**Pacific Gas and Electric Company**

**Gregory M. Rueger**
Senior Vice President and General Manager
Nuclear Power Generation

77 Beale Street, 32nd Floor
San Francisco, CA 94105

*Mailing Address*
Mail Code B32
P.O. Box 770000
San Francisco, CA 94177

415.973.4684
Fax: 415.973.2313

December 23, 1999

PG&E Letter DCL-99-165

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
License Amendment Request 99-02
Exclusion Zones for Alternate Repair Criteria

Dear Commissioners and Staff:

Enclosed is an application for amendment to Facility Operating License Nos. DPR-80 and DPR-82 pursuant to 10 CFR 50.90. This license amendment request (LAR) proposes new steam generator exclusion zones for voltage-based alternate repair criteria (ARC) for outside diameter stress corrosion cracking at tube support plate (TSP) intersections as identified in Technical Specification (TS) 3.4.5 (improved TS 5.5.9).

Exclusion zones are tube locations ineligible for the application of ARC because of high stress. The exclusion zones currently approved in License Amendments (LAs) 124 and 122 are based on a loss of coolant accident (LOCA) plus safe shutdown earthquake (SSE) analysis performed in 1992. The new exclusion zones are based on new analyses of LOCA plus SSE and feedline break (FLB)/steamline break (SLB).

The LOCA plus SSE loads cause potential tube collapse in certain wedge regions. Wedge regions are a group of tubes located adjacent to wedges, which provide support for the TSPs. The FLB/SLB plus SSE loads cause certain tubes at the seventh TSP to exceed the maximum imposed bending stress for existing test data (equal to approximately the lower tolerance limit yield stress). The revised wedge region exclusion zone results in a reduction in tubes excluded from ARC, when compared to the prior wedge region exclusion zone approved by LAs 124 and 122 for TS 3.4.5, and is therefore less restrictive. The seventh TSP bending exclusion zone is more restrictive because it is a new exclusion zone.

A001

The reduced wedge region exclusion zone results in less tubes required to be plugged, increased reactor coolant system flow, and less impact on radiation dose and cost.

PG&E applied the more restrictive seventh TSP bending exclusion zone in the Unit 2 ninth refueling outage, which began in September 1999. The exclusion zone is based on new analysis, as part of a general reanalysis for locked TSPs. PG&E has not identified any cracks or ARC candidates at the seventh TSP on any of its steam generators.

A description of the proposed TS change, and the basis for the change, are provided in Enclosure A. The proposed TS change is noted on the marked-up copy of the current TS page provided in Enclosure B and the improved TS page in Enclosure C. The proposed current TS page is provided in Enclosure D and the proposed improved TS page in Enclosure E.

The changes proposed in this LAR are not required to address an immediate safety concern. PG&E requests that the NRC assign a medium priority for review and approval of this LAR.

Sincerely,

Gregory M. Rueger

cc: Edgar Bailey, DHS
Steven D. Bloom
Ellis W. Merschoff
David L. Proulx
Diablo Distribution

Enclosures

GRC/2057

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

| | | |
|---|---|---|
| | ) | Docket No. 50-275 |
| In the Matter of | ) | Facility Operating License |
| PACIFIC GAS AND ELECTRIC COMPANY | ) | No. DPR-80 |
| | ) | |
| Diablo Canyon Power Plant | ) | Docket No. 50-323 |
| Units 1 and 2 | ) | Facility Operating License |
| | ) | No. DPR-82 |

## AFFIDAVIT

Gregory M. Rueger, of lawful age, first being duly sworn upon oath says that he is Senior Vice President - Nuclear Power Generation of Pacific Gas and Electric Company; that he has executed LAR 99-02 on behalf of said company with full power and authority to do so; that he is familiar with the content thereof; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

Gregory M. Rueger
Senior Vice President
Nuclear Power Generation

Subscribed and sworn to before me this 23rd day of December, 1999
County of San Francisco
State of California

Amy Emiko Dong

Notary Public

AMY EMIKO DONG
Commission # 1206749
Notary Public - California
San Francisco County
My Comm. Expires Jan 2, 2003

# REVISION OF TECHNICAL SPECIFICATION SURVEILLANCE REQUIREMENT 4.4.5.A.10)d TO REVISE EXCLUSION ZONES FOR STEAM GENERATOR TUBE VOLTAGE BASED ALTERNATE REPAIR CRITERIA

## A. DESCRIPTION OF AMENDMENT REQUEST

The proposed amendment would change current Technical Specification (TS) 4.4.5.4.a.10)d and Improved TS (ITS) 5.5.9.d.1.j)(iv) to revise the tube support plate (TSP) intersections that are excluded from application of steam generator (SG) tube voltage based repair criteria for outside diameter stress corrosion cracking indications at TSPs.

The change replaces current TS 4.4.5.4.a10)d and Improved TS 5.5.9.d.1.j)(iv) with the following:

> Certain wedge region intersections, and seventh TSP intersections, as identified in the analysis attached to PG&E Letter DCL-99-165, dated December 23, 1999, are excluded from application of the voltage-based repair criteria.

The proposed change is noted on the marked up copy of the current TS page provided in Enclosure B and on the improved TS page provided in Enclosure C. The proposed current TS page is included in Enclosure D and the proposed ITS page is included in Enclosure E.

This proposed amendment applies to Diablo Canyon Power Plant (DCPP) Units 1 and 2.

## B. BACKGROUND

The NRC approved implementation of voltage-based repair criteria at DCPP in License Amendment (LA) Nos. 124 and 122, dated March 12, 1998. The LAs included new TS 4.4.5.4.a.10)d. The LAs required that certain intersections located in wedge regions be excluded from application of voltage-based repair criteria since these intersections may collapse or deform following a postulated loss of coolant accident (LOCA) plus safe shutdown earthquake (SSE) event. Tubes that have preexisting through-wall cracks that are left in service under an alternate repair criteria (ARC), and that may deform under a postulated LOCA plus SSE event, may result in secondary to primary inleakage following the event. Therefore, tubes that have crack-like indications in the wedge region exclusion zone will be excluded from ARC.

The description of the 1992 LOCA plus SSE analysis performed by Westinghouse was submitted to the NRC in License Amendment Request (LAR) 97-03, "Voltage Based Alternate Steam Generator Tube Repair Limit for Outside Diameter Stress Corrosion Cracking at Tube Support Plate Intersections," dated February 26, 1997, including wedge region tube intersections to be excluded from voltage-based repair criteria as a result of the analysis. Wedge regions are a group of tubes located adjacent to wedges, which provide support for the TSPs. The NRC safety evaluation for LA Nos. 124 and 122, reviewed and approved the LOCA plus SSE analysis and tube intersections to be excluded from voltage-based repair criteria.

In 1998, Westinghouse performed a revised LOCA plus SSE analysis for DCPP Units 1 and 2, which updates the results of the 1992 analysis. The revised analysis assumes locked TSP intersections and incorporates DCPP-specific LOCA and seismic loads that were not available when the prior analysis was performed. The revised analysis reduces the number of tubes that are potentially susceptible to deformation and inleakage, from 468 tubes (1992 analysis) to 244 tubes (1998 analysis) per SG. Tables 2 through 5 identify the updated tube locations susceptible to deformation.

In 1998, Westinghouse also reevaluated tube stresses for feed line break (FLB)/steam line break (SLB) plus SSE loading under locked TSP conditions and DCPP-specific loads. As such, Westinghouse identified tubes at the seventh TSP that should be excluded from application of ARC due to high bending stresses. Because FLB/SLB plus SSE loading cause the tube stresses to exceed the maximum imposed bending stress for existing test data (equal to approximately the lower tolerance limit yield stress), 914 tubes per SG should be excluded from ARC at the seventh TSP. These tubes are located in rows 11 to 15 and 36 to 46. This LAR would revise the TS to require that tubes in these rows be excluded from application of ARC at the seventh TSP.

## C. JUSTIFICATION

PG&E's goal is to prolong SG life to the full licensed life of the plant. This goal is best achieved by proactive measures that defer or eliminate the need to replace SGs. The need to replace SGs results from the loss of reactor coolant system flow margin due to tube plugging.

Over the operating life of the SGs, application of the 1992 wedge region exclusion zone would result in unnecessarily plugging SG tubes containing DCPP TS allowable cracking at TSP intersections that are not susceptible to collapse and inleakage following a LOCA plus SSE event. Unnecessarily plugged tubes reduce SG heat removal capability in both accident conditions and normal operations. The proposed amendment would preserve the reactor coolant flow margin and reduce the occupational radiation exposure that would otherwise be incurred by plant workers involved in tube plugging operations.

D. SAFETY EVALUATION

For plants in seismic regions, the limiting loads for establishing the tube integrity are imposed during faulted plant conditions. Pipe break events are combined with limiting seismic events (SSE in the case of DCPP), and the loadings are evaluated against appropriate stress limits. The pipe break events are separated into primary side (LOCA) and secondary side blowdown (FLB and SLB). The more limiting of the FLB and SLB loads are evaluated and referred to as "FLB/SLB" loads. The pipe break events are assumed to initiate at 100 percent full power to maximize the tube loadings. The effects of packed tube conditions have been considered by assuming the tube to be fully coupled to the TSPs at each plate location. The basis that the tubes are locked in place with TSPs is provided in WCAP-14707, "Model 51 Steam Generator Limited tube Support Plate Displacement Analysis for Dented or Packed Tube to Tube Support Plate Crevices," submitted to the NRC by PG&E letter DCL-96-206, dated October 4, 1996.

<u>TSP 1 THROUGH 6 WEDGE REGION EXCLUSION ZONE (LOCA PLUS SSE)</u>

In addressing the combined loading effects of a LOCA and SSE on the SGs, as required by General Design Criterion 2, the potential exists for yielding of the TSP in the vicinity of the wedge groups, accompanied by deformation of tubes and a subsequent postulated inleakage. Tube deformation could lead to opening of preexisting tight through wall cracks, resulting in secondary to primary inleakage following the event. Secondary to primary inleakage is a potential concern because, although not quantified, inleakage could have an adverse affect on the final safety analysis report (FSAR) safety analysis results. Thus, any tubes that are defined to be potentially susceptible to significant deformation under LOCA plus SSE loads are excluded from application of ARC.

<u>Loads</u>

LOCA loads are developed as a result of transient flow and pressure fluctuations following a postulated main coolant pipe break. Based on the prior qualification of DCPP Units 1 and 2 for leak-before-break requirements for the primary piping, the limiting LOCA event is the residual heat removal (RHR) line break. As a result of a LOCA, the SG U-tubes are subjected to three distinct types of loading mechanisms:

- Primary fluid rarefaction wave loads.
- SG shaking loads due to the coolant loop motion.
- External hydrostatic pressure loads as the primary side blows down to atmospheric pressure.

The first two loading mechanisms occur simultaneously during the course of a LOCA and result predominantly in bending stresses in the tube U-bends at the top TSP. The third loading mechanism (resulting in the maximum secondary-to-primary pressure differential) does not result in any net load on the TSP that would affect plate deformation, and is not considered in this evaluation.

With regard to LOCA shaking loads, for large (primary) pipe break events that are assumed to occur immediately adjacent to the primary piping inlet or outlet, the pipe break event results in shaking of the overall SG. However, as noted above, under leak-before-break conditions, the limiting small pipe break event is considered in this analysis. Since the small pipe break event is remote to the SG and of a much reduced pipe size, the potential for shaking loads being introduced to the SG is significantly reduced. Even for large pipe break events, the plate loads resulting from shaking of the SG are small compared to the rarefaction wave loads. Due to the remoteness of the small pipe break and reduced size of the pipe failure, it is judged that LOCA shaking loads for the small pipe break event will not result in any significant plate loads. As such, no further consideration is given to the LOCA shaking conditions for this analysis.

The LOCA rarefaction wave initiates at the postulated break location and travels around the tube U-bends. A differential pressure is created across the two legs of the tubes, which causes an in-plane horizontal motion of the U-bend. The integrated response of the tube bundle to the individual tube loads results in significant lateral loads on the tubes.

The pressure-time history input to the structural analysis is obtained from a transient thermal-hydraulic analysis using the MULTIFLEX computer code. A break opening time of 1.0 msec to full flow area, simulating an instantaneous double-ended rupture is assumed to obtain conservative hydraulic loads. The fluid-structure interaction effect due to the flexibility of the divider plate between the inlet and outlet plenums of the primary chamber is included in the analysis. Pressure-time histories are calculated for three tube radii, identified as the minimum, average, and maximum radius tubes. The limiting small pipe break is the RHR line return path (lines 235 and 236, 6 in., safety injection pump discharge to the hot legs 1 and 2).

For the rarefaction wave induced loadings, the predominant motion of the U-bends is in the plane of the U-bend. Thus, the antivibration bars do not couple the individual tube motions. Also, only the U-bend region is subjected to high bending stresses. Therefore, the structural analysis is performed using single tube models limited to the U-bend region. In performing the dynamic analysis, the mass inertia of the tube is input as effective material density and includes the weight of the tube, weight of the primary fluid inside the tube, and the hydrodynamic mass effects of the secondary fluid.

The results of the dynamic time history analysis show that the three tube geometries develop maximum plate loads at different times in the transient. However, for conservatism, it is assumed that the peak forces occur simultaneously. This results in a conservative load on the TSP. In order to calculate an overall load for the bundle, loads are approximated for the other tube rows by linearly interpolating the loads for the three tubes analyzed. This is judged to be an acceptable approximation due to the conservatism inherent in assuming that the peak loads for all of the tubes occur simultaneously.

Seismic Analysis

SSE loads are developed as a result of the motion of the ground during an earthquake. Plant specific response spectra for DCPP Units 1 and 2 are used to obtain the loads and stresses in the tube bundle internals. A nonlinear time-history analysis is used to account for the effects of radial gaps between the secondary shell and the TSP. The tubes are modeled as locked to the TSPs. SSE is used in a generic sense to represent the seismic event categorized as a faulted event. For DCPP, the limiting faulted seismic event is the double design earthquake (DDE). The DDE stresses on the tubes are greater than the Hosgri stresses. In calculating the affected tubes, plate loads from an analysis of the DDE event are used.

The seismic excitation defined for the SGs is in the form of acceleration response spectra at the SG supports. In order to perform the nonlinear time history analysis, the response spectra are converted into acceleration time history input. Acceleration time-histories for the nonlinear analysis are synthesized from reference motions, using a frequency suppression/raising technique.

The seismic analysis is performed using the ANSYS computer program. The mathematical model consists of three-dimensional lumped mass, beam, and pipe elements as well as general matrix input to provide a plant specific representation of the SG and reactor coolant piping stiffnesses. Two equivalent beams model the straight leg region on both the hot-leg side and cold-leg side of the tube bundle. The U-bend region, however, is modeled as five equivalent tubes of different bend radii, each equivalent tube representing a group of SG tubes. In addition, a single tube representing the outermost tube row is also modeled. The values of the equivalent U-bend radii are determined based on how various groups of tubes contact the anti-vibration bars during the out-of-plane motion of the tube bundle. Continuity between the straight leg and U-bend tubes, as well as between the U-bend tubes themselves, is accomplished through appropriate nodal couplings.

Combined LOCA plus SSE Loads

In calculating a combined TSP load, the LOCA and SSE loads are combined using the square root of the sum of the squares. For the Model 51 SGs used at DCPP, six wedge groups located every 60 degrees around the plate circumference transmit these loadings into the SG shell/wrapper structure and form localized areas of higher stress within the TSP (i.e., the wedge regions). The distribution of load among wedge groups is approximated as a cosine function among those groups reacting the load, which corresponds to half the wedge groups. Except for the bottom TSP, the wedge groups for each of the TSPs are located at the same angular location as for the top TSP. Thus, if TSP deformation occurs at the lower plates, the same tubes are affected as for the top TSP. For the top TSP, however, the wedge groups have a 10 inch width, compared to a 6 inch width for the other plates. This larger wedge group width distributes the load over a larger portion of the plate, resulting in less plate and tube deformation for a given load level. For the bottom TSP, the wedge group width is 6 inches, and the wedge groups are rotated 36 degrees relative to the other TSPs. The distribution of load among the various wedge groups for the LOCA load results in a maximum wedge load of 0.634 of the total plate load. For seismic loads, which can have a random orientation, the maximum wedge load is 0.667, approximately 67 percent, of the maximum TSP load.

Identification of Potentially Susceptible Tubes

Combining the above inputs for loads, number of deformed tubes as a function of load, and load factors, calculations are performed to determine the number of deformed tubes for each plate and wedge location.

The number and location of the tubes that are identified as being potentially susceptible to significant deformation under combined LOCA and SSE loads, and thus susceptible to inleakage, is based on results of plate crush tests for Series 51 SGs. The tests were performed on prototypic TSP samples with tubes present in the tube holes. However, the test samples incorporated nominal clearances (gaps) between the tubes and the plate. For DCPP, where essentially all intersections are packed, the gaps do not exist. The plates with packed intersections will respond in a different manner than the plates in the tests. In comparing the in-plane stiffness characteristics of the two plate configurations, the plate with packed intersections is found to be 2.5 times as stiff as the plate with gaps. Due to the significantly higher stiffness of the plate with packed intersections, it is judged that the test results are conservative relative to plate deformation for the plate with packed intersections.

An overall summary of the number of potentially affected tubes is provided in Table 1. Based on the plate crush tests, a maximum of 148 tubes (4.4 percent) will deform. However, to account for uncertainties in the analysis, more tubes at each affected wedge group, for a total of 244 tubes, are assumed to deform and will be excluded from ARC. For example, misalignment of holes and other local anomalies could cause a slightly different set of tubes to be deformed than indicated in the plate crush tests. As such, it is not possible to identify exactly the tubes that might be limiting at each wedge group.

Tabular summaries of the 244 tubes that are potentially susceptible to significant deformation and subsequent inleakage are summarized in Tables 2 and 3 for DCPP SGs 1-1, 1-3, 2-2, and 2-4 (left-hand units), and in Tables 4 and 5 for DCPP SGs 1-2, 1-4, 2-1, and 2-3 (right-hand units).

The number of tubes in the exclusion zone has been reduced compared to the previously licensed 1992 exclusion zone. For the 1992 analysis, in the absence of DCPP specific seismic and LOCA TSP forces, it was conservatively assumed that a 7.5 percent area reduction would result. Assuming that all of the wedge areas would be affected equally, this resulted in 43 tubes/wedges being affected. The results for the 1998 analysis, which incorporates plant specific seismic and LOCA analyses that account for packed tube conditions, show that a significantly reduced number of tubes may be potentially affected by the LOCA plus SSE loads, with the exception of the first TSP at the 168 degree location, where 47 tubes are calculated to be potentially susceptible to significant deformation.

Enhanced Inspection Practices

Enhanced eddy current inspection requirements have been established at DCPP Units 1 and 2 at wedge region exclusion zones to reduce the potential for leaving through-wall indications in service that could potentially cause inleakage following a LOCA plus SSE event. Tubes in the wedge region exclusion zone are inspected by bobbin coil every outage. If degradation is identified by the bobbin coil at a wedge region exclusion zone tube, then the tube intersection is inspected by rotating pancake coil (RPC). If RPC confirms a crack-like indication at the wedge region exclusion zone, then the tube will be excluded from ARC and plugged.

## TSP 7 TUBE BENDING EXCLUSION ZONE (FLB/SLB PLUS SSE)

### FLB/SLB Loads

During the postulated FLB/SLB accidents, the predominant primary tube stresses result from the differential pressure loading. The peak differential pressures for these events are obtained from the results of transient blowdown analyses. These secondary side blowdown transients are based on an instantaneous full double-ended rupture of the main feed line/steam line. In both cases, the secondary side of the faulted steam generator blows down to ambient pressure. A peak transient pressure differential of 2650 psi (due to feed line break) is used as an umbrella load for the stress evaluation of these two events.

In addition to the primary pressure loads, bending of the tube may occur as a result of flow-induced vibration. Stresses due to flow-induced vibration are not specifically evaluated since they are enveloped by the in-plane U-bend stresses from LOCA plus SSE, and since they are axial bending stresses which would not propagate an axially oriented crack. The FLB/SLB transient duration is comparatively short, such that no significant circumferential crack propagation would occur. As a result, flow-induced vibration stresses due to FLB/SLB do not significantly influence burst pressure of an axial crack.

For the case where the SLB event is assumed to occur immediately adjacent to the outlet nozzle, the potential also exists for shaking of the overall SG. In the absence of an analysis to establish shaking loads specific to SLB, the shaking of the SG due to forces from a large LOCA (severance of the primary coolant outlet pipe) is conservatively assumed for the SLB event. Stresses due to shaking of the SG have been previously analyzed in WCAP-7832-A, "Evaluation of Steam Generator Tube, Tubesheet, and Divider Plate Under Combined LOCA Plus SSE Conditions," April 1978, Westinghouse proprietary. The maximum dynamic primary stress (which is also very nearly the maximum bending stress) on a tube near the U-bend and top support plate region of the tube bundle peaks at approximately 12,500 psi. Since there are essentially no direct stresses acting on the tube due to shaking, it is conservatively assumed that the maximum tube bending stress due to pipe shaking is +/- 12,500 psi at the outer surface of the tube. The remaining stress components due to shaking are essentially zero for all tubes. The bending stress of +/- 12,500 psi occurs near the U-bend and is conservatively assumed to apply at all U-bend locations.

The seismic axial stresses are combined with the FLB/SLB stresses (combined sum of bending stress of 12.5 ksi due to shaking, plus internal pressure) using the square root of the sum of the squares.

Effect of Combined Accident Conditions on Application of Axial Tube Burst Correlation

Loads caused by postulated accident conditions cause tubes to bend at the uppermost TSP intersections. This bending stress is distributed around the circumference of the tube cross section, tension on one side and compression on the other side, and is oriented in the axial (along the tube axis) directions. Axial cracks distributed around the tube circumference will thus experience either tension stress, which tends to close the crack, or compressive stress, which tends to open the crack. The compressive stress has the potential to reduce the burst capability of the cracked tube due to the crack opening.

Reference 4 of the DCPP FSAR Update Section 5.5.2 (WCAP-7832-A), provides test results of tube bending. A tube with 8 in. long through-wall slots oriented on the compressive and tensile sides and on the bending neutral axial was tested under combined beam bending and internal pressure to achieve burst pressures at each of the three locations. The neutral axial and compressive side burst results are almost identical and within normal data scatter of the burst pressure without bending stress. Test results for the tension side slot show a slight increase in the burst pressure as might be expected, as the tensile stresses tend to close the axial slot in the tube. Bending stresses exceeding 34 ksi were not evaluated as part of the test program due to local collapse limitations in the tube at the point of load application. It is concluded from the test results that tube bending stresses on the order of 34 ksi, which is very close to the tube yield strength at operating temperature, will not have a significant effect on tube burst strength. In the absence of test data for bending stresses above the tube yield strength, it is conservatively assumed that the high bending (above yield) stresses will cause a degrading effect on tube burst pressure.

Burst capability during accident conditions is required to be at least 1.43 times the maximum primary to secondary pressure differential following the FLB or SLB. Regulatory Guide 1.121 requires that SSE be combined with these events. The tube bending stresses from FLB/SLB plus SSE loads at the TSP elevations must be combined with the FLB/SLB pressure differential to establish that burst capability meets FLB/SLB requirements. Rather than retest burst capability with combined bending stress, it is sufficient to establish that the stress at any TSP elevation is less than the tube material yield strength at operating temperature based on the tests results in WCAP 7832-A.

The 1998 Westinghouse finite element analysis concluded that the potential exists for the combined FLB/SLB plus SSE axial bending stress to influence the tube burst strength for axial flaws located at the seventh TSP in rows 11 through 15 and rows 36 through 46, for a total of 914 tubes per SG. These tube locations are also provided in Table 6.

The finite element model consisted of 6 tube groups based on tube radius: rows 1-5, 6-10, 11-15, 16-27, 28-45, and 46 (outermost row). The maximum combined bending stress in the straight sections of tube up to, but not including, the seventh TSP was calculated to be less than the lower tolerance limit (LTL) yield stress of 35.5 ksi. (The LTL yield stress value of 35.5 ksi is based on Westinghouse statistical analyses of tensile test data of actual alloy 600 production tubing in the industry.) However, at the seventh TSP, the bending stress for rows 11-15 and row 46 exceeds this LTL yield stress. Additionally, it was not possible without further analysis to establish that tube rows immediately inboard of row 46 would not have a bending stress that exceeds this LTL yield stress. The equivalent radius of rows 28-45, where the bending stress is below yield, has the same approximate radius of tube row 35. Therefore, tube rows 36 to 45 are assumed to have a bending stress that exceeds the LTL yield stress.

Enhanced Inspection Practices

Enhanced eddy current inspection requirements have been established at DCPP Units 1 and 2 at seventh TSP bending exclusion zones to reduce the potential for leaving crack-like indications in service that could be subjected to large bending stresses following a postulated FLB/SLB plus SSE event. Tubes in the seventh TSP exclusion zone are inspected by bobbin coil every outage. If degradation is identified by the bobbin coil, then the tube intersection will be inspected by RPC. If RPC confirms a crack-like indication at the seventh TSP exclusion zone, then the tube will be excluded from ARC and plugged.

Conclusion

Based on the implementation of enhanced eddy current inspection practices in tubes subject to deformation from LOCA plus SSE loads and in tubes subject to high bending stresses from FLB/SLB plus SSE loads, in conjunction with preserving reactor coolant flow margin and reducing occupational radiation exposure by not unnecessarily plugging tubes, the proposed TS change to revise the exclusion zone for application of voltage-based repair criteria will not adversely affect the health and safety of the public.

## E. NO SIGNIFICANT HAZARDS EVALUATION

PG&E has evaluated the no significant hazards considerations involved with the proposed amendment, focusing on the three standards set forth in 10 CFR 50.92(c):

> *"The commission may make a final determination, pursuant to the procedures in paragraph 50.91, that a proposed amendment to an operating license for a facility licensed under paragraph 50.21(b) or paragraph 50.22 or for a testing facility involves no significant hazards considerations, if operation of the facility in accordance with the proposed amendment would not:*
>
> *(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or*
>
> *(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or*
>
> *(3) Involve a significant reduction in a margin of safety."*

The following evaluation is provided for the no significant hazards considerations.

1. *Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?*

Application of a smaller wedge region exclusion zone [due to loss of coolant accident (LOCA) plus safe shutdown earthquake (SSE)] and a new seventh tube support plate (TSP) bending stress exclusion zone (due to feedline break (FLB)/steamline break (SLB) plus SSE) with respect to alternate repair criteria (ARC), does not increase the probability of tube burst or leakage following a postulated main steam line break (MSLB). Exclusion zones tubes will be inspected by bobbin every outage and by rotating pancake coil (RPC) if bobbin detects degradation. Tubes containing RPC-confirmed crack-like degradation at wedge region exclusion zone intersections and at the seventh TSP bending exclusion zone intersections will be plugged.

Tube burst criteria are inherently satisfied during normal operating conditions because of the proximity of the TSP. It is conservatively assumed that the entire crevice region is uncovered because of TSP displacement during the secondary side blowdown of a MSLB. Therefore, during a postulated MSLB accident, tube burst capability must exceed the Regulatory Guide 1.121

criterion requiring a margin of 1.43 times the SLB pressure differential on tube burst.

Relative to the expected leakage during accident condition loadings, a postulated MSLB outside of containment, but upstream of the main steam isolation valve, represents the most limiting radiological condition. The steam generator (SG) tubes are subjected to an increase in differential pressure following a MSLB, resulting in a postulated increase in leakage and associated offsite doses. Leakage following a MSLB bypasses containment.

Following each inspection, condition monitoring will be performed to verify that tube burst and leakage performance criteria were satisfied for all degradation.

Therefore, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?*

   Implementation of revised ARC exclusion zones does not introduce any significant change to the plant design basis. Use of new exclusion zones does not create a mechanism which could result in an accident in the free span. It is expected that for all plant conditions, neither a single nor multiple tube rupture event would likely occur in a SG where ARC exclusion zones have been applied.

   Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the change involve a significant reduction in a margin of safety?*

   Revised wedge region exclusion zones are based on a DCPP-specific analysis under locked tube conditions for the combined effects of a LOCA and SSE. The number of wedge region tubes that are predicted to collapse has been decreased when compared to the prior analysis, which used highly conservative assumptions. The revised analysis incorporates DCPP-specific LOCA and seismic loads that were not available when the prior analysis was performed. However, the revised analysis also yields conservative results, such that the number of tubes in the exclusion zone (244 per SG) bound the number of tubes calculated to collapse (144 per SG). Tubes located in the revised wedge region exclusion zone will continue to be subject to enhanced eddy current inspection requirements and will be excluded from application of

ARC. Thus, existing tube integrity requirements apply to these tubes and the margin of safety is not reduced.

New seventh TSP bending exclusion zones are also based on a DCPP-specific analysis under locked tube conditions for the combined effects of a FLB/SLB and SSE. The analysis yields conservative results, such that 914 tubes per SG at the seventh TSP are assumed to exceed the Westinghouse lower tolerance limit yield stress of the tubing. Tubes located in the seventh TSP bending exclusion zone will be subject to enhanced eddy current inspection requirements and will be excluded from application of ARC. Thus, existing tube integrity requirements apply to these tubes and the margin of safety is not reduced.

Therefore, the proposed changes do not involve a significant reduction in a margin of safety.

## F. NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

Based on the above safety evaluation, PG&E concludes that the changes proposed by this LAR satisfy the no significant hazards consideration standards of 10 CFR 50.92(c), and accordingly a no significant hazards finding is justified.

## G. ENVIRONMENTAL EVALUATION

PG&E has evaluated the proposed changes and determined the changes do not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed changes meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.

Table 1
Number of SG Tubes Potentially Susceptible to Collapse and Inleakage Excluded from ARC
Diablo Canyon Units 1 and 2

| TSP | Hot Leg Wedge location | Crush Test | Full bundle (HL + CL) | Assumed[1] | Full bundle (HL + CL) |
|---|---|---|---|---|---|
| 1 | 168 deg | 47 | 94 | 67 | 134 |
| 2 | 132 deg | 9 | 18 | 55 | 110 |
| 3 | 132 deg | 7 | 14 | 55 | 110 |
| 4 | 132 deg | 5 | 10 | 55 | 110 |
| 5 | 132 deg | 5 | 10 | 55 | 110 |
| 6 | 132 deg | 1 | 2 | 55 | 110 |
| Total tubes | | 74 | 148 | 122[2] | 244 |

Notes:

1. The number of tubes assumed to collapse is greater than the number of collapsed tubes in crush tests.
2. 55 tubes in wedge group 132 deg are common to TSP 2 through TSP 6. Therefore, total hot leg tubes affected are 67 + 55 = 122.

Table 2

DCPP SG Tube Intersections Potentially Susceptible to Collapse and Inleakage Excluded from ARC
Tube Support Plate 1, Left-Hand SGs
DCPP Unit 1 SGs 1-1, 1-3
DCPP Unit 2 SGs 2-2, 2-4

| Hot Leg | | | Cold Leg | | |
|---|---|---|---|---|---|
| Wedge Location | Row | Column | Wedge Location | Row | Column |
| 48 degrees | No tubes affected | | 228 degrees | No tubes affected | |
| 108 degrees | No tubes affected | | 288 degrees | No tubes affected | |
| 168 degrees | 5 | 86-94 | 348 degrees | 5 | 1-9 |
| | 6 | 86-94 | | 6 | 1-9 |
| | 7 | 86-94 | | 7 | 1-9 |
| | 8 | 86-93 | | 8 | 2-9 |
| | 9 | 86-93 | | 9 | 2-9 |
| | 10 | 86-93 | | 10 | 2-9 |
| | 11 | 86-93 | | 11 | 2-9 |
| | 12 | 86-93 | | 12 | 2-9 |

Table 3

DCPP SG Tube Intersections Potentially Susceptible to Collapse and Inleakage Excluded from ARC
Tube Support Plates 2 through 6, Left-Hand SGs
DCPP Unit 1 SGs 1-1, 1-3
DCPP Unit 2 SGs 2-2, 2-4

| Hot Leg | | | Cold Leg | | |
|---|---|---|---|---|---|
| Wedge Location | Row | Column | Wedge Location | Row | Column |
| 12 degrees | No tubes affected | | 192 degrees | No tubes affected | |
| 72 degrees | No tubes affected | | 252 degrees | No tubes affected | |
| 132 degrees | 28 | 74-76 | 312 degrees | 28 | 19-21 |
| | 29 | 73-78 | | 29 | 17-22 |
| | 30 | 72-80 | | 30 | 15-23 |
| | 31 | 72-81 | | 31 | 14-23 |
| | 32 | 72-79 | | 32 | 16-23 |
| | 33 | 73-79 | | 33 | 16-22 |
| | 34 | 74-79 | | 34 | 16-21 |
| | 35 | 75-78 | | 35 | 17-20 |
| | 36 | 76-77 | | 36 | 18-19 |

Table 4

DCPP SG Tube Intersections Potentially Susceptible to Collapse and Inleakage
Excluded from ARC
Tube Support Plate 1, Right-Hand SGs
DCPP Unit 1 SGs 1-2, 1-4
DCPP Unit 2 SGs 2-1, 2-3

| Hot Leg | | | Cold Leg | | |
|---|---|---|---|---|---|
| Wedge Location | Row | Column | Wedge Location | Row | Column |
| 48 degrees | No tubes affected | | 228 degrees | No tubes affected | |
| 108 degrees | No tubes affected | | 288 degrees | No tubes affected | |
| 168 degrees | 5 | 1-9 | 348 degrees | 5 | 86-94 |
| | 6 | 1-9 | | 6 | 86-94 |
| | 7 | 1-9 | | 7 | 86-94 |
| | 8 | 2-9 | | 8 | 86-93 |
| | 9 | 2-9 | | 9 | 86-93 |
| | 10 | 2-9 | | 10 | 86-93 |
| | 11 | 2-9 | | 11 | 86-93 |
| | 12 | 2-9 | | 12 | 86-93 |

Table 5

DCPP SG Tube Intersections Potentially Susceptible to Collapse and Inleakage
Excluded from ARC
Tube Support Plates 2 through 6, Right-Hand SGs
DCPP Unit 1 SGs 1-2, 1-4
DCPP Unit 2 SGs 2-1, 2-3

| Hot Leg | | | Cold Leg | | |
|---|---|---|---|---|---|
| Wedge Location | Row | Column | Wedge Location | Row | Column |
| 12 degrees | No tubes affected | | 192 degrees | No tubes affected | |
| 72 degrees | No tubes affected | | 252 degrees | No tubes affected | |
| 132 degrees | 28 | 19-21 | 312 degrees | 28 | 74-76 |
| | 29 | 17-22 | | 29 | 73-78 |
| | 30 | 15-23 | | 30 | 72-80 |
| | 31 | 14-23 | | 31 | 72-81 |
| | 32 | 16-23 | | 32 | 72-79 |
| | 33 | 16-22 | | 33 | 73-79 |
| | 34 | 16-21 | | 34 | 74-79 |
| | 35 | 17-20 | | 35 | 75-78 |
| | 36 | 18-19 | | 36 | 76-77 |

Table 6

DCPP SG Tube Intersections with High Bending Stress (Greater than 34 ksi)
Excluded from ARC
DCPP Unit 1 SGs 1-1, 1-2, 1-3, 1-4
DCPP Unit 2 SGs 2-1, 2-2, 2-3, 2-4

| Hot Leg | | | Cold Leg | | |
|---|---|---|---|---|---|
| TSP | Row | All Columns | TSP | Row | All Columns |
| 7H | 46 | 41-54 | 7C | 46 | 41-54 |
| | 45 | 36-59 | | 45 | 36-59 |
| | 44 | 33-62 | | 44 | 33-62 |
| | 43 | 30-65 | | 43 | 30-65 |
| | 42 | 28-67 | | 42 | 28-67 |
| | 41 | 26-69 | | 41 | 26-69 |
| | 40 | 24-71 | | 40 | 24-71 |
| | 39 | 22-73 | | 39 | 22-73 |
| | 38 | 21-74 | | 38 | 21-74 |
| | 37 | 19-76 | | 37 | 19-76 |
| | 36 | 18-77 | | 36 | 18-77 |
| | 15 | 3-92 | | 15 | 3-92 |
| | 14 | 3-92 | | 14 | 3-92 |
| | 13 | 3-92 | | 13 | 3-92 |
| | 12 | 2-93 | | 12 | 2-93 |
| | 11 | 2-93 | | 11 | 2-93 |

## MARKED-UP CURRENT TECHNICAL SPECIFICATIONS

| Remove Page | Insert Page |
|---|---|
| 3/4 4-14a | 3/4 4-14a |

10) Tube Support Plate Plugging Limit is used for the disposition of an alloy 600 steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the plugging limit is based on maintaining steam generator tube serviceability as described below:

a. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to the lower voltage repair limit (Note 1), will be allowed to remain in service.

b. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (Note 1), will be repaired or plugged, except as noted in 4.4.5.4a.10)c below.

c. Steam generator tubes, with indication of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (Note 1) but less than or equal to the upper voltage repair limit (Note 2), may remain in service if a rotating pancake coil inspection does not detect degradation. Steam generator tubes, within indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit (Note 2) will be plugged or repaired.

d. Certain ~~intersections~~ as identified in ~~Westinghouse letter to PG&E dated September 3, 1992, "Deformation of Steam Generator Tubes Following a Postulated LOCA and SSE Event,"~~ will be excluded from application of the voltage-based repair criteria ~~as it is determined that these intersections may collapse or deform following a postulated LOCA + SSE event~~.

Wedge region intersections, and seventh tube support plate intersections,

the analysis attached to PG&E Letter DCL-99-165, dated December 23, 1999, are

Enclosure C
PG&E Letter DCL-99-165

## MARKED-UP IMPROVED TECHNICAL SPECIFICATIONS

| Remove Page | Insert Page |
|---|---|
| 5.0-14 | 5.0-14 |

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

(iv) Certain intersections as identified in Westinghouse letter to PG&E dated September 3, 1992, "Deformation of Steam Generator Tubes Following a Postulated LOCA and SSE Event", will be excluded from application of the voltage-based repair criteria as it is determined that these intersections may collapse or deform following a postulated LOCA + SSE event.

Wedge region intersections and Seventh tube support plate intersections,

(v) If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits identified in 5.5.9.d.1.j (i), 5.5.9.d.1.j (ii), and 5.5.9.d.1.j (iii). The mid-cycle repair limits are determined from the following equations :

the analysis is attached to PG&E Letter DCL-99-165, dated December 23, 1999, are

$$V_{MURL} = \frac{V_{SL}}{1.0 + NDE + Gr\frac{(CL - \Delta t)}{CL}}$$

$$V_{MLRL} = V_{MURL} - (V_{URL} - V_{LRL})\frac{(CL - \Delta t)}{CL}$$

where :

$V_{URL}$ = upper voltage repair limit

$V_{LRL}$ = lower voltage repair limit

$V_{MURL}$ = mid-cycle upper voltage repair limit based on time into cycle

$V_{MLRL}$ = mid-cycle lower voltage repair limit based on $V_{MURL}$ and time into cycle

$\Delta t$ = length of time since last scheduled inspection during which $V_{URL}$ and $V_{LRL}$ were implemented

CL = cycle length (the time between two scheduled steam generator inspections)

$V_{SL}$ = structural limit voltage

Gr = average growth rate per cycle length

NDE = 95% cumulative probability allowance for nondestructive examination uncertainty (i.e., a value of 20% has been approved by the NRC)

Implementation of these mid-cycle repair limits should follow the same approach as in TS 5.5.9.d.1.j (i), 5.5.9.d.1.j (ii), and 5.5.9.d.1.j (iii).

(continued)

# PROPOSED CURRENT TECHNICAL SPECIFICATIONS PAGE

SURVEILLANCE REQUIREMENTS (Continued)

10) Tube Support Plate Plugging Limit is used for the disposition of an alloy 600 steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the plugging limit is based on maintaining steam generator tube serviceability as described below:

a. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to the lower voltage repair limit (Note 1), will be allowed to remain in service.

b. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (Note 1), will be repaired or plugged, except as noted in 4.4.5.4a.10)c below.

c. Steam generator tubes, with indication of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (Note 1) but less than or equal to the upper voltage repair limit (Note 2), may remain in service if a rotating pancake coil inspection does not detect degradation. Steam generator tubes, within indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit (Note 2) will be plugged or repaired.

d. Certain wedge region intersections, and seventh Tube Support Plate intersections, as identified in the analysis attached to PG&E Letter DCL-99-165, dated December 23, 1999, are excluded from application of the voltage-based repair criteria.

# PROPOSED IMPROVED TECHNICAL SPECIFICATIONS PAGE

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

(iv) Certain wedge region intersections, and seventh tube support plate intersections, as identified in the analysis attached to PG&E Letter DCL-99-165, dated December 23, 1999, are excluded from application of the voltage-based repair criteria.

(v) If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits identified in 5.5.9.d.1.j (i), 5.5.9.d.1.j (ii), and 5.5.9.d.1.j (iii). The mid-cycle repair limits are determined from the following equations :

$$V_{MURL} = \frac{V_{SL}}{1.0 + NDE + Gr\frac{(CL - \Delta t)}{CL}}$$

$$V_{MLRL} = V_{MURL} - (V_{URL} - V_{LRL})\frac{(CL - \Delta t)}{CL}$$

where :

$V_{URL}$ = upper voltage repair limit

$V_{LRL}$ = lower voltage repair limit

$V_{MURL}$ = mid-cycle upper voltage repair limit based on time into cycle

$V_{MLRL}$ = mid-cycle lower voltage repair limit based on $V_{MURL}$ and time into cycle

$\Delta t$ = length of time since last scheduled inspection during which $V_{URL}$ and $V_{LRL}$ were implemented

CL = cycle length (the time between two scheduled steam generator inspections)

$V_{SL}$ = structural limit voltage

Gr = average growth rate per cycle length

NDE = 95% cumulative probability allowance for nondestructive examination uncertainty (i.e., a value of 20% has been approved by the NRC)

Implementation of these mid-cycle repair limits should follow the same approach as in TS 5.5.9.d.1.j (i), 5.5.9.d.1.j (ii), and 5.5.9.d.1.j (iii).

(continued)