Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

G B Slade
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July 3, 1992

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT - REACTOR VESSEL STRUCTURAL INTEGRITY - RESPONSE TO GENERIC LETTER 92-01, REVISION 1.

The enclosed information is provided in response to Generic Letter 92-01, Revision 1, dated March 6, 1992.

Gerald B Slade
General Manager

CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

Enclosure

070073

PALISADES NUCLEAR PLANT

A028 1/1

CONSUMERS POWER COMPANY

To the best of my knowledge, information and belief, the contents of this submittal are truthful and complete.

By _____
David P Hoffman, Vice President
Nuclear Operations

Sworn and subscribed to before me this 30 day of June 1992.

_____ [SEAL]
LeAnn Morse, Notary Public
Van Buren County, Michigan
My Commission expires June 6, 1994

ENCLOSURE

Consumers Power Company
Palisades Plant
Docket 50-255

REACTOR VESSEL STRUCTURAL INTEGRITY
RESPONSE TO GENERIC LETTER 92-01, REVISION 1

June 1992

16 Pages

1. *Certain addressees are requested to provide the following information regarding Appendix H to CFR Part 50:*

> *Addressees who do not have a surveillance program meeting ASTM E 185-73, -79, or -82 and who do not have an integrated surveillance program approved by the NRC (see Enclosure 2), are requested to describe actions taken or to be taken to ensure compliance with Appendix H to 10 CFR Part 50. Addressees who plan to revise the surveillance program to meet Appendix H to 10 CFR Part 50 are requested to indicate when the revised program will be submitted to the NRC staff for review. If the surveillance program is not to be revised to meet Appendix H to 10 CFR Part 50, addressees are requested to indicate when they plan to request an exemption from Appendix H to 10 CFR Part 50 under 10 CFR 50.60(b).*

Response

Paragraph II.B.1 of Appendix H to 10 CFR Part 50 states "That part of the surveillance program conducted prior to the first capsule withdrawal must meet the requirements of the edition of ASTM E 185 that is current on the issue date of the ASME Code to which the reactor vessel was purchased." The Palisades reactor vessel was designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section III, 1965 Edition, including all addenda through Winter 1965.[1] The reactor vessel surveillance program was developed with the intent to comply, where possible, with the guidance of ASTM E 185-66, "Recommended Practice for Surveillance Tests on Structural Materials in Nuclear Reactors".[2] Appendices G and H did not exist at that time.

Section 3 of ASTM E 185-66 describes the requirements for test specimens. Paragraph 3.1.2 of ASTM E 185-66 requires the base metal specimen be from "...one heat with the highest initial ductile-brittle transition temperature", also known as the nil-ductility transition temperature (NDTT). Drop weight tests of Palisades beltline samples identified five of the plates in contention for the highest initial NDTT at -30°F. The material from shell course D-3803-1 was selected over the other specimens, because it had the highest temperature at the 30 ft-lb Charpy impact value.[3]

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[1]Palisades Nuclear Plant Final Safety Analysis Report Update, Revision 13, Section 4.2.4, p. 4.2-2.

[2]Koziol, "Recommended Program for Irradiation Surveillance of Palisades Reactor Vessel Material", August 8, 1968, p. 1; attachment to Hoffman (CPCo) to Ziemann (NRC), "Docket 50-255 - License DPR-20 - Palisades Plant - Reactor Vessel Material Surveillance", May 23, 1978.

[3]Groeschel, P-NLM-019, "Summary Report on Manufacture of Test Specimens and Assembly of Capsules for Irradiation Surveillance of Palisades Reactor Vessel Materials", April 1, 1971, pp. 2-3.

Paragraph 3.1 of ASTM E 185-66 requires a sample to represent one butt weld if a weld occurs in the irradiated region and that the sample have a fabrication history fully representative of the material being surveyed. The Palisades surveillance welds were fabricated by welding two plate sections from the intermediate shell course of the vessel with the same procedure used to fabricate the reactor vessel axial welds.[4] The surveillance welds were fabricated with the same type of filler wire and flux as were the reactor vessel beltline axial seams. The surveillance welds were not fabricated with the same heat of wire or batch of flux as were the vessel welds.[5]

Paragraphs 3.2 and 3.3 of ASTM E 185-66 specify the type and number of specimens required for the surveillance program. The Palisades surveillance program was designed with six surveillance capsules scheduled for removal at different neutron exposure levels. The current removal schedule has recently been revised and will be included in the next revision to the Updated Safety Analysis Report.[6] Each of these capsules are mounted on the inside vessel wall in the beltline region and are exposed to conditions which are conservative compared to those experienced by the reactor vessel inner surface. As a supplement, the surveillance program also contains two accelerated and two thermal capsules mounted on the core support barrel in the beltline region and above the core respectively.[7] A surveillance capsule contains 12 impact and 3 tension specimens each for base metal, weld and heat-affected-zone (HAZ) material. The base metal samples are oriented with the major axis parallel to the principal rolling direction of the plate and the notches in the impact specimens perpendicular to the material surface. The weld metal impact specimens are oriented perpendicular to the direction of the weld, while the weld metal tension specimens are oriented parallel to the direction of the weld. The HAZ specimens are oriented perpendicular to the direction of the weld with the notch of the impact specimens centered near the weld/base metal fusion line. Six of the capsules also contain 12 base metal impact specimens oriented perpendicular to the principal rolling direction. The four remaining capsules contain 12 impact specimens fabricated from standard reference material (Charpy impact specimens made from HSST reference plate 01, section MY of ASTM A533 Grade B, Class 1 steel[8]) oriented parallel with the principal rolling direction.[9]

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[4]Reference 4, Appendix A-2, p.3.

[5]VandeWalle (CPCo) to NRC, "Docket 50-255 - License DPR-20 - Palisades Plant - Proposed Technical Specification Change Request - Palisades Reactor Vessel Pressure/Temperature Limits," Pressure Attachment III, pp. 4-7.

[6]Holian (NRC) to Slade (CPCo), "Palisades Plant - Amendment No. 142 to Facility Operating License No. DPR-20 (TAC No. M82162), March 27, 1992.

[7]Reference 8, Figure No. 4-11.

[8]Reference 4, p.37.

[9]Reference 4, pp. 8-12.

Paragraph II.B.1 of Appendix H requires that each capsule withdrawn after July 26, 1983 be tested and reported to the requirements of ASTM E 185-82. Capsules removed prior to July 26, 1983 may be tested using the 1973, 1979 or 1982 edition of ASTM E 185. The Palisades reactor vessel unirradiated mechanical properties were evaluated in accordance with ASTM E 185-73.[10] Because the analysis of irradiated mechanical properties was purchased at the same time, we assume that accelerated capsule A-240 was also evaluated in accordance with ASTM E 185-73.[11] Thermal capsule T-330 and surveillance capsule W-290 were tested in accordance with ASTM E 185-82.[12]

In the Palisades reactor vessel (RV) surveillance program, instead of using the Palisades weld material surveillance data for surveillance of the Palisades RV welds, we use industry data from surveillance programs which generated that data by the testing of weld materials which are similar (same weld wire heat number) to the weld material in the Palisades reactor vessel. The use of data from other plants has been approved by the NRC in Amendments 97, 117, and 131 to the Palisades Operating License; and is necessary because, although the Palisades RV weld material surveillance coupons were made to the same specifications as the vessel welds, the weld material in them is from a different heat.

In view of the above, we interpret the Palisades reactor vessel material surveillance program as satisfying the requirements of Appendix H.

2. *Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:*

   a. *Addressees of plants for which the Charpy upper shelf energy is predicted to be less than 50 foot-pounds at the end of their licenses using the guidance in Paragraphs C.1.2 or C.2.2 in Regulatory Guide 1.99, Revision 2, are requested to provide to the NRC the Charpy upper shelf energy predicted for December 16, 1991, and for the end of their current license for the limiting beltline weld and the plate or forging and are requested to describe the actions taken pursuant to Paragraphs IV.A.1 or V.C of Appendix G to 10 CFR Part 50.*

Response

This is not applicable to Palisades. CPCo's most recent submittal to the NRC

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[10]Perrin and Fromm (Battelle), "Final Report on Palisades Pressure Vessel Irradiation Capsule Program: Unirradiated Mechanical Properties to Consumers Power", August 25, 1977, p.2.

[11]Jenkins to Baker (Battelle), Purchase Order No. 89738-Q, November 17, 1976.

[12]Kunka and Cheney, WCAP-10637, "Analysis of Capsules T-330 and W-290 from the Consumers Power Company Palisades Reactor Vessel Radiation Surveillance Program", September 1984, p. 5-1.

regarding upper shelf energy (USE) of Palisades reactor vessel beltline materials concluded that the base metal would not fall below 50 ft-lbs until the year 2032, well beyond the licensed end of life of March 14, 2007.[13]

2. Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:

b. Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:

(1) the results from all Charpy and drop weight tests for all unirradiated beltline materials, the unirradiated reference temperature for each beltline material, and the method of determining the unirradiated reference temperature from the Charpy and drop weight test;

Response

The unirradiated properties of the reactor vessel and surveillance program materials are detailed in the surveillance program fabrication[14] and test[15] reports. The Palisades reactor vessel surveillance program includes base metal material from intermediate shell plate D-3803-1 which was selected based on having the highest initial NDTT (-30°F) and the highest temperature at the 30 ft-lb Charpy impact value of the beltline region plates. Analysis of the unirradiated surveillance specimens showed the NDTT value and the estimated RT_{NDT} to be -10°F.[16] Subsequent review of manufacturer records has shown that the lowest initial upper shelf energy belonged to plate D-3804-1, and that the USE of this plate will remain above 50 ft-lbs through the end of licensed plant life. Palisades used a conservative value of 0°F for the unirradiated reference temperature for base metal in the pressurized thermal shock submittal.[17]

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[13]Slade (CPCo) to NRC, "Docket 50-255 - License DPR-20 - Upper Shelf Energy of Material in Reactor Beltline", August 31, 1990.

[14]Reference 4

[15]Reference 9

[16]Reference 9, pg. 44.

[17]Slade (CPCo) to NRC, "Docket 50-255 - License DPR-20 - Palisades Plant - 10CFR50.61 Pressurized Thermal Shock - Revised Projected Values of RT_{PTS} for Reactor Beltline Materials", June 5, 1992, attachment, p. 4-1.

Charpy impact and drop weight tests were performed on the surveillance weld material. Because the surveillance weld was determined to be not representative of the Palisades reactor vessel beltline welds, a generic value for the initial RT_{NDT} of -56°F was assumed as specified in 10CFR50.61 for welds fabricated with Linde 1092 and 124 fluxes.[18]

2. *Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:*

   b. *Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:*

      (2) the heat treatment received by all beltline and surveillance materials;

Response

The heat treatment of the beltline and surveillance materials was not considered in the RT_{PTS} analyses because 10CFR50.61 contains no provision for heat treatment consideration.

The heat treatment performed on the basemetal consisted of austenization at 1575±25°F for four hours, water quenched and tempered at 1225±25°F for four hours, followed by intermediate and final assembly stress relief at 1150±25°F for 40 hours. The Palisades reactor vessel axial welds received intermediate and final heat treatment at 1150±25°F for 40 hours. The circumferential weld received only the final heat treatment of 18 hours.[19] The surveillance weld received 1-3/4 hours interstage and 30 hours final heat at 1150±25°F.[20]

Both the axial weld surveillance material (Heat W5214) at Indian Point 3[21] and the circumferential weld surveillance material (Heat 27204) at Diablo Canyon 1[22] were heat treated for 40 hours at 1150±25°F. The heat treatment of these materials,which were used to calculate the USE of the Palisades

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[18]Reference 10, p. 4-1.

[19]Reference 2, Attachment, pp. 3-5.

[20]Reference 4, Appendix A-1.

[21]Westinghouse Electric Corporation Report WCAP-8475, "Indian Point Unit No. 3 Reactor Vessel Radiation Surveillance Program," January 1985.

[22]Westinghouse Electric Corporation Report WCAP-11567, "Analysis of Capsules from the Diablo Canyon Unit 1 Reactor Vessel Radiation Surveillance Program," December 1987.

reactor vessel welds, is considered to be equivalent to the heat treatment of the Palisades reactor vessel.

The heat treatment of the base plate surveillance coupons is considered to be equivalent to that of the installed baseplate and therefore ensures that surveillance specimen fracture toughness test results reflect the condition of the installed baseplate.

2. *Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:*

   b. *Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:*

      (3) the heat number for each beltline plate or forging and the heat number of wire and flux lot number used to fabricate each beltline weld;

Response

Heat numbers were considered in that, for each heat used for the Palisades reactor vessel beltline base metal, bounding values of copper, nickel, initial RT_{NDT} and initial USE have been assumed for RT_{PTS} and USE evaluations.

Palisades beltline welds best-estimate chemistries are derived from welds fabricated with the same weld wire heat numbers as were the Palisades beltline welds.[23]

Beltline material (See Fig 2)	Plate or weld wire heat number	Ni wire heat number	Flux lot number
D-3803-1,3	C1279		
D-3803-2	A0313		
D-3804-1,2	C1308		
D-3804-3	B5294		
2-112A/C	W5214	N7753A	Linde 1092, lot 3617
3-112A/C	W5214,34B009	N7753A	Linde 1092, lot 3692
9-112	27204		Linde 124, lot 3687

[23]Reference 10, Attachment, Section 2.

2. Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:

b. Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:

(4) the heat number for each surveillance plate or forging and the heat number of wire and flux lot number used to fabricate the surveillance weld;

Response

The surveillance plate material is from intermediate shell section D-3803-1 fabricated from heat number C1279. This material appears to reasonably represent the limiting reactor vessel base metal RT_{PTS}. In evaluating the base metal USE, CPCo recognized that plate D-3804-1, fabricated from heat number C1308, had the lowest initial USE of the beltline materials and evaluated compliance with Appendix G accordingly.

The Palisades surveillance weld material was fabricated with weld wire heat number 3277 plus nickel addition wire heat number N0591A and Linde 1092 flux lot 3833. This is a different heat than those used for the Palisades RV fabrication. Therefore, the Palisades surveillance weld test results are not considered applicable to the Palisades RV except for informational purposes after those results have been adjusted per RG 1.99 Rev 2.

2. Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:

b. Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:

(5) the chemical composition, in particular the weight in percent of copper, nickel, phosphorous, and sulfur for each beltline and surveillance material; and

Response

A great deal of consideration has been given to the copper and nickel content of the beltline and surveillance welds with regard to PTS and USE. The best-estimate copper and nickel concentrations have recently been revised.[24] Phosphorous[25] is not believed to be a significant contributors to risk in vessels fabricated with material containing the high levels of copper and nickel found in the Palisades reactor vessel. Sulfur content has not been considered since RG 1.99, neither in Revision 1 nor Revision 2, considered sulfur content. With the understanding that CPCo's review of phosphorous and sulfur values has been minimal, available best-estimate values are detailed below.

Beltline material (See Fig 2)	Cu(%)	Ni(%)	P(%)	S(%)
D-3803-1	0.24	0.51	0.009	0.020
D-3803-2	0.24	0.52	0.010	0.023
D-3803-3	0.24	0.50	0.011	0.020
D-3804-1	0.19	0.48	0.016	0.022
D-3804-2	0.19	0.50	0.015	0.020
D-3804-3	0.12	0.55	0.010	0.020
Surveillance plate	0.24	0.51	0.009	0.020
2/3-112A/C	0.18	1.05	0.019	0.016
9-112	0.21	1.00	0.013	0.012
Surveillance weld	0.25	1.13	0.013	0.011

2. Certain addressees are requested to provide the following information regarding Appendix G to 10 CFR Part 50:

b. Addressees whose reactor vessels were constructed to an ASME Code earlier than the Summer 1972 Addenda of the 1971 Edition are requested to describe the consideration given to the following material properties in their evaluations performed pursuant to 10 CFR 50.61 and Paragraph III.A of 10 CFR Part 50, Appendix G:

(6) the heat number of the wire used for determining the weld metal chemical composition if different than Item (3) above.

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[24]Reference 10, Attachment, p. 2-15.

[25]PNRandall, NRC, to ACRS, on February 18, 1988, for the purpose of publishing Revision 2 of "Regulatory Guide 1.99, "Radiation Embrittlement of Reactor Vessel Materials."

Response

This is not applicable to Palisades because the Palisades reactor vessel beltline weld chemistry was determined from chemical analyses performed on welds fabricated with the same weld wire heat number as that used in fabrication of the Palisades beltline welds.

3. *Addressees are requested to provide the following information regarding commitments made to respond to GL 88-11:*

   a. *How the embrittlement effects of operating at an irradiation temperature (cold leg or recirculation suction temperature) below 525°F were considered. In particular licensees are requested to describe consideration given to determining the effect of lower irradiation temperature on the reference temperature and on the Charpy upper shelf energy.*

Response

As shown in Section 4.4 of Reference 10, the effect of the Palisades plant operating 3 degrees less than 525°F during parts of the first two (2) fuel cycles is considered negligible. This judgement applies to both RT_{PTS} and USE.

3. *Addressees are requested to provide the following information regarding commitments made to respond to GL 88-11:*

   b. *How their surveillance results on the predicted amount of embrittlement were considered.*

Response

CPCo has determined through review of Palisades and other reactor vessel surveillance programs that the Palisades reactor vessel is less embrittled with regard to RT_{NDT} than predicted per the guidance of Regulatory Guide 1.99, Revision 2.[26] USE evaluations have concluded the Palisades reactor vessel beltline materials fall within the embrittlement limitations allowed by Appendix G and Regulatory Guide 1.99, Revision 2.

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[26]Reference 10, Attachment, Section 4.

3. *Addressees are requested to provide the following information regarding commitments made to respond to GL 88-11:*

   c. *If a measured increase in reference temperature exceeds the mean-plus-two standard deviations predicted in Regulatory Guide 1.99, Revision 2, or if a measured decrease in Charpy upper shelf energy exceeds the value predicted using the guidance in Paragraph C.1.2 in Regulatory Guide 1.99, Revision 2, the licensee is requested to report the information and describe the effect of the surveillance results on the adjusted reference temperature and Charpy upper shelf energy for each beltline material as predicted for December 16, 1991, and for the end of its current license.*

Response

CPCo has determined that the increases in beltline material reference temperatures fall within the mean-plus-two standard deviations of the values predicted in accordance with Regulatory Guide 1.99, Revision 2;[27] and that the measured decrease in USE for the welds does exceed the values predicted per Paragraph C.1.2.

It is assumed that surveillance welds fabricated with weld wire heats that are the same as those used in the Palisades reactor vessel beltline welds will demonstrate embrittlement behavior similar to the embrittlement behavior of the Palisades welds. Table 1 lists the surveillance data from other plants which have surveillance weld specimens made from the same weld wire heats as the Palisades RV welds and compares measured with predicted decrease in Charpy USE. Figure 1 visually provides the same information.

All of the surveillance data, except for the circumferential weld data (heat 27204) from Diablo Canyon, indicates the decrease in USE is greater than that predicted by the regulatory guide. The fact that surveillance results show the USE of the weld material decreasing faster than previously projected has caused the projected USE of the weld material at EOL (March 2007) to be decreased. However, using the guidance of Regulatory Guide 1.99, Revision 2, paragraph C.2.2, none of the Palisades reactor vessel beltline welds are projected to fall below 50 ft-lbs prior to the end of licensed life. The estimated USE as of December 16, 1991 and projected USE at EOL is shown on Table 2. Although the measured decrease in the base metal USE does not exceed the predicted decrease, information regarding the base metal has been included.

The only surveillance data available to CPCo on welds fabricated with weld wire heat 34B009 (lower baseplate axial welds) is from the Millstone 1 surveillance program (Reference 1) which concluded "Decrease in upper shelf energy was estimated, but the values are not reliable since the upper shelf energies of irradiated materials were not clearly established because of the

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[27]Reference 10, pp. 4-8 thorough 4-14.

small number of specimens available."[28] This report estimated a 25% uncertainty in the fluence measurement and conservatively chose the 75 ft-lb measurement as the irradiated USE measurement; although, the plot of Figure 5-9 of Reference 1 shows 90 ft-lbs.[29] The irradiated USE surveillance results for Millstone 1 show too much variation (when compared to results from other surveillance programs) to be considered credible and are not considered to be applicable to the Palisades RV welds.

[28]Reference 1, page 2-3

[29]Reference 1, page 5-15/5-16

References

1. Caine, NEDC-30833, "Millstone Nuclear Power Station, Unit 1, Reactor Pressure Vessel Surveillance Materials Testing and Fracture Toughness Analysis," December 1984.

2. Hoffman (CPCo) to Ziemann (NRC), "Docket 50-255 - License DPR-20 - Palisades Plant - Reactor Vessel Material Surveillance," May 23, 1978.

3. Holian (NRC) to Slade (CPCo), Palisades Plant - Amendment No. 142 to Facility Operating License No. DPR-20 (TAC No. M82162), March 27, 1992.

4. Groeschel, P-NLM-019, "Summary Report on Manufacture of Test Specimens and Assembly of Capsules for Irradiation Surveillance of Palisades Reactor Vessel Materials," April 1, 1971.

5. Jenkins to Baker (Battelle), Purchase Order No. 89738-Q, November 17, 1976.

6. Koziol, "Recommended Program for Irradiation Surveillance of Palisades Reactor Vessel Material," August 8, 1968.

7. Kunka and Cheney, WCAP-10637, "Analysis of Capsules T-330 and W-290 from the Consumers Power Company Palisades Reactor Vessel Radiation Surveillance Program," September 1984.

8. Palisades Nuclear Plant Final Safety Analysis Report Update, Revision 13.

9. Perrin and Fromm (Battelle), "Final Report on Palisades Pressure Vessel Irradiation Capsule Program: Unirradiated Mechanical Properties to Consumers Power," August 25, 1977.

10. Slade (CPCo) to NRC, "Docket 50-255 - License DPR-20 - Palisades Plant - 10CFR50.61 Pressurized Thermal Shock - Revised Projected Values of RT_{PTS} for Reactor Beltline Materials," June 5, 1992.

11. VandeWalle (CPCo) to NRC, "Docket 50-255 - License DPR-20 - Palisades Plant - Proposed Technical Specification Change Request - Palisades Reactor Pressure Vessel Pressure/Temperature Limits," June 14, 1985.

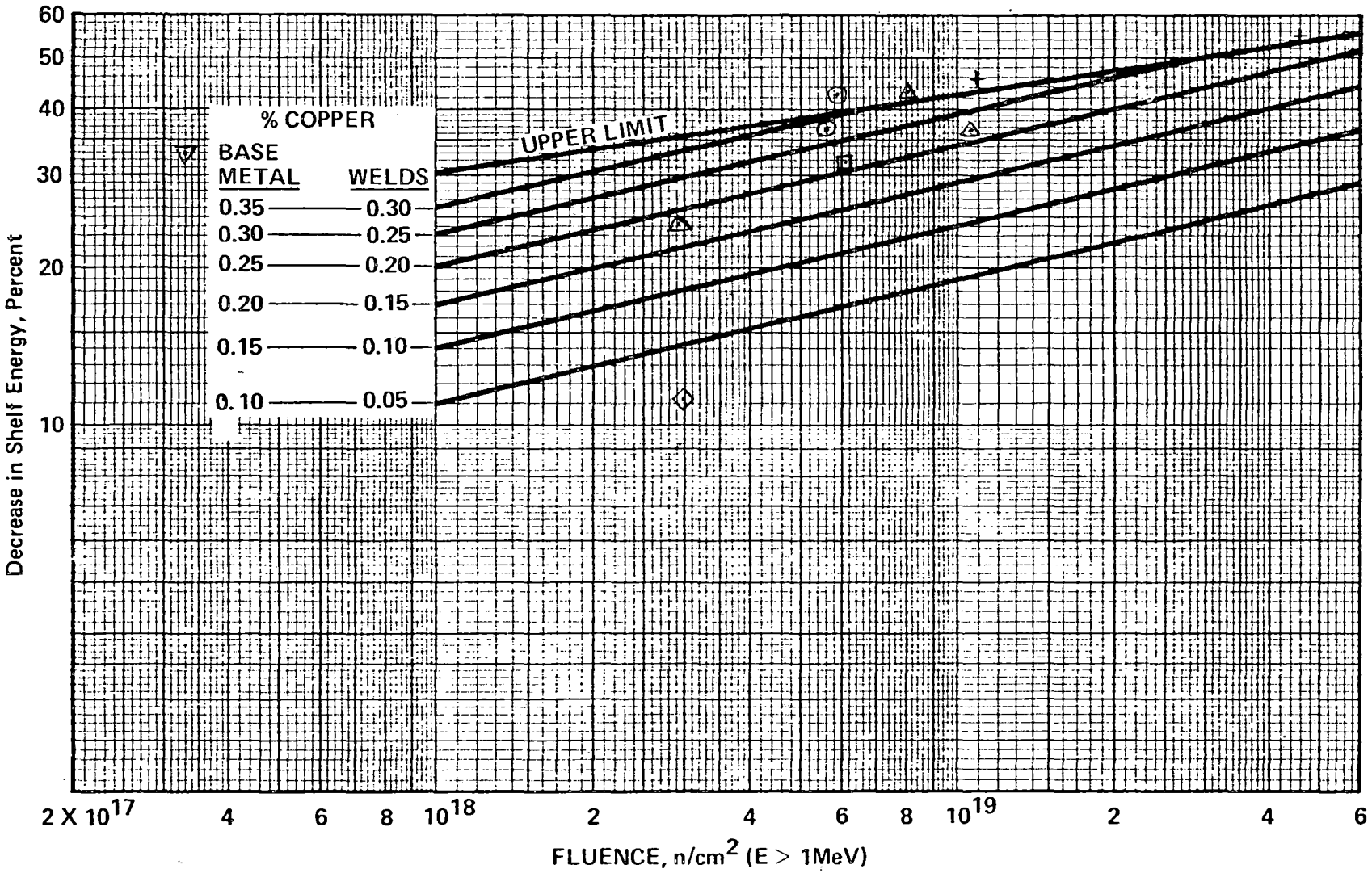
TABLE 1

Weld wire heat number	Plant	Capsule	Fluence ($E19n/cm^2$)	USE (ft-lbs) Initial	USE (ft-lbs) Measured	Reduction (%) Measured	Reduction (%) Predicted
W5214	Indian Point 2 Cu (%) = 0.20	V	0.559	118	75	36.4	30
		Y	0.589		68		42.430
	Indian Point 3 Cu (%) = 0.16	T	0.292	120	91	24.2	23
		Y	0.805		68	43.3	28
		Z	1.07		76	36.7	31
34B009	Millstone 1 Cu (%) = 0.18	2	0.033	112	75	33.0	Undefined
27204	Diablo Canyon 1 Cu (%) = 0.20	S	0.298	98	87	11.2	26
	Mihama Cu (%) = 0.18	N	0.61	101	69	31.7	29
3277	Palisades Cu (%) = 0.25	W-290	1.09	118	64	45.8	42
		A-240	4.6	120	54	55.0	54

TABLE 2

Weld wire heat number	Estimated USE as of 12/16/91, ft-lbs	Estimated ART (RT_{PTS}) as of 12/16/91, °F	Predicted USE at EOL, ft-lbs	Predicted ART (RT_{PTS}) at EOL, °F
W5124 (Axial Welds)	64.9	238	57.8	265
27204 (Circ Welds)	62.7	268	58.8	298
Base Metal	54.6	220	52.4	243

FIGURE 1



Predicted Decrease in Shelf Energy as a Function of Copper Content and Fluence (From R.G. 1.99, Rev. 2)

Indian Point 2 ⊙ Diablo Canyon 1 ◇ Palisades +

Indian Point 3 △ Millstone 1 ▽ Mihama ⊡

Figure 2
PALISADES REACTOR VESSEL

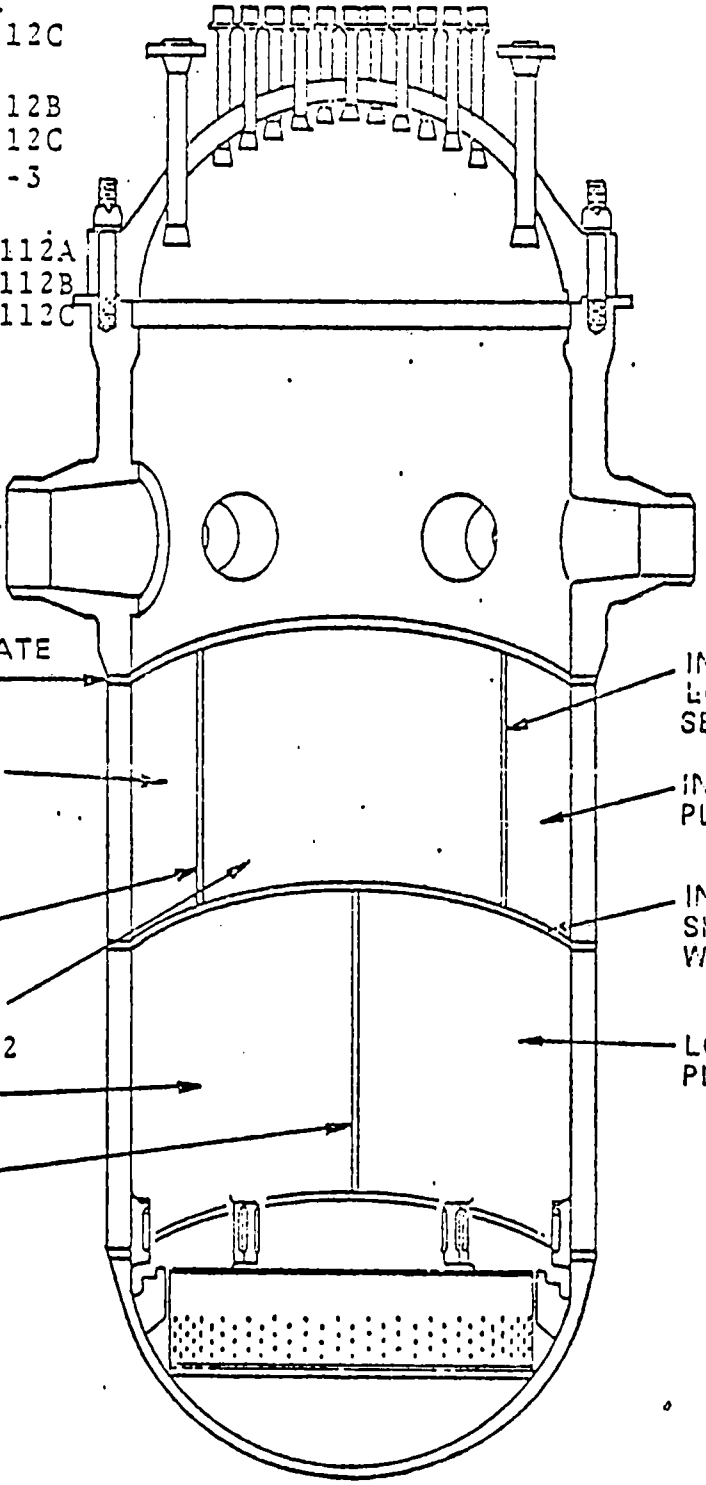
REACTOR-VESSEL BELTLINE MATERIALS

NOT SHOWN

INTERMEDIATE SHELL
WELD SEAM No. 2-112C

LOWER SHELL
WELD SEAM No. 3-112B
WELD SEAM No. 3-112C
PLATE No. D-3804-3

UPPER SHELL
WELD SEAM NO.1-112A
WELD SEAM NO.1-112B
WELD SEAM NO.1-112C



REACTOR VESSEL