

The systems covered by the revisions in this proposed change are already used and surveilled in a manner similar to that proposed herein. Therefore, the proposed revisions will merely formally require their operability and surveillance. The requirement to perform a reactor coolant system water inventory balance already exists, the proposed change merely increases the required frequency. The proposed surveillance requirements, in three cases, reference surveillance requirements that already exist in other sections of the technical specifications. The format changes the addition of a new leakage ACTION statement, merely allows a similar action time similar to that in the STS. Therefore, it is concluded that this proposed change will not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Will operation of the facility in accordance with this proposed change involve a significant reduction in a margin of safety?

Response: No

As previously stated, the systems whose operability and surveillance requirements are proposed herein are systems already in use at San Onofre Unit 1. Accordingly, it is not expected that the imposition of these operability and surveillance requirements on these systems would impact any margin of safety and considering their purpose, these additional requirements result in a net increase in the margin of safety. The allowance for action time to respond to exceedance of leakage limits is similar to that in the STS that is allowed for other safety systems. Therefore, it is concluded that this proposed change will not result in a significant reduction in a margin of safety.

The Commission has provided guidance concerning the application of the standards for determining whether a significant hazards consideration exists by providing certain examples (48 FR 14870) of amendments that are considered not likely to involve significant hazards considerations. This proposed change is most similar to example (ii) because it is a change that constitutes an additional limitation, restriction, or control not presently included in the technical specifications.

SAFETY AND SIGNIFICANT HAZARDS DETERMINATION

Based on the safety evaluation, it is concluded that: (1) the proposed change does not involve a significant hazards consideration as defined by 10 CFR 50.92; and (2) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed change; and (3) this action will not result in a condition which significantly alters the impact of the station on the environment as described in the NRC Environmental Statement.

Attachment 1 - Existing Specification Section 3.1.4
Attachment 2 - Proposed Specification Sections 3.1.4 and 4.1.13

3.1.4 LEAKAGE

APPLICABILITY: Applies to reactor coolant system leakage.

OBJECTIVE: To ensure that leakage from the reactor coolant system does not exceed acceptable limits.

SPECIFICATION: A. The reactor coolant system shall be monitored for evidence of leakage.

B. Detectable leakage from the primary coolant system shall be investigated and evaluated. In any event, if the leakage exceeds 1 gpm and the source of leakage is not identified, the reactor shall be shut down. If the sources of leakage have been identified and the results of the evaluations are that continued operation is safe, operation of the reactor with a total leakage rate not exceeding 6 gpm shall be permitted. 7 1/13/72

C. The reactor will be placed in hot standby within six hours and in cold shutdown within the following thirty hours on detection and confirmation of any of the following conditions:

1. An increase in primary to secondary leakage of 140 gpd (0.1 gpm) over a period of twenty-four hours in any steam generator.

2. Any primary to secondary leakage in excess of 215 gpd (0.15 gpm) in any steam generator; or

3. Measured increase in primary to secondary leakage in excess of 15 gpd (0.01 gpm) per day, when measured primary to secondary leakage is above 140 gpd. 60 6/8/81

Following reactor shutdown, leaking tubes will be repaired or plugged.

D. In addition, in accordance with the Technical Specifications, the reactor will be placed in hot standby within six hours and in cold shutdown within the following thirty hours on detection and confirmation of primary to secondary leaks in excess of 0.3 gpm in any steam generator. Following reactor shutdown, an eddy current inspection will be performed as required by the Technical Specifications, any leaking steam generator tubes will be repaired or plugged and the NRC be notified pursuant to Specification 6.9.2 prior to resumption of plant operation. 91 11/14/85

BASIS: Two basic kinds of leakage from the reactor coolant system are possible, namely:

1. To other closed systems.

2. Directly to the containment.

Systems into which leakage from the reactor coolant system could occur are designed to accept such leakage. However, leakage directly into the containment indicates the possibility of a breach in the coolant envelope. For this reason, the acceptable value for a source of leakage not identified was set at one gpm.

Once the source of leakage has been identified, it can be determined if operation can safely continue. Under these conditions, an allowable leakage rate of 6 gpm has been established. This is based upon the contingency of sustained loss of all off-site power and failure of the onsite generation. With 6 gpm leakage, decay heat removal can safely be accomplished for a period in excess of 12 hours. Within the 12 hour period, the reactor coolant system can be depressurized.

7
1/13/72

To comply with Paragraph IV.C.1(b)(4) of the "Interim Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Power Reactors" adopted by the AEC on June 19, 1971, the maximum allowable identified leakage rate from the primary coolant system has been established as not exceeding 6 gpm. This value is based on operating experience regarding non-safety related equipment limitations which has shown that, under certain circumstances where primary system leakage is directed to the gas handling portion of the radwaste system, the capacity of this system would be exceeded during extended operation with a leakage greater than 6 gpm. 7 1/13/72

Detection of leaks from the reactor coolant system to the containment is accomplished through use of any or all of the following methods:

1. Sump level

2. Radiation monitoring

3. Humidity measurements

With these methods, a leak of one gpm can be detected in a matter of hours. Detection of leaks to other systems is accomplished through the use of radiation monitoring, level indications in the affected system, and water chemistry variations. In both cases, large leaks would be detected by indications from process variables in the reactor coolant and related systems.

The justification for the 0.3 gpm primary to secondary leakage limit is as described in the Basis for Technical Specification 4.16. 44 10/31/78

3.1.4 LEAKAGE AND LEAKAGE DETECTION SYSTEMS

APPLICABILITY: Applies to reactor coolant system leakage and leakage detection systems during MODES 1, 2, 3 and 4.

OBJECTIVE: To ensure that leakage from the reactor coolant system is detected and does not exceed acceptable limits.

SPECIFICATION:

a. The reactor coolant system shall be monitored for evidence of leakage. Abnormal or significant leakage from the reactor coolant system shall be investigated and evaluated. The following reactor coolant system leakage limits shall apply:

   (i) The total unidentified leakage shall not exceed 1 gpm.

   (ii) The total leakage shall not exceed 6 gpm.

b. The following detection systems shall be OPERABLE:

   (i) The containment atmosphere monitor R1211 or R1212, or containment atmosphere grab samples shall be taken every 12 hours and analyzed within the following 6 hours.

   (ii) The sphere sump level instrumentation LIS 2001, LIS 3001 or both LS 80 and LS 82.

   (iii) The steam generator blowdown effluent line monitor R1216 or steam generator blowdown effluent grab samples shall be taken every 12 hours and analyzed within the following 6 hours.

ACTION:

A. With any reactor coolant system leakage greater than the above defined limits, reduce the leakage rate to within the limits within 4 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

B. Upon detection and confirmation of any of the following conditions:

   1. An increase in primary to secondary leakage of 140 gpd (0.1 gpm) over a period of 24 hours in any steam generator; or

   2. Any primary to secondary leakage in excess of 215 gpd (0.15 gpm) in any steam generator; or

3. Measured increase in primary to secondary leakage in excess of 15 gpd (0.01 gpm) per day in any steam generator, when measured primary to secondary leakage is above 140 gpd;

the reactor will be placed in HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours. Following reactor shutdown, leaking tubes shall be repaired or plugged.

C. Upon detection and confirmation of primary to secondary leaks in excess of 0.3 gpm in any steam generator, the reactor will be placed in HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours. Following reactor shutdown, an eddy current inspection will be performed as required by Technical Specification 4.16, any leaking steam generator tubes shall be repaired or plugged and the NRC be notified pursuant to Specification 6.9.2 prior to resumption of plant operation.

D. With only two of the above required leakage detection systems/methods OPERABLE, operation may continue for up to 30 days provided a Reactor Coolant System water inventory balance is performed every 24 hours; otherwise, be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

<u>BASIS</u>: Two basic kinds of leakage from the reactor coolant system are possible, namely:

1. To other closed systems.

2. Directly to the containment.

Systems into which leakage from the reactor coolant system could occur are designed to accept such leakage. However, leakage directly into the containment indicates the possibility of a breach in the coolant envelope. For this reason, the acceptable value for a source of leakage not identified was set at 1 gpm.

Once the source of leakage has been identified, it can be determined if operation can safely continue. Under these conditions, an allowable leakage rate of 6 gpm has been established. This is based upon the contingency of sustained loss of all off-site power and failure of the on-site generation. With 6 gpm leakage, decay heat removal can safely be accomplished for a period in excess of 12 hours. Within the 12 hour period, the reactor coolant system can be depressurized.

To comply with Paragraph IV.C.1(b)(4) of the "Interim Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Power Reactors" adopted by the AEC on June 19, 1971, the maximum allowable identified leakage rate from the primary coolant system has been established as not exceeding 6 gpm. This value is based on operating experience regarding non-safety related equipment limitations which has shown that, under certain circumstances where primary system leakage is directed to the gas handling portion of the radwaste system, the capacity of this system would be exceeded during extended operation with a leakage greater than 6 gpm. The justification for the 0.3 gpm primary to secondary leakage limit is as described in the Basis for Technical Specification 4.16.

Detection of leaks from the reactor coolant system to the containment and/or secondary system is accomplished primarily through use of the following methods:

1. Sump level

2. Radiation monitoring

3. Blowdown effluent monitoring

With these methods, a leak of 1 gpm can be detected in a matter of hours. The radiation monitors can measure the presence of a leak into the containment by monitoring the change in background radiation levels. As an alternate to direct measurement, the use of grab samples at an appropriate frequency is also acceptable. The sump level control system consists of two instrumentation inputs which alert the operators of changing conditions at different sump levels and, as such, both LS-80 and 82 are required in order to fulfill their function. The sump level monitoring system (LIS 2001 and LIS 3001) is an alternate to the sump level control system, but since it is not alarmed, it is required by surveillance to be monitored every 12 hours. Additional indicators of potential RCS leakage include containment temperature, humidity and pressure. Leakage through the steam generators is detected primarily through use of the blowdown effluent monitor and alternately by grab samples. In the event of unavailability of one of the three methods of reactor coolant system leakage detection, the performance of a reactor coolant system water inventory balance at an increased frequency assures safety.

4.1.13 LEAKAGE AND LEAKAGE DETECTION SYSTEMS

APPLICABILITY: Applies to the reactor coolant leakage and detection systems delineated in Specification 3.1.4.

OBJECTIVE: To ensure the reactor coolant system leakage limits are maintained and to ensure the OPERABILITY of those systems that are used to detect leakage from the reactor coolant system.

SPECIFICATION:

A. Reactor Coolant System leakage shall be demonstrated to be within limits by:

1. Monitoring the containment atmosphere radioactivity at least once per 12 hours.

2. Performance of a Reactor Coolant System water inventory balance at least once per 72 hours.

3. Monitoring the steam generator blowdown effluent radioactivity at least once per 12 hours.

4. Monitoring the containment sump level indicator (LIS 2001 or 3001)at least once per 12 hours.

B. The leakage detection systems shall be demonstrated OPERABLE by the performance of CHANNEL CHECK, SOURCE CHECK, CHANNEL TEST, and CHANNEL CALIBRATION at the frequencies specified in Table 4.1.13-1;

BASIS: The monitoring of reactor coolant system leakage and maintenance of OPERABILITY of the reactor coolant leakage detection systems will assure that the sources of leakage are monitored and/or identified. The methods described above provide an acceptable means of verifying the OPERABILITY required by Specification 3.1.4.

REFERENCES:

1. SEP Topic V-5, Reactor Coolant Pressure Boundary Leakage, NUREG-0829, December 1986

2. Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," May 1973

3. Standard Technical Specifications for Westinghouse Pressurized Water Reactors, Revision 4, NUREG-0452

TABLE 4.1.13-1

LEAKAGE DETECTION SYSTEMS

	INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL TEST	CHANNEL CALIBRATION
1.	Containment Atmosphere Particulate Monitor (R1211)	D	M	N/A	R
2.	Containment Atmosphere Gaseous Monitor (R1212)	*	*	*	*
3.	Sphere Sump Level Control System (LS80 and 82)	N/A	N/A	N/A	R
4.	Containment Sphere Sump Level Monitor (LIS 2001 and 3001)	**	N/A	N/A	**
5.	Steam Generator Blowdown Effluent Monitor (R1216)	***	***	***	***

*   In accordance with Table 4.1.3.1, surveillance requirements for this instrument channel.
** In accordance with Table 4.1.5-1, surveillance requirements for these instrument channels.
*** In accordance with Table 4.1.2.1, surveillance requirements for this instrument channel.