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U.S. Nuclear Regulatory Commission
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Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Reactor Vessel Material Surveillance Program Capsule V Technical Report

Dear Commissioners and Staff:

On October 13, 1999, surveillance Capsule V was withdrawn from the Diablo Canyon Power Plant (DCPP) Unit 2 reactor vessel and shipped to Westinghouse for testing. Pursuant to 10 CFR 50 Appendix H, Part IV.A, the technical report was originally due October 13, 2000. However, by letter dated October 13, 2000, the NRC staff granted PG&E a 3-month extension for submitting the Capsule V report. Provided herein as Enclosure B is the Westinghouse technical report, WCAP-15423, Revision 0, "Analysis of Capsule V from Pacific Gas and Electric Company Diablo Canyon Unit 2 Reactor Vessel Radiation Surveillance Program."

Pursuant to 10 CFR 50.61(b)(1) and 10 CFR 50 Appendix H, Part IV.C, included herein are the results of: (1) the pressurized thermal shock (PTS) evaluation, (2) the reactor coolant system (RCS) pressure/temperature (P/T) limit curve evaluation, (3) the low temperature overpressure (LTOP) setpoint evaluation, and the upper shelf energy (USE) evaluation. These evaluations were all developed by PG&E.

Enclosure A contains supplemental calculation tables for the least-squares best-fit chemistry factor (CF) and the USE, utilizing best-estimate fast neutron fluences. These supplemental best-fit CF and USE tables are included because the corresponding tables in WCAP-15423 (Table 7-1, Table C-1, Table D-1 and Table D-2) utilize pure transport theory fast neutron fluences, whereas DCPP is currently licensed to the best-estimate fluence methodology. This methodology was previously used in the development of P/T curves and LTOP setpoints in License Amendment Request 98-06 (Ref. PG&E Letter DCL-98-121, "Revision of Technical Specification 3.4.9.1, Figures 3.4-2 and 3.4-3 – RCS Pressure/Temperature Limits and Request for Exemption from 10 CFR 50.60," dated September 3, 1998), which was approved by the NRC in License Amendment 133/131. For the most limiting surveillance Capsule V material, intermediate shell plate B5454-1, the best-estimate methodology yields a more conservative (higher) calculated adjusted reference

temperature (ART). The following discussion identifies the PG&E data used in place of the Westinghouse data included in WCAP-15423.

PG&E Evaluation/WCAP Differences

Table 1 of Enclosure A provides the best-estimate maximum vessel fluences (at the clad/base metal interface), the capsule fluences, the capsule lead factors, the removal time, and the equivalent capsule effective full power years (EFPY) exposures. The corresponding transport theory values are provided in Table 7-1 of the WCAP-15423.

For the Unit 2 end of operating license (EOL) at approximately 35 EFPY (April 26, 2025), the limiting RT_{PTS} values calculated and their respective 10 CFR 50.61 screening limits are:

RT_{PTS}(plate B5454-2) = 209.8 °F, which is <270 °F plate or axial weld limit

RT_{PTS}(weld 9-201) = 18.3 °F, which is <300 °F circumferential weld limit

Therefore, the PTS screening limits are met at EOL. PG&E performed this evaluation.

Table 2 of Enclosure A summarizes the best-fit surveillance capsule data CF evaluation. The Capsule V weld data point resulted in a new best-fit curve. As a result, the Capsule U weld data point now has a scatter value that exceeds a one sigma value of 28 °F, and the weld data is no longer deemed to be credible. Thus, the Table 2 CF derived for the weld metal was not used. Unit 2 weld metal is not limiting for the P/T curves and LTOP setpoint; however, the data for the surveillance plate material, which is more limiting for Unit 2, remains credible. The corresponding transport theory CF values are provided in Tables D-1 and D-2 of WCAP-15423.

Table 3 of Enclosure A shows that the DCPP Unit 2 ARTs projected to 16 EFPY are less than the T/4 and 3T/4 values assumed for the existing 16 EFPY P/T limit curves and LTOP setpoint found in the DCPP pressure and temperature limits report (PTLR). The P/T limit curves and LTOP setpoints for 16 EFPY remain bounding and valid. This evaluation was not included in the scope of the enclosed Westinghouse report. Instead, PG&E performed this evaluation with the results shown in Table 3.

Using the capsule fluences of Table 1 with the methodology of Regulatory Guide (RG) 1.99, Revision 2, the predicted USE values for irradiated and unirradiated surveillance material were developed. The values are provided in Table 4 of Enclosure A. Appendix G of 10 CFR 50 requires that the USE remain $\geq$ 50 ft-lb throughout the life of the vessel at T/4. This requirement is met for Capsule V, which

has an equivalent vessel exposure of >54 EFPY at the clad/base metal interface. The corresponding Westinghouse USE evaluation is provided in Table C-1 of the enclosed report. Note that the results of the PG&E evaluation are more conservative, because PG&E employed the bounding line method outlined in RG 1.99, Revision 2, whereas Westinghouse did not. In addition, using best-estimate fluences, PG&E calculated the USE for vessel materials not in the capsules. The most limiting (minimum) USE at EOL (approximately 35 EFPY) is 58 ft-lbs. This is predicted to occur for axial weld 3-201 B. Thus, the 50 ft-lb minimum requirement is met for all Unit 2 vessel materials to the EOL.

Conclusion

In conclusion, the results of the specimen testing show that the limiting vessel beltline plate and weld material are behaving in accordance with previous predictions. Consequently, the results from Capsule V do not indicate any changes needed to the LTOP setpoints or P/T curves currently approved. Capsule V is the last planned capsule to be evaluated in the DCPP Unit 2 surveillance program.

In a future submittal, PG&E will request NRC review and approval of PG&E's proposed application of the PTLR methodology that will allow PG&E to calculate new P/T and LTOP limits without prior staff approval. As required by Technical Specification 5.6.6(c), PG&E will also submit the revised PTLR, including data from the Capsule V report, when the PTLR is issued, upon approval of the PTLR methodology.

Sincerely,

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cc: Ellis W. Merschoff
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Enclosures

WEC/1249/R0188505

TABLES 1 THROUGH 4

Table 1
Best-Estimate Capsule/Vessel Fluences and Lead Factors

Capsule	Capsule Fluence (10^{19} n/cm^2)(1)	Max. Vessel Fluence (10^{19} n/cm^2) @ 0T(2)	Lead Factor	Removal Time (EFPY)	Equivalent Capsule EFPY
U	0.3394	0.0601	5.65	1.02	5.76
X	0.8413	0.155	5.42	3.16	17.1
Y	1.337	0.311	4.30	7.08	30.4
V	2.288	0.481	4.76	11.49	54.7

(1) Table 6-9 of WCAP-15423, Revision 0
(2) Table 6-13 of WCAP-15423, Revision 0

Table 2

Diablo Canyon Unit 2 Best Fit of Surveillance Capsule Data

Material	Capsule	F[1]	FF[2]	ΔRT_{NDT}[3]	FF x ΔRT_{NDT}	FF^2
Intermediate Shell Plate B5454-1 (Transverse)	U	0.339	0.702	73.30	51.46	0.493
	X	0.841	0.951	99.52	94.69	0.905
	Y	1.34	1.081	111.59	120.67	1.169
	V	2.29	1.224	112.90	138.20	1.498
Intermediate Shell Plate B5454-1 (Longitudinal)	U	0.339	0.702	65.39	45.91	0.493
	X	0.841	0.951	100.06	95.20	0.905
	Y	1.34	1.081	111.58	120.66	1.169
	V	2.29	1.224	123.43	151.09	1.498
				SUM =	817.87	8.132
		$CF_{Plate} = \Sigma(FF \times \Delta RT_{NDT})/\Sigma(FF^2) = 817.87/8.132 = 100.578$				
Weld Metal (Interm. Shell Long.)	U	0.339	0.702	172.99	121.45	0.493
	X	0.841	0.951	203.23	193.36	0.905
	Y	1.34	1.081	211.39	228.59	1.169
	V	2.29	1.224	224.47	274.77	1.498
				SUM =	818.17	4.066
		$CF_{Weld} = \Sigma(FF \times \Delta RT_{NDT})/\Sigma(FF^2) = 818.17/4.066 = 201.230$				

NOTES:
1. F = Best-Estimate Fluence (x 10^{19} n/cm^2, E>1.0 MeV) from WCAP-15423, Rev. 0
2. FF = fluence factor = $F^{(0.28-0.1 \times \log(F))}$
3. ΔRT_{NDT} values are the measured 30 ft-lb shift values.

Material	CF (°F)	FF	Measured ΔRT_{NDT}	Best Fit ΔRT_{NDT}	Scatter of ΔRT_{NDT}	<17 °F (base metal) <28 °F (weld metal)
Intermediate Shell Plate B5454-1 (Transverse)	100.578	0.702	73.30	70.61	2.69	YES
	100.578	0.951	99.52	95.69	3.83	YES
	100.578	1.081	111.59	108.76	2.83	YES
	100.578	1.224	112.90	123.11	-10.21	YES
Intermediate Shell Plate B5454-1 (Longitudinal)	100.578	0.702	65.39	70.61	-5.22	YES
	100.578	0.951	100.06	95.69	4.37	YES
	100.578	1.081	111.58	108.76	2.82	YES
	100.578	1.224	123.43	123.11	0.32	YES
Weld Metal (Interm. Shell Long.)	201.230	0.702	172.99	141.28	31.71	NO
	201.230	0.951	203.23	191.46	11.77	YES
	201.230	1.081	211.39	217.60	-6.21	YES
	201.230	1.224	224.47	246.32	-21.85	YES

Table 3
Comparison of Unit 2, 16 EFPY Projected ARTs With Existing P/T Curve Assumptions (°F)

ART Location	16 EFPY	P/T Curve Basis
T/4	174.2	183.7
3T/4	149.0	151.4

Table 4
Bounding Predicted USE Values (ft-lb)

Material	Unirradiated	Caps. U	Caps. X	Caps. Y	Caps. V
Shell Plate (longitudinal)	132.7	109.0	103.4	100.0	95.6
Shell Plate (transverse)	91.2	74.9	71.1	68.7	65.7
Weld Metal	118.3	81.4	72.8	67.7	61.1

WCAP-15423, Revision 0

Analysis of Capsule V from Pacific Gas and Electric Company Diablo Canyon Unit 2 Reactor Vessel Radiation Surveillance Program