



**Pacific Gas and
Electric Company®**

Barry S. Allen
Site Vice President

Diablo Canyon Power Plant
Mail Code 104/6
P. O. Box 56
Avila Beach, CA 93424

805.545.4888
Internal: 691.4888
Fax: 805.545.6445

August 7, 2014

PG&E Letter DCL-14-070

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

10 CFR 50.46

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
10 CFR 50.46 Annual Report of Emergency Core Cooling System Evaluation
Model Changes for Peak Cladding Temperature for 2013

Dear Commissioners and Staff:

Pursuant to 10 CFR 50.46, the enclosure to this letter is the annual report of changes in the Westinghouse emergency core cooling system evaluation models that affect peak cladding temperature (PCT) calculations for Pacific Gas and Electric Company's (PG&E's) Diablo Canyon Power Plant, Units 1 and 2. The attachments to the enclosure provide a summary of the PCT margin allocations and their bases.

PG&E makes no new or revised regulatory commitments (as defined by NEI 99-04) in this report.

If you have questions regarding this submittal please contact Mr. Mark Sharp at 805-545-3031.

Sincerely,

Barry S. Allen

j8l3/4486/64093434/50640861/50640862

Enclosure

cc/enc: Peter J. Bamford, NRR Project Manager
Marc L. Dapas, NRC Region IV Administrator
Thomas R. Hipschman, NRC Senior Resident Inspector
Diablo Distribution

**ANNUAL REPORT OF EMERGENCY CORE COOLING SYSTEM
EVALUATION MODEL CHANGES FOR PEAK CLADDING TEMPERATURE**

Pursuant to 10 CFR 50.46, this enclosure provides an annual report of changes in the Westinghouse emergency core cooling system (ECCS) evaluation models that affect peak cladding temperature (PCT) calculations for Pacific Gas and Electric Company's (PG&E's) Diablo Canyon Power Plant, Units 1 and 2. This report is based on changes described in Westinghouse Letter LTR-LIS-14-94, "Diablo Canyon Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 2013," dated March 17, 2014.

Attachment A contains Unit 1 small-break loss-of-coolant accident (SBLOCA) and best-estimate, large-break loss-of-coolant accident (BELOCA) PCT margin utilization sheets. Attachment B contains the corresponding Unit 2 data. Attachment C has a summary of ECCS evaluation model changes and PCT margin allocations that have occurred since the last report. There have been no changes in the SBLOCA PCT results for either Unit 1 or Unit 2 since the last annual update. The last annual update was provided in PG&E Letter DCL-13-077, "10 CFR 50.46 Annual Report of Emergency Core Cooling System Evaluation Model Changes for Peak Cladding Temperature for 2012," dated July 30, 2013. Subsequently a 30-day notification report was provided in PG&E Letter DCL-13-111, "Thirty-Day Notification Report of Significant Emergency Core Cooling System Evaluation Model Changes that Affect Peak Cladding Temperature," dated November 14, 2013.

There have been additional changes in the Unit 1 and Unit 2 BELOCA PCT results in 2013 and the final net PCT values are listed below for each unit. Two PCT values are reported for the Unit 1 BELOCA results. The two BELOCA PCT values are labeled Reflood 1 and Reflood 2, as they represent the two distinctive PCT peaks that occur during the reflood phase for the Unit 1 BELOCA Code Qualification Document methodology. The Unit 2 BELOCA reports only one PCT value consistent with the BELOCA ASTRUM methodology.

<u>SBLOCA</u>	<u>BELOCA</u>	
	<u>Reflood 1</u>	<u>Reflood 2</u>
Unit 1: 1391°F (no change)	2049°F	2124°F
Unit 2: 1288°F (no change)	2125°F	

The PCT values remain within the 2200°F limit specified in 10 CFR 50.46. However, because Unit 1 and Unit 2 BELOCA have a total PCT margin allocation that is currently greater than 50°F, PG&E will complete the Unit 1 BELOCA reanalysis and provide the updated PCT results to the NRC by December 2016,

as stated in PG&E Letter DCL-13-111. Also, PG&E will complete the Unit 2 BELOCA reanalysis and provide the updated PCT results to the NRC by December 2016.

**DIABLO CANYON POWER PLANT UNIT 1 PEAK CLADDING
TEMPERATURE MARGIN UTILIZATION**

<u>SMALL-BREAK LOCA</u>		<u>PG&E Letter¹</u>	
A.	ANALYSIS OF RECORD	PCT =	1391°F DCL-09-057
B.	PRIOR 10 CFR 50.46 Emergency Core Cooling System (ECCS) MODEL ASSESSMENTS ²		
1.	None	Δ PCT =	0°F
C.	10 CFR 50.46 ECCS MODEL ASSESSMENTS THIS YEAR		
1.	None	Δ PCT =	0°F
D.	SUM OF 10 CFR 50.46 CHANGES		
1.	Net Sum of 10 CFR 50.46 PCT Changes	Δ PCT =	0°F
2.	Absolute Sum of 10 CFR 50.46 PCT Changes	Δ PCT =	0°F
E.	ANALYSIS OF RECORD PCT (Line A) + Line D.1 Net Sum of 10 CFR 50.46 PCT Changes		<hr/> 1391°F

The sum of the peak cladding temperature (PCT) from the most recent analysis of record using an acceptable evaluation model and the estimates of the net PCT effect for changes and errors identified since this analysis remains less than 2200°F.

¹ For those issues that have been previously reported under 10 CFR 50.46, a PG&E letter number is listed.

² Only permanent assessments of PCT margin are included. Temporary PCT allocations that address current loss-of-coolant accident (LOCA) model issues are not considered with respect to 10 CFR 50.46 reporting requirements.

**DIABLO CANYON POWER PLANT UNIT 1 PEAK CLADDING
TEMPERATURE MARGIN UTILIZATION**

Best-Estimate, Large-Break Loss-of-Coolant Accident

PG&E Letter¹

	Reflood 1	Reflood 2	
A. ANALYSIS OF RECORD	1900°F	1860°F	DCL-05-146
	<u>ΔPCT</u>	<u>ΔPCT</u>	
B. PRIOR 10 CFR 50.46 ECCS MODEL ASSESSMENTS ²			
1. Revised blowdown heatup uncertainty distribution.	5°F	5°F	DCL-05-086
2. HOTSPOT Fuel Relocation Error.	10°F	0°F	DCL-07-071
3. Replacement Steam Generators	75°F	71°F	DCL-09-057
4. 230 kV Degraded Voltage Event	0°F	39°F	DCL-11-082
5. Performance and Design 4.0 Implementation	-118°F	-118°F	DCL-12-102
6. Fuel Thermal Conductivity Degradation and Peaking Factor Burndown	133°F	238°F	DCL-12-102
7. Revised Heat Transfer Multiplier Distributions	5°F	-35°F	DCL-13-111
8. Changes to Grid Blockage and Porosity	24°F	24°F	DCL-13-111
C. 10 CFR 50.46 ECCS MODEL ASSESSMENTS THIS YEAR			
1. Error in Burst Strain Application	15°F	40°F	This Letter
D. SUM OF 10 CFR 50.46 CHANGES			
1. Net Sum of PCT Changes	149°F	264°F	
2. Absolute Sum of PCT Changes	385°F	570°F	
E. Analysis of Record PCT (Line A) + Line D.1 Net Sum of 10 CFR 50.46 PCT Changes	2049°F	2124°F	

The sum of the PCT from the most recent analysis of record using an acceptable evaluation model and the estimates of the net PCT effect for changes and errors identified since this analysis remains less than 2200°F.

- ¹ For those issues that have been previously reported under 10 CFR 50.46, a PG&E letter number is listed.
- ² Only permanent assessments of PCT margin are included. Temporary PCT allocations that address current LOCA model issues are not considered with respect to 10 CFR 50.46 reporting requirements.

**DIABLO CANYON POWER PLANT UNIT 2 PEAK CLADDING
TEMPERATURE MARGIN UTILIZATION**

Small-Break Loss-of-Coolant Accident

PG&E Letter¹

A.	ANALYSIS OF RECORD	PCT =	1288°F	DCL-08-061
B.	PRIOR 10 CFR 50.46 Emergency Core Cooling System (ECCS) MODEL ASSESSMENTS ²			
	1. None	Δ PCT =	0°F	
C.	10 CFR 50.46 ECCS MODEL ASSESSMENTS THIS YEAR			
	1. None	Δ PCT =	0°F	
D.	SUM OF 10 CFR 50.46 CHANGES			
	1. Net Sum of 10 CFR 50.46 PCT Changes	Δ PCT =	0°F	
	2. Absolute Sum of 10 CFR 50.46 PCT Changes	Δ PCT =	0°F	
E.	ANALYSIS OF RECORD PCT (Line A) + Line D.1 Net Sum of 10 CFR 50.46 PCT Changes		<hr/> 1288°F	

The sum of the peak cladding temperature (PCT) from the most recent analysis of record using an acceptable evaluation model and the estimates of the net PCT effect for changes and errors identified since this analysis remains less than 2200°F.

¹ For those issues that have been previously reported under 10 CFR 50.46, a PG&E Letter number is listed.

² Only permanent assessments of PCT margin are included. Temporary PCT allocations that address current loss-of-coolant accident (LOCA) model issues are not considered with respect to 10 CFR 50.46 reporting requirements.

**DIABLO CANYON POWER PLANT UNIT 2 PEAK CLADDING
TEMPERATURE MARGIN UTILIZATION**

Best-Estimate, Large-Break Loss-of-Coolant Accident

PG&E Letter¹

A.	ANALYSIS OF RECORD	PCT=	1872°F	DCL-07-071
B.	PRIOR 10 CFR 50.46 ECCS MODEL ASSESSMENTS ²			
	1. HOTSPOT Fuel Relocation Error.	Δ PCT=	0°F	DCL-07-071
	2. 230 kV Degraded Voltage Event.	Δ PCT=	16°F	DCL-11-082
	3. Fuel Thermal Conductivity Degradation and Peaking Factor Burndown	Δ PCT=	209°F	DCL-12-102
	4. Revised Heat Transfer Multiplier Distribution	Δ PCT=	-17°F	DCL-13-111
	5. Changes to Grid Blockage and Porosity	Δ PCT=	24°F	DCL-13-111
C.	10 CFR 50.46 ECCS MODEL ASSESSMENTS THIS YEAR			
	1. Error in Burst Strain Application	Δ PCT=	21°F	This Letter
D.	SUM OF 10 CFR 50.46 CHANGES			
	1. Net Sum of 10 CFR 50.46 PCT Changes	Δ PCT=	253°F	
	2. Absolute Sum of 10 CFR 50.46 PCT Changes	Δ PCT=	287°F	
E.	ANALYSIS OF RECORD PCT (Line A) + Line D.1 Net Sum of 10 CFR 50.46 PCT Changes		2125°F	

The sum of the PCT from the most recent analysis of record using an acceptable evaluation model and the estimates of the net PCT effect for changes and errors identified since this analysis remains less than 2200°F.

¹ For those issues that have been previously reported under 10 CFR 50.46, a PG&E letter number is listed.

² Only permanent assessments of PCT margin are included. Temporary PCT allocations that address current LOCA model issues are not considered with respect to 10 CFR 50.46 reporting requirements.

CURRENT EMERGENCY CORE COOLING SYSTEM MODEL CHANGES AND ERRORS

Unit 1

Error in Burst Strain Application

Background

An error in the application of the burst strain was discovered in HOTSPOT. The equation for the application of the burst strain is given as Equation 7-69 in WCAP-16009-P-A and in WCAP-12945-P-A. The outer radius of the cladding after burst occurs should be calculated based on the burst strain, and the inner radius of the cladding should be calculated based on the outer radius. In HOTSPOT, the burst strain is applied to the calculation of the cladding inner radius. The cladding outer radius is then calculated based on the inner radius. As such, the burst strain is incorrectly applied to the inner radius rather than the outer radius, which impacts the resulting cladding geometry at the burst elevation after burst occurs. Correction of the erroneous calculation results in thinner cladding at the burst node and more fuel relocating into the burst node, leading to an increase in the peak cladding temperature (PCT) at the burst node. This issue has been evaluated to estimate the impact on existing best-estimate, large-break loss-of-coolant accident (BELOCA) analysis results.

Affected Evaluation Model

1996 Westinghouse BELOCA Evaluation Model

Estimated Effect

A representative Diablo Canyon Power Plant Unit 1 case was run using HOTSPOT versions which only differ in the burst strain application. Based on the change in the 95th percentile results, estimated PCT effects of 15°F for Reflood 1 and 40°F for Reflood 2 have been established for 10 CFR 50.46 reporting purposes for Diablo Canyon Power Plant Unit 1.

Unit 2

Error in Burst Strain Application

Background

An error in the application of the burst strain was discovered in HOTSPOT. The equation for the application of the burst strain is given as Equation 7-69 in WCAP-16009-P-A and in WCAP-12945-P-A. The outer radius of the cladding after burst occurs should be calculated based on the burst strain, and the inner radius of the cladding should be calculated based on the outer radius. In HOTSPOT, the burst strain is applied to the calculation of the cladding inner radius. The cladding outer radius is then calculated based on the inner radius. As such, the burst strain is incorrectly applied to the inner radius rather than the outer radius, which impacts the resulting cladding geometry at the burst elevation after burst occurs. Correction of the erroneous calculation results in thinner cladding at the burst node and more fuel relocating into the burst node, leading to an increase in the PCT at the burst node. This issue has been evaluated to estimate the impact on existing BELOCA analysis results.

Affected Evaluation Model

2004 Westinghouse Realistic BELOCA Evaluation Model Using ASTRUM

Estimated Effect

The issue described above was evaluated based on the results of executing the most limiting plant-specific HOTSPOT runs for similar plants with a HOTSPOT version that includes the correction of this error. This resulted in an estimated PCT impact of 21°F for Diablo Canyon Power Plant Unit 2.