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PG&E Letter DCL-00-013

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

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Licensee Event Report 2-97-006-02
Nuclear Fuel System Outside Design Basis Due to Fuel Pellet-to-Clad Gap Reopening

Dear Commissioners and Staff:

Pursuant to 10 CFR 50.73(a)(2)(ii)(B), PG&E is submitting the enclosed supplemental licensee event report regarding the nuclear fuel system being outside design basis due to fuel pellet-to-clad gap. The previous report on this condition, DCL 98-147, dated December 18, 1998, indicated that a revised report would be submitted no later than February 1, 2000.

As done previously , only the "Event Description" Section of the original report is being changed. Information has been added, using revision bars, to update the NRC on the status of gap reopening for both units, fuel Cycle 10.

Based on discussions with Westinghouse, PG&E does not expect the scope of the condition, cause, or corrective actions to change. Therefore, PG&E does not intend to provide additional supplemental reports on this condition.

This event was not considered risk significant and did not adversely affect the health and safety of the public.

Sincerely,

Lawrence F. Womack

IE22

cc: Steven D. Bloom
Ellis W. Merschoff
David L. Proulx
Diablo Distribution
INPO

Enclosure

TLH /2246/ A0446521

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Diablo Canyon Unit 2	0 5 0 0 0 3 2 3	1 OF 15

TITLE (4)

Nuclear Fuel System Outside Design Basis Due to Fuel Pellet-to-Clad Gap Reopening

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
12	11	1997	1997	- 0 0 6 -	0 2	02	01	2000	Diablo canyon Unit 1	0 5 0 0 0 2 7 5

OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)
1	X 10 CFR 50.73(a)(2)(ii)(B)
POWER LEVEL (10)	OTHER ____ (SPECIFY IN ABSTRACT BELOW AND IN TEXT, NRC FORM 366A)
1 0 0	

LICENSEE CONTACT FOR THIS LER (12)	TELEPHONE NUMBER AREA CODE	
Roger Russell - Senior Regulatory Services Engineer	805	545-4327

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MON	DAY	YR
[ ] YES (If yes, complete EXPECTED SUBMISSION DATE)	[X] NO				

ABSTRACT (Limit to 1400 spaces. i.e., approximately 15 single-spaced typewritten lines.) (16)

On December 11, 1997, at 1115 PST, with Unit 2 in Mode 1 (Power Operation) at 100 percent power, PG&E determined that fuel pellet-to-clad gap reopening had been predicted on a 95 percent upper bound basis for lead rods at cycle burnups greater than 18,000 megawatt days per metric ton uranium. This burnup occurred in Unit 2 on September 1, 1997. This condition is outside the design basis for the plant. Additionally, Westinghouse completed analyses which show that although gap reopening is predicted for Unit 2, Cycle 8, the 10 CFR 50.46 criterion for localized 17 percent total oxidation continues to be met. On December 11, 1997, at 1130 PST, PG&E made a 1-hour, non-emergency report to the NRC in accordance with 10 CFR 50.72 (b)(1)(ii)(B). The December 11, 1997, report was updated on January 6, 1998.

Westinghouse discovered the potential for this condition in high duty integral burnable absorber rods when the effects of increased Zirc-4 corrosion on high duty rods were incorporated into the current version of the fuel performance computer code.

The condition was caused by Zirc-4 cladding material corrosion rates higher than previously expected on high duty fuel rods.

PG&E will continue to communicate with Westinghouse through implementation of a long term resolution plan and will take appropriate actions for Diablo Canyon Power Plant, Units 1 and 2.

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I. Plant Conditions

Unit 2 was in Mode 1 (Power Operations) at 100 percent power.

II. Description of Problem

A. Summary

On October 29 and November 14, 1997, PG&E voluntarily notified the NRC that the Westinghouse fuel performance code may not have been as conservative as originally believed. New analyses were predicting that fuel pellet-to-clad gap reopening may occur for high duty integral fuel burnable absorber (IFBA) rods during the second half of their duty cycle. Unit 2 is in the second half of its fuel cycle and has second duty cycle Zirc-4 IFBA fuel. Unit 1 is in the first half of its fuel cycle. Therefore, this condition will not be applicable to Unit 1 until after May 1998.

On December 11, 1997, at 1115 PST, with Unit 2 in Mode 1 at 100 percent power, PG&E determined that fuel pellet-to-clad gap reopening had been predicted on a 95 percent upper bound basis for lead rods at cycle burnups greater than 18,000 megawatt days per metric ton uranium. This burnup occurred in Unit 2 on September 1, 1997. This condition is outside the design basis for the plant. Additionally, Westinghouse completed analyses which show that although gap reopening is predicted for Unit 2, Cycle 8, the 10 CFR 50.46 level for localized 17 percent total oxidation continues to be met. On December 11, 1997, at 1130 PST, PG&E made a 1-hour, non-emergency report to the NRC in accordance with 10 CFR 50.72 (b)(1)(ii)(B). The December 11, 1997, report was updated on January 6, 1998.

B. Background

In early 1996, Westinghouse discovered that the rod internal pressure buildup due to helium release from IFBA rods was higher than previously modeled. Westinghouse has since conservatively assumed 100 percent theoretical helium release in all IFBA rods. In late 1996, Westinghouse completed a new corrosion model for Zirc-4 cladding material to address higher levels of corrosion being measured in the field in high duty rods. This model was presented to the NRC in December 1996. Since then, Westinghouse has been pursuing the incorporation of this new corrosion model into its fuel performance computer code, PAD, and assessing the feedback effects on other fuel performance criteria. With the new corrosion

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model incorporated, PAD indicates that the higher levels of corrosion are causing elevated fuel cladding temperatures at the end of cycle life conditions, and consequently higher outward clad creep rates and reduced pressure margin to the no gap reopening design criterion. Westinghouse believes that conservatism exists in the PAD code that will compensate for the increased corrosion feedback effects. However, additional development time is needed to quantify these conservatisms and implement PAD improvements.

In the interim development period, when the effects of increased Zirc-4 corrosion are incorporated into the current licensed version of the PAD code, gap reopening may be predicted for IFBA rods as early as the second half of their duty cycle. Furthermore, the 10 CFR 50.46 limit of 17 percent maximum cladding oxidation following a postulated loss-of-coolant accident (LOCA) may be also be exceeded.

10 CFR 50.46 (b)(2) defines the maximum cladding oxidation limit. Values less than 17 percent ensure that coolable geometry will be maintained during a LOCA by limiting the amount of localized cladding embrittlement and the potential for fuel fragmentation, which minimizes the possibility of significant changes in fuel assembly geometry. Westinghouse conservatively established a pretransient oxidation level of 12 percent as a screening level for compliance with 10 CFR 50.46 until further plant specific calculations for transient oxidation during a LOCA can be completed. At present, Units 1 and 2 have less than 12 percent oxidation levels and are in compliance with 10 CFR 50.46 requirements.

Westinghouse fuel performance methodology evaluates corrosion levels and gap reopening margins for the most limiting single fuel rod in the core. Fuel performance limits are checked considering appropriate material and method uncertainties to ensure a 95 percent probability that limits will be satisfied for the limiting fuel rod. Westinghouse used this conservative methodology to conclude that Unit 2 exceeded gap reopening criterion.

Westinghouse has identified and described the technical details of this condition to the NRC through written correspondence and formal presentations. Westinghouse has also performed evaluations and recommended generic corrective actions. Therefore, this report focuses on the condition as it relates to Diablo Canyon Power Plant (DCPP), Unit 2.

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C. Event Description

On October 28, 1997, Westinghouse notified PG&E that based on a generic bounding analysis, fuel rods in the current core design may not meet Westinghouse fuel design criteria for gap reopening, as well as the maximum cladding oxidation limit specified in 10 CFR 50.46. Westinghouse also provided a justification for continued operation (JCO) dated October 27, 1997.

On October 29, 1997, PG&E voluntarily notified the NRC that the 10 CFR 50.46 cladding oxidation limit may be exceeded.

On November 14, 1997, PG&E updated the voluntary report and indicated that Unit 2 was not expected to exceed the preaccident fuel oxidation screening level of 12 percent before January 9, 1998. This level was established to ensure the sum of preaccident and post-LOCA oxidation would not exceed 17 percent.

On November 19, 1997, PG&E completed an operability evaluation for Unit 2. The evaluation concluded that Unit 2 was bounded by the Westinghouse generic JCO.

On December 11, 1997, Westinghouse notified PG&E that they had finalized the plant and cycle-specific calculations for gap reopening and End-of-Cycle (EOC) 8 corrosion level for rods predicted to have gap reopening. The results indicated:

- Gap reopening was predicted on a 95 percent upper bound basis for lead rods at cycle burnups greater than 18,000 megawatt days per metric ton uranium (MWD/MTU). This occurred on September 1, 1997.

- A maximum EOC 8 clad oxidation of 12.5 percent for those rods predicted to have gap reopening.

- The 12 percent oxidation screening level for those rods predicted to have gap reopening was expected to be exceeded at a cycle burnup of 23,800 MWD/MTU (projected to occur after January 23, 1998).

On December 11, 1997, at 1130 PST, PG&E made a 1-hour, non-emergency report to the NRC regarding gap reopening in accordance with 10 CFR 50.72 (b)(1)(ii)(B).

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On December 23, 1997, Westinghouse provided additional information for gap reopening and clad oxidation. These values are identified in Section IV of this report.

On January 6, 1998, PG&E provided an update to the December 11, 1997, report. The update provided confirmation that the 12 percent pre-transient oxidation level would be exceeded after January 23, 1997, and discussed the analyses used by Westinghouse.

On March 4, 1998, Westinghouse provided the following information to PG&E on the fuel used in Unit 1, Cycle 9.

- Gap reopening was predicted to occur in Unit 1 at 17,000 MWD/MTU. This occurred on July 27, 1998.

- As a conservative allowance for the effect of zinc injection during the last half of Cycle 9, the corrosion model included a 1.10 multiplier on the oxidation levels predicted for the end of Cycle 9.

- The predicted 12 percent pre-transient screening level was predicted to be reached at a Cycle 9 burnup of 21,797 MWD/MTU. This occurred on November 25, 1998. The end-of-full-power-capability (EOFPC) (24,490 MWD/MTU Cycle 9 burnup) oxidation level is predicted to be 13.52 percent. The EOFPC including coastdown (25,490 MWC/MTU Cycle 9 burnup) oxidation level is predicted to be 14.19 percent.

- To determine the transient oxidation, a bounding evaluation was performed for Cycle 9 which considered both the Appendix K and the BELOCA analyses of record. The bounding results indicate a transient oxide level of 3.4 percent for EOFPC and a 2 percent oxide level at end-of-cycle (EOC) (EOFPC plus 1000 MWD/MTU coastdown).

- The 10 CFR 50.46 criterion of 17 percent total localized oxidation continues to be met for Cycle 9 with zinc injection during the second half of Cycle 9.

On November 25, 1998, Westinghouse provided the following information to PG&E on the fuel used in Unit 2, Cycle 9.

- Gap reopening is predicted to occur at a Cycle 9 burnup of 16,800 MWD/MTU. This should occur on May 5, 1999. The IFBA rods in the

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assemblies in full core loading pattern map locations H-3, H-13, C-8, and N-8 are predicted to open at this cycle burnup. Rods in other assemblies are also predicted to open, but at a later cycle burnup.

- The predicted rod average burnup and upper bound internal pressure for rods in these limiting assemblies at the gap reopening burnup of 16,800 MWD/MTU are approximately 51,000 MWD/MTU and 2900 psi, respectively.

- The upper bound steady-state cladding oxide thickness for the fuel rods in the assemblies with predicted gap reopening, including the effects of zinc injection, was 2.0 mils. This translates to a cladding metal wastage of less than 6 percent at the end of cycle. The low corrosion is due to the use of ZIRLO cladding for these assemblies. These analyses have considered the impacts of zinc injection in the primary system in Cycle 9 for a maximum of 12 months at nominal concentration of 40 parts per billion (ppb). Operation at less than 40 ppb are bounded by this analysis. The zinc impact considered was a 12 percent increase (1 percent increase for each month of zinc injection) in the predicted end of life thickness.

- With an upper bound steady-state cladding metal wastage of less than 6 percent at the end of cycle, the 12 percent pre-transient screening level will not be reached. Westinghouse performed a confirmatory assessment that with this pre-transient oxidation, operation of Unit 2 Cycle 9 will remain compliant with the 10 CFR 50.46 17 percent local oxidation criteria. Based on engineering judgment, it is estimated that the transient oxidation at the end of the cycle would be approximately 5 to 6 percent when taking into account the lower peaking factors in the high burnup fuel. Thus, the total localized oxidation is estimated to be approximately 11 to 12 percent and compliance with the 10 CFR 50.46 17 percent oxidation limit is met.

On January 27, 1999, Westinghouse provided the following information to PG&E on the fuel used in Unit 1, Cycle 10.

- Gap reopening was predicted to occur in the Region 11 fuel, but the 10 CFR 50.46 criterion of 17 percent total localized oxidation was met.

- Gap reopening was predicted to occur in the Region 11 fuel in Cycle 10 at a cycle burnup of 16870 MWD/MTU. The IFBA rods in the

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assemblies in full core LP locations D-11, E-12, D-5, E-4 L-4 M-5, L-12, and M-11 were predicted to open at this burnup. Pellet/clad gaps in other assemblies were also predicted to open, but at a later cycle burnup. The upper bound steady state cladding oxidation thickness for the fuel rods in the assemblies with predicted gap reopening, including the effects of zinc injection, was 2.82 mils. This is equivalent to a steady state cladding metal wastage of 8.03 percent at the end of Cycle 10. The analyses considered the impacts of zinc injection in Cycle 9 of 10 months and in Cycle 10 of 12 months at a nominal concentration of 40 ppb. Operation at concentrations less than 40 ppb is bounded by the analyses. The zinc impact considered a 10 percent increase (1 percent increase for each month of zinc injection) in the EOC 9 predicted oxide thickness and a 12 percent increase in the EOC 10 predicted oxide thickness. The analyses conservatively assumed full power operation throughout Cycle 10 and were valid out to a rod average burnup of 60,000 MWD/MTU.

- Transient oxidation of the fuel rods during a LOCA was based on the amount of time the cladding was exposed to elevated temperatures. Because of this, compliance with the 17 percent local oxidation criterion specified 10 CFR 50.46, must be proven with either a case from a plant specific LOCA analysis or another transient that bounds the analysis of record from time vs. temperature standpoint. The Cycle 10 evaluation was based on a WCOBRA/TRAC best estimate BELOCA transient model that bounds the BE analysis corrosion evaluation. Because the transient used for the Cycle 10 evaluation exceeds (from a time vs. temperature standpoint) the oxidation analysis, the evaluation for Cycle 10 was conservative.

- The transient oxidation calculated for the limiting assembly in Cycle 10 was approximately 9 percent. This was greater than values calculated for previous cycles (Unit 1, Cycle 9 and Unit 2, Cycle 8) for the following reasons: 1) the evaluations performed for Unit 1, Cycle 10 and Unit 2, Cycle 9 were based on a more limiting LOCA transient, and 2) the cycle specific burndown credits calculated for Unit 1, Cycle 10 and Unit 2, Cycle 9 were not as great as those calculated for Unit 1, Cycle 9 and Unit 2, Cycle 8. As such, the time at temperature used for the transient oxidation calculations is more severe which leads to higher transient oxidation results. In summary, a more limiting transient not specific to DCPP was used to evaluate the transient oxidation for gap reopened fuel in Unit 1, Cycle 10. If the Cycle 10 evaluation were to be based on

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the original transient used to assess oxidation BE analysis, it is expected that the amount of transient oxidation observed during a large break LOCA would be reduced.

- Based on the bounding transient assumed for Cycle 10, coupled with the burndown credits calculated for the cycle, total oxidation for the limiting assembly was calculated to be a maximum of 16.86 percent for any time step in the cycle up to, and including, EOC. Even when the effects of zinc injection combined with cladding lift-off are considered, the 10 CFR 50.46 local oxidation criteria is met for the entire burnup of the cycle.

On August 25, 1999, Westinghouse provided the following information to PG&E on the fuel used in Unit 2, Cycle 10

- Gap reopening was predicted to occur in the Region 9A center assembly but the 10 CFR 50.46 limit of 17 percent total localized oxidation was met.

- Gap reopening was predicted to first occur in the Region 9A center assembly (full core location H-8) IFBA fuel rods at a Cycle 10 burnup of 19,700 MWD/MTU and a corresponding rod burnup of 46,740 MWD/MTU. The upper bound rod internal pressure at the predicted time of gap reopening was 2530 psi. The IFBA fuel rods in the Region 11B fuel assembly in full core locations C-6, C-10, N-6, N-10, F-3, F-13, K-3, and K-13 were the first Region 11 fuel locations predicted to open at a Cycle 10 burnup of 22,100 MWD/MTU. IFBA pellet/clad gaps in other Region 11 assemblies were also predicted to open, but at a later cycle burnup. The upper bound steady state cladding oxide thickness for the fuel rods in the Region 9A center assembly, including the effects of zinc injection, was 4.1 mils at EOFP and 4.3 mils at EOC. This translated to a steady state cladding metal wastage or oxidation of 11.8 percent at EOFP and 12.3 percent at EOC. The upper bound steady state cladding oxide thickness for the fuel rods in the assemblies of Regions 11A and 11B, including the effects of zinc injection, was 2.8 mils. This translated to a steady state cladding metal wastage or oxidation of 7.9 percent at the end of Cycle 10. These analyses considered the impacts of zinc injection in the primary system in Cycle 9 of 6 months and in Cycle 10 of 20 months at a nominal concentration of 40 ppb. Operation at concentrations less than 40 ppb is bounded by the analysis. The zinc impact considered was a 6 percent increase

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(1 percent increase for each month of zinc injection) in the EOC 9 predicted oxide thickness (Region 11 only) and a 20 percent increase in the EOC 10 predicted oxide thickness (Regions 9A and 11). The corrosion and rod internal pressure analyses conservatively assumed full power operation throughout Cycle 10 and are valid out to a Cycle 10 burnup of 1,000 MWD/MTU beyond the end of full power capability consistent with the Cycle 10 Reload Safety Evaluation Report.

- Transient oxidation of the fuel rods during a LOCA was based upon the amount of time the cladding is exposed to elevated temperatures. Because of this, compliance of gap reopened fuel with the 10 CFR 50.46 17 percent local oxidation criterion must be proven. Since the upper bound steady-state oxidation for the Region 11 A and B fuel is only 7.9 percent, and this fuel experiences gap reopening very late in the cycle, and has significant peaking factor burndown credits, this fuel would not experience any significant oxidation during a LOCA, and is therefore not as limiting as the Region 9A fuel. The Region 9A center assembly was evaluated to show compliance with the 10 CFR 50.46 17 percent local oxidation criterion. Considering the initial oxidation and the corresponding power and burndown credits at the time of gap reopening, at EOFP, and at EOC, the EOFP case was judged to be the time in Cycle 10 which would have the highest amount of total oxidation if a LOCA were to occur. The key oxidation parameters for Region 9A gap reopened fuel at EOFP were compared to previously evaluated gap reopened fuel parameters for fuel in Diablo Canyon Unit 1, Cycle 9. Table 1 below compares the oxidation parameters from the gap reopened fuel evaluation from Unit 1, Cycle 9 to EOFP oxidation parameters of Region 9A in Unit 2, Cycle 10.

Table 1

COMPARISON OF OXIDATION PARAMETERS FROM THE GAP REOPENED FUEL EVALUATION FROM UNIT 1, CYCLE 9 TO EOFP OXIDATION PARAMENTERS OF REGION 9A IN UNIT 2, CYCLE 10

Case	$F_{\Delta H}$ Burndown	Peak Power	Initial Oxidation	Final Oxidation	Oxidation Change	Fuel Temp
Unit 1 Cycle 9	20%	9.25 W/ft	12.9%	16.21%	3.31%	2111°F
Unit 2 Cycle 10 Rgn 9A	29.9%	8.49kW/ft	11.8%	15.11%	3.31%	1810°F

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- The transient oxidation of 3.31 percent from the Unit 1, Cycle 9 analysis was added to the EOFP initial oxidation of 11.8 percent for the DCPP Unit 2, Cycle 10 to obtain the final oxidation in Table 1.

- The final oxidation value of 15.11 percent in Table 1 can be decreased further by accounting for the difference in the burndown credits. The analyses performed for Unit 1, Cycle 9 provided a sensitivity of oxidation with respect to peak power. Based upon this sensitivity, crediting the lower peak power for the Region 9A fuel in Unit 2, Cycle 10 results in a reduction of the final oxidation value from 15.11 percent to 14.66 percent. Thus, the fuel in Unit 2, Cycle 10 complies with the 17 percent criterion in 10 CFR 50.46. Further reductions in the transient oxidation could be obtained by taking into account the higher $F_{\Delta H}$ burndown credit and the lower fuel temperature in the Region 9A fuel in Unit 2, Cycle 10.

Based on discussions with Westinghouse, PG&E does not expect the scope of the condition, cause, or corrective actions to change. Therefore, PG&E does not intend to provide additional supplemental reports on this condition.

D. Inoperable Structures, Components, or Systems that Contributed to the Event

None.

E. Dates and Approximate Times for Major Occurrences

1. October 28, 1997:	Westinghouse notified PG&E of the potential to exceed gap reopening and clad oxidation acceptance criteria.
2. October 29, 1997:	PG&E submitted a voluntary 10 CFR 50.72 notification.
3. November 14, 1997:	PG&E submitted an updated 10 CFR 50.72 notification.

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4. December 11, 1997: PG&E submitted a 1-hour non-emergency report for Unit 2 in accordance with 10 CFR 50.72 (b)(1)(ii)(B).

5. January 6, 1998: PG&E submitted an updated 10 CFR 50.72 notification.

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

Westinghouse discovered the potential for this condition in high duty IFBA rods when the effects of increased Zirc-4 corrosion on high duty rods observed in the field were incorporated into the current licensed version of the Westinghouse fuel performance computer code PAD.

H. Operator Actions

None.

I. Safety System Responses

None.

III. <u>Cause of the Problem</u>

A. Immediate Cause

The Westinghouse fuel performance models were nonconservative.

B. Root Cause

The condition was caused by Zirc-4 cladding material corrosion rates higher than previously experienced on high duty fuel rods.

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IV. Analysis of the Event

Westinghouse presented the safety consequences and implications of gap reopening and clad corrosion to the NRC on November 6, 1997. Those consequences and implications are bounding for the condition in Unit 2, Cycle 8. The following general conclusions were also discussed during the meeting.

Generic Safety Assessment for Gap Reopening Summary

- Gap reopening does not lead to fuel failures.
- Gap reopening causes elevated temperatures and pressures in high duty rods.
- Gap reopening does not cause analyzed design basis accident scenarios to become worse.
- Gap reopening is of low safety significance.

Westinghouse also concluded that the condition does not represent a substantial safety hazard, nor is it reportable under 10 CFR 21.

Safety Assessment for Unit 2, Cycle 8

During its discussions with the NRC, Westinghouse committed to perform a plant-by-plant review of all operating cores prior to exceeding burnups at which pretransient oxidation levels would exceed 12 percent. The review would determine if the plant would potentially exceed the 10 CFR 50.46 maximum cladding oxidation limit by the EOC, and in cases where this was possible, determine mitigating actions to be taken in operation of the core to maintain compliance with the 10 CFR 50.46 limit.

Overall, the Westinghouse safety assessment concluded that gap reopening is predicted for Unit 2, Cycle 8, but the safety analyses continue to show acceptable results, including the check performed for the 10 CFR 50.46 maximum cladding oxidation limit. Portions of the safety assessment are summarized below.

1. Rod Internal Pressure

   Westinghouse performed calculations using PAD and associated methodology outlined in the November 6, 1997, meeting, but did not include any modifications to reduce the inherent conservatism.

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The rod internal pressure assessment showed gap reopening at or beyond 20,000 MWD/MTU cycle burnup for the rod which is limiting for corrosion.

Unit 2, Cycle 8, limiting rod internal pressure and gap reopening burnup are bounded by the limiting values assumed in the Westinghouse generic safety assessment.

2. Maximum Pretransient Oxidation

The methodology for calculating oxidation/corrosion levels applied the same model as that presented to the NRC during a meeting in December 1996.

Westinghouse calculated the oxidation level as a function of burnup for the most limiting fuel rod. For determining compliance with the 10 CFR 50.46 maximum cladding oxidation limit, Westinghouse used upper bound predictions that consider the effects of uncertainties at the 95 percent probability level. The maximum pretransient oxidation for the rods with gap reopening is 12.5 percent.

Unit 2 is expected to exceed the 12 percent screening level at a cycle burnup of 23,685 MWD/MTU on or after January 22, 1998.

3. Power Burndown Behavior

Fuel assemblies that have high levels of burnup and corrosion will have lower levels of achievable power peaking factors (which determines fuel and cladding temperatures and corrosion rates) due to reactivity reduction with burnup. The degree of power burndown credit available is loading pattern dependent. Westinghouse assessed burndown credit for DCPP Unit 2, Cycle 8, relative to the plant Technical Specification peaking factor limits.

4. Fuel Temperatures for Gap Reopened Conditions

Westinghouse calculated fuel rod temperatures with the same version of PAD that was used to calculate internal rod pressures. The fuel temperatures were calculated for input to the large-break LOCA assessment of transient oxidation accumulation. The temperatures contain conservative peaking factor burndown credits.

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5. 10 CFR 50.46 LOCA Oxidation Limit Compliance

   Westinghouse performed plant-specific analyses for DCPP Unit 2, Cycle 8, to assess compliance with 10 CFR50.46. Since the DCPP best estimate LOCA analysis is currently under NRC review, the assessment was performed using two separate approaches - Appendix K and best estimate. Both methods yielded acceptable results. Both methods are described in a Westinghouse Owners Group (WOG) letter to the NRC, "Transmittal of Response to NRC Request for Additional Information on the Fuel Rod Internal Pressure Issue," dated November 12, 1997.

   The WCOBRA/TRAC transient used to calculate the maximum local oxidation at beginning of life for the DCPP best estimate LOCA analysis was selected as the starting point for the assessment. This is consistent with the "Best Estimate Approach," provided in the WOG letter. The same transient also bounds the DCPP, Appendix K analysis, plus additional peak cladding temperature assessments, and is appropriate for use with the Appendix K approach.

   The results indicated a maximum transient oxidation equivalent of 3.3 percent of the initial cladding thickness. When added to the pretransient oxidation of 12.5 percent, the total cladding oxidation of 15.8 percent remains below the 17 percent limit. Therefore, compliance with the 10 CFR 50.46 LOCA limit on total localized oxidation was demonstrated.

6. Other Gap Reopening Safety Analyses for Condition I, II, III, and IV Events

   Westinghouse assessed the effects of gap reopening on Condition I, II, III, and IV accident analyses. Results were shown to be acceptable on a generic basis. Details of this assessment were originally documented in the Westinghouse JCO, dated October 27, 1997. The JCO arguments and safety assessment were presented to the NRC by the WOG in the November 6, 1997, meeting. The assessment concluded that gap reopening is considered a low safety significance issue because gap reopening does not lead to fuel rod failures and previously analyzed design basis accident scenarios remain bounding.

   Westinghouse reviewed plant specific information for Unit 2 and concluded that the generic safety assessment for gap reopened conditions is bounding and applicable. Unit specific assessments of rod internal pressure, maximum pretransient oxidation, peaking factor burndown credit, and fuel temperatures

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show that all parameters are less limiting or equal to the bounding values assumed in the generic safety assessment. Therefore, the generic safety assessment conclusion that gap reopened conditions do not adversely affect the overall outcome of the Conditions I, II, III, and IV transient analyses is applicable to Unit 2, Cycle 8.

Based on the completion of the above safety assessment and the operability evaluation, no modifications or restrictions to the cycle are necessary through EOC. Therefore, this condition does not affect the health and safety of public.

V. Corrective Actions

A. Immediate Corrective Actions

PG&E documented the condition and performed an operability evaluation. The evaluation was based on the Westinghouse report entitled, "Justification for Continued Operation for Exceeding Steady State Pressure Limit." The Westinghouse report assumed that gap reopening had occurred. Therefore, it remains valid for the condition that presently exists in Unit 2. The report and operability evaluation concluded that Unit 2 is operable.

B. Corrective Actions to Prevent Recurrence

During the November 6, 1997, presentation to the NRC, Westinghouse identified a "Plan for Resolution" that contained several long term corrective actions. PG&E will continue to communicate with Westinghouse through implementation of its long term resolution plan and will take appropriate actions for DCPP Units 1 and 2.

VI. Additional Information

A. Failed Components

None.

B. Previous Similar Events

None.