Maine Yankee
RELIABLE ELECTRICITY SINCE 1972

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May 20, 1994
MN- 4-50 JRH-94-118

UNITED STATES NUCLEAR REGULATORY COMMISSION
Attention: Document Control Desk
Washington, D. C. 20555

References: (a) License No. DPR-36 (Docket No. 50-309)
(b) USNRC Letter to MY dated April 12, 1994, Generic Letter (GL) 92-01, Revision 1, "Reactor Vessel Structural Integrity", Maine Yankee Review Status (TAC No. M83479).
(c) MY Letter to USNRC dated December 3, 1993 (MN-93-111), - Response to Generic Letter 92-01, Revision 1, (Reactor Vessel Structural Integrity).
(d) MY Letter to USNRC dated July 2, 1992 (MN-92-65) - Response to Generic Letter 92-01, Revision 1 (Reactor Vessel Structural Integrity).

Subject: Response to Generic Letter 92-01, Revision 1 (Reactor Vessel Structural Integrity) Maine Yankee Review Status (TAC No. M83479)

Gentlemen:

This letter responds to Reference (b) letter which includes a summary status of Maine Yankee reactor vessel material properties based on References (c), (d) and other previously docketed information. The Reference (b) letter requested a response within thirty days to address use of generic values of initial upper shelf energy (USE) for the Maine Yankee reactor vessel Longitudinal Welds 2-203 and 3-203. The letter also requested that Maine Yankee verify the data entered into the summary tables by the NRC.

Our response to this request is provided in Enclosure 1. The response is provided in a question and answer format in order to facilitate the Staff review.

We trust this information is satisfactory.

Very truly yours,

James R. Hebert, Manager
Licensing and Engineering Support Department

RPJ/

Attachment

c: Mr. Thomas T. Martin
Mr. J. T. Yerokun
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ENCLOSURE 1

MAINE YANKEE

Response to USNRC Request for Additional Information
Related to Reactor Vessel Structural Integrity
(Generic Letter 92-01, Revision 1)
Maine Yankee Review Status

MAINE YANKEE

Response to USNRC Request for Additional Information
Related to Reactor Vessel Structural Integrity
(Generic Letter 92-01, Revision 1)
Maine Yankee Review Status

Maine Yankee's response to your request for additional data and to verify data listed in tables in the NRC Reference (b) letter is provided in this enclosure. The format is a question and answer format.

I. USNRC Question 1 [Reference (b), Paragraph 5].

Additional data is required to confirm that the USE at end-of-life (EOL) is greater than 50 ft-lbs, because you have provided a generic unirradiated USE value that was either a mean value from welds fabricated using the same flux type, or a value based on your surveillance material. This type of value is unacceptable because it does not consider heat variability of the unirradiated USE.

MYAPCo Response to Question 1

We have reviewed the Upper-Shelf Energy Table (Enclosure 2) of Reference (b). Based upon our review of this table, we understand that this question pertains to Longitudinal Welds 2-203 A, B and C, and 3-203 A, B and C. Furthermore, we understand that no similar issue exists for Circumferential Weld 9-203.

A. General Response

Maine Yankee participated in a Combustion Engineering Owner's Group (CEOG) task to perform generic bounding analyses for Upper Shelf Energy (USE). Combustion Engineering's analyses, which were transmitted to the NRC in Reference (j), concluded that actual material properties for CEOG vessels will not fall below the 50 ft-lb criterion of 10 CFR 50 Appendix G. Furthermore, Combustion Engineering concluded that beltline materials with Charpy USE levels as low as 38 ft-lbs for an axially-orientated flaw meet the acceptance criteria of ASME Code Case N-512.

Although Maine Yankee's position is that the USE for the Maine Yankee vessel will not fall below 50 ft-lbs at end of the operating license (10/21/2008), the generic bounding analyses provide additional technical evidence that there are no safety concerns with low USE.

The Combustion Engineering Owners Group (CEOG) has authorized a task to supplement the existing CEOG analyses to include equivalent margin analysis for welds. This task is scheduled to begin in mid-1994 with a completion date of late 1994.

Maine Yankee plans to participate in this CEOG task. Maine Yankee will provide the results of this CEOG task in writing to your staff by January 30, 1995.

B. Longitudinal Weld 2-203

The initial (unirradiated) USE for Longitudinal Welds 2-203 A, B and C reported in Reference (c) is $\geq$ 83.5 ft-lbs. This value is based upon the results of a Combustion Engineering (CE) evaluation performed to establish a generic lower bound (mean minus 2-sigma) initial USE for weldments using Linde 124 flux. We concluded in Reference (c), based upon the results of the three (3) Charpy tests results at a temperature of +10°F and the results of CE's evaluation, that the initial USE of Weld 2-203 is $\geq$ 83.5 ft-lbs.

The NRC Staff in Enclosure 2 of Reference (b) reported a generic initial USE of 75 ft-lbs based on a different study, Reference (e). We understand that this study combines weld data from several flux types.

It is the Maine Yankee position that:

(a) the USNRC Staff's study is overly conservative since flux types have a predominate effect on USE and should not be mixed in determining generic initial USE, and

(b) The previously reported Maine Yankee initial USE of $\geq$ 83.5 ft-lbs provides a conservative value for initial USE for Longitudinal Welds 2-203 A, B and C.

Therefore, the correct value of the initial USE for Longitudinal Weld 2-203 is $\geq$83.5 ft-lbs. In further support of this position, the Combustion Engineering Owners Group (CEOG) and the CE Reactor Vessel Group (RVG) are considering a task to supplement the original CE evaluation. The scope of this task is based upon the USNRC Staff's guidance related to use of generic initial USE provided in Reference (b). This task is scheduled to begin in early 1995 with a completion date of mid-1995. Maine Yankee plans to participate in this CEOG task.

Maine Yankee will provide the results of this CEOG task in writing to your staff by July 31, 1995.

C. Longitudinal Weld 3-203

The initial USE data provided in Reference (c) for Longitudinal Weld 3-203 A, B and C was based on an evaluation of sister weld data performed by Yankee Atomic Electric Company (YAEC). YAEC's evaluation concluded that the initial USE for welds comprised of Linde 1092 flux and Weld Wire Heat Nos. 13253 and 12008 were always higher than the initial USE of 107 ft-lbs for Maine Yankee's surveillance weld.

Since the submittal of Reference (c), Maine Yankee has learned that there is specific USE and Charpy data on a CE fabricated weld which was produced with the same procedure and constituents (weld wire heat and flux lot) used in Longitudinal Weld 3-203. This weld was provided by Combustion Engineering (CE) to Materials Engineering Associates (MEA) for a test irradiation program.

The unirradiated properties for that weld based upon preliminary information from MEA are:

Initial 41J (30 ft-lbs) fixed temperature = -73°C (-100°F).

Initial USE is 168J or 124 ft-lbs.

Upon verification, Maine Yankee will use the initial USE value of 124 ft-lbs from these weld test results.

MEA's preliminary reported copper and nickel contents are similar to those specified in Table 5.1 of Reference (f), (0.22/0.84 w/o).

Using the initial USE of 124 ft-lbs and the reported and established copper content for this weld of 0.22 w/o, the 1/4 T USE at EOL for Welds 3-203 A, B, and C will not drop below 50 ft-lbs. This is demonstrated using Figure 2 of NRC Regulatory Guide 1.99, Revision 2. (See response to Question 2, below.)

Maine Yankee is working cooperatively with MEA and CE to verify the above values. Maine Yankee will provide verified values of initial USE and chemical composition for Longitudinal Welds 3-203 A, B and C in writing to the NRC by July 31, 1994.

II. USNRC Question 2 [Second to last paragraph of Reference (a)].

We request that you submit within 30 days a schedule for performing these (USE) analyses. Further, we request that you verify that the information you have provided for your plant has been accurately entered in the pressurized thermal shock and upper shelf energy tables for Maine Yankee (Enclosures 1 and 2, respectively). If your response gives no comment to this summary data file verification request, the staff will use the current information in the enclosed tables for future NRC assessments of your reactor pressure vessel.

A. MYAPCo Response to Question 2: Schedule for Performing USE Analyses

Maine Yankee's schedule for performing USE analyses for Longitudinal Welds 2-203 A, B and C, and 3-203 A, B and C was provided in the responses to question 1.

B. MYAPCo Response to Question 2: Verification of Information in Pressurized Thermal Shock and USE Tables

A comparison between Maine Yankee's values and the USNRC Staff's supplied values in the Pressurized Thermal Shock (PTS) and USE tables of Reference (b) is provided in Tables 1 and 2, attached. Significant differences between Maine Yankee's values and the USNRC Staff's supplied values are highlighted in the tables. The Maine Yankee values are based upon References (c), (d) and other previously docketed information.

The following significant differences between the Maine Yankee values and the USNRC Staff's supplied values have been identified as a result of this comparison:

Pressurized Thermal Shock Table (Table 1)

- Intermediate Shell Plates D-8406-1 and D-8406-2; Chemistry Factor (CF) and Method of Determining CF.
- Circumferential Weld 9-203; Chemistry Factor (CF) and Method of Determining CF.

Upper-Shelf Energy Table (Table 2)

- Intermediate Shell Plate D-8406-1; 1/4 T USE at EOL.
- Circumferential Weld 9-203; Initial (unirradiated) USE, and 1/4 T USE at EOL.
- Longitudinal (axial) Welds 2-203 and 3-203; Method of Determining Initial (unirradiated) USE, Initial USE, and 1/4 T USE at EOL.

Each of these significant differences is addressed in the section below.

With respect to other differences, minor discrepancies between Maine Yankee and the Staff's values also exist as indicated in the "comments" columns of Tables 1 and 2. However, no further explanation beyond that provided in the "comments" columns is necessary.

1. Pressurized Thermal Shock Table (Table 1)

   a. Intermediate Shell Plates D-8406-1 and D-8406-2; Chemistry Factor (CF) and Method of Determining CF

      The Chemistry Factors for Plates D-8406-1 (109°F) and D-8406-2 (124°F) were provided by Maine Yankee in Table 5.2 of Reference (f). These values were obtained using the copper/nickel contents specified in Table 5.1 of Reference (f), and Table 2 (Chemistry Factor table for base metal in RG

      1.99, Revision 2) of the PTS Rule (10 CFR 50.61). This approach, rather than use of surveillance data, was selected as required in the Section (b)(2)(iv) of the PTS Rule, 10 CFR 50.61. Maine Yankee established the creditability of the surveillance data prior to the use of Table 2 of the PTS Rule in Section 6, Attachment F of Reference (g).

Maine Yankee has also determined the Chemistry Factor for the surveillance plate (Plate D-8406-1) in Table 5-9 of Attachment F of Reference (g). Maine Yankee's value, 118.2 °F, is in close agreement with the USNRC Staff's value in Table 2 of Reference (b), 119.53 °F.

The principal difference between Maine Yankee's and USNRC Staff's Chemistry Factors is founded in the use of Table 2 of 10 CFR 50.61, rather than fit of the surveillance data.

Maine Yankee concludes that the Chemistry Factor for Plates D-8406-1 and D-8406-2 are 109 and 124 °F, respectively, following the requirements of the PTS Rule, 10 CFR 50.61.

b. Circumferential Weld 9-203 Chemistry Factor (CF) and Method of Determining CF

The chemistry factor for Circumferential Weld 9-203 (222°F) was provided by Maine Yankee in Table 5.2 of Reference (f). This value was obtained using the copper/nickel contents (0.31/0.76w/o) specified in Table 5.1 of Reference (f), and Table 1 (Chemistry Factor table for weld metal in RG 1.99, Revision 2) of the PTS Rule as required in Section (b)(2)(iv) of 10 CFR 50.61.

The copper/nickel contents (0.31/0.76 w/o) are the best estimate values for weld heat IP 35/1 Linde 1092 Flux Lot 3958. The best estimate values are the means of the measured values from weld samples made from the weld wire heat number that matches the weld, as required by Section (b)(2)(iv) of the PTS Rule. Additional information on the method of determining these means is provided in Table B-2 of Reference (f). Although additional measured values have been obtained since issuance of Reference (f) (October 1991), the means and Chemistry Factor remain essentially unchanged.

Maine Yankee agrees with the Staff's determination that the Chemistry Factor (calculated) obtained from surveillance weld data using the procedures in RG 1.99, Revision 2 is 241°F. However, this value is only used by Maine Yankee to establish credibility of the surveillance weld data in accordance with RG 1.99, Revision 2. Once credibility is established, (a) the use of the Position 2.1 of RG 1.99, Revision 2 to determine the adjusted reference temperature, and (b) the use of 10 CFR 50.61(b)(2) to determine RT_{PTS}, is justified.

Maine Yankee's evaluation of the credibility of surveillance data and Chemistry Factor for Circumferential Weld 9-203 is provided in Section 6, Attachment F of Reference (g). This assessment was updated following the removal of Maine Yankee's Second Surveillance Wall Capsule in 1991 (Reference h). Maine Yankee concluded that the surveillance data was credible as a result of this assessment.

Application of Position 2.1 of RG 1.99, Revision 2 to Circumferential Weld 9-203 yields a Chemistry Factor of 217°F (Copper/Nickel content of 0.31/0.76 w/o), Reference (h). This Chemistry Factor (217°F) is similar to the value obtained above from Table 1 of the PTS Rule, 222°F. Regardless, Maine Yankee used the latter approach as required by the PTS Rule, 10 CFR 50.61.

Maine Yankee concludes that the Chemistry Factor for Circumferential Weld 9-203, following the requirements of the PTS Rule, is 222°F.

2. Upper Shelf Energy Table (Table 2)

a. Intermediate Shell Plate D-8406-1: 1/4 T USE at EOL

The Maine Yankee value for 1/4 T USE at EOL for Plate D-8406-1 provided in Table 2 (87 ft-lbs) is based upon the following:

Calculation of Decrease in USE
Plate D-8406-1 at End-of-License (EOL)

Parameter	Value
Initial USE (ft-lbs)	115
Cu content (w/o)	0.15
Fast Fluence ($x10^{19} n/cm^2$)	1.073
Decrease in USE (%)*	24

*Decrease in USE (%) is obtained from Figure 2 of R.G. 1.99, Revision 2 for for base metal.

1/4 T USE @ EOL = 115 ft-lbs - 115 ft-lbs * 0.24

1/4 T USE @ EOL = 87 ft-lbs.

The NRC Staff's value of 80 ft-lbs appears to be calculated using a decrease in USE of 30%. This decrease in USE is undocumented and, therefore, Maine Yankee cannot speculate as to the origin or validity of this value.

Maine Yankee concludes that a 1/4 T USE at EOL of 87 ft-lbs for Plate D-8406-1 is the correct value.

b. Circumferential Weld 9-203; Initial USE and 1/4 T USE at EOL

The Maine Yankee values for the initial USE for Circumferential Weld 9-203 provided in Table 2 (107 ft-lbs) is based upon Maine Yankee's Surveillance Weld data. Specifically, the initial USE is the average of all Charpy test results for the Surveillance Weld exhibiting over 95% shear fracture appearance (105.0 106.8 and 109.4 ft-lbs). See Table 10 of Reference (i) for the source of these test results.

The NRC Staff's value of 105 ft-lbs appears to be based upon the value provided in Figure 5 of Reference (i).

Maine Yankee concludes that the correct value for the initial USE for Circumferential Weld 9-203 is 107 ft-lbs since this value is derived using the guidance in ASTM E-185.

Maine Yankee has also determined the decrease in 1/4 T USE at EOL for Circumferential Weld 9-203 following the guidance in RG 1.99, Revision 2. Specifically, the decrease in USE for welds with a copper content of the Circumferential Weld 9-203(0.31 w/o) and an EOL fast fluence of $1.073X10^{19}$ n/cm^2 obtained directly from Figure 2 is 43%. This drop corresponds to the upper limit of Figure 2. The determination of 1/4T USE at EOL is summarized below:

Calculation of Decrease in USE
Weld 9-203 at End-of-License (EOL)

Parameter	Value
Initial USE (ft-lbs)	107
Cu content (w/o)	0.31
Fast Fluence ($x10^{19}$n/cm^2)	1.073
Decrease in USE (%)*	43

* Decrease in USE (%) is obtained from Figure 2 of R.G. 1.99, Revision 2, for the weld metal.

1/4T USE at EOL = 107 ft-lbs - 107 ft-lbs * 43%

1/4T USE at EOL = 61 ft-lbs

Maine Yankee concludes that direct use of the upper limit of Figure 2 of RG 1.99, Revision 2 yields a conservative decrease in 1/4 T USE at EOL (43%) for Circumferential Weld 9-203.

Therefore, the 1/4 T USE at EOL for Circumferential Weld 9-203 (initial USE of 107 ft-lbs) is 61 ft-lbs.

c. Longitudinal Welds 2-203 and 3-203; Method of Determining Initial USE, Initial USE, and 1/4 T USE at EOL

Both the method of determining initial USE and the value of initial USE for Longitudinal Welds 2-203 A, B and C, and 3-203 A, B and C were discussed in the response to NRC question 1 of this enclosure. That response included a schedule for performing additional analysis and providing additional information.

Maine Yankee has also reviewed the Staff's values for the decrease in 1/4 T USE at EOL for these welds. The decrease in 1/4 T USE at EOL appears to be based on Figure 2 of R.G. 1.99, Revision 2 evaluated at the corresponding copper conte . provided in Table 1 and EOL fluence of Table 2. The following Table summarizes this evaluation:

Calculation of Decrease in 1/4 T USE
Welds 2-203 and 3-203 at End-of-License (EOL)

Weld	Cu(%)	Fluence ($x10^{19}n/cm^2$)	Decrease in USE(%)
2-203 A, B and C	0.17	0.882	29
3-203 A, B and C	0.22	0.882	35

We concur with the Staff's values for the decrease in 1/4 T USE at EOL for these welds

Resolution of the values of 1/4 T USE at EOL for Longitudinal Welds 2-203 A, B and C, and 3-203 A, B, C is, therefore, contingent upon resolution of initial USE for these welds in accordance with our schedule.

References:

(a) License No. DPR-36 (Docket No. 50-309)

(b) USNRC Letter to MY dated April 12, 1994, "Generic Letter (GL) 92-01, Revision 1, Reactor Vessel Structural Integrity, Maine Yankee Review Status (TAC No. M83479)".

(c) MY Letter to USNRC dated December 3, 1993, MN-93-111, "Response to Generic Letter 92-01, Revision 1, (Reactor Vessel Structural Integrity)".

(d) MY Letter to USNRC dated July 2, 1992, MN-92-65, "Response to Generic Letter 92-01, Revision 1 (Reactor Vessel Structural Integrity)".

(e) USNRC Letter, S. Bloom to T. L. Paterson of Omaha Public Power District dated December 3, 1993.

(f) MY Letter to USNRC dated October 28, 1991, MN-91-151, "Update of PTS Assessment to Address the Revised PTS Rule (10 CFR 50.61)".

(g) MY Letter to USNRC dated December 2, 1988, MN-88-116, "Proposed Change No. 145 - Combined Heatup, Cooldown and Pressure-Temperature Limitations".

(h) MY Letter to USNRC dated September 30, 1991, MN-91-138, "Proposed Change No. 163: Revision to Combined Heatup, Cooldown and Pressure-Temperature Limitation to Reflect Analysis of Wall Capsule 253".

(i) MY Letter to USNRC dated October 22, 1975, WMY 75-120 (Enclosure), "Unirradiated Mechanical Properties of Maine Yankee Nuclear Pressure Vessel Materials", CR 75-269, February, 1975.

(j) CEOG Letter to USNRC dated September 27, 1993, CEOG-93-479, "Final Evaluation of Low Upper Shelf Energy".

(k) MY Letter to USNRC dated May 14, 1991, MN-91-81, "Analysis of the Second Reactor Pressure Vessel Surveillance Wall Capsule".

TABLE 1
Comparison of Pressurized Thermal Shock Values
USNRC Staff[1] versus Maine Yankee[2]

Plant Name	Beltline Ident.	Heat No. Ident.	ID Neut. Fluence at EOL/EFPY	IRT_{NDT}	Method of Determin. IRT_{NDT}	Chemistry Factor		Method of Determin. CF		%Cu	%Ni	COMMENTS
						NRC	MY	NRC	MY			
Maine Yankee	Int. Shell Plate D-8406-1	B-7955-1	1.80E19	-10°F	Plant Specific	119.53	109	Calc.	Table	0.15	0.59	See Section II.B.1.a.
EOL: 10/21/ 2008	Int. Shell Plate D-8406-2	B-7955-2	1.80E19	0°F	MTEB 5-2	119.53	124	Calc.	Table	0.17	0.56	See Section II.B.1.a.
	Int. Shell Plate D-8406-3	C-3982-5	1.80E19	0°F	MTEB 5-2	83.3	83	Table		0.12	0.62	Insignificant difference in CF likely due to rounding.
	Lower Shell Plate D-8407-1	B-8330-1	1.80E19	-20°F	MTEB 5-2	174		Table		0.24	0.62	
	Lower Shell Plate D-8407-2	B-8330-2	1.80E19	2°F	MTEB 5-2	169		Table		0.23	0.62	
	Lower Shell Plate D-8407-3	B-8324-1	1.80E19	0°F	MTEB 5-2	92.25	92	Table		0.13	0.65	Insignificant difference in CF likely due to rounding.
	Circ. Weld 9-203	IP3571	1.80E19	-56°F	Generic	240.96	222	Calc.	Table	0.31	0.76	See Section II.B.1.b.
	Axial Welds 2-203	51989	1.48E19	-56°F	Generic	89.45	89	Table		0.17	0.17	Insignificant difference in CF likely due to rounding.
	Axial Welds 3-203	13253 and 12008	1.48E19	-56°F	Generic	206.4	206	Table		0.22	0.84	Insignificant difference in CF likely due to rounding.

[1]USNRC Staff Values are obtained from Enclosure 1, "Pressurized Thermal Shock Table", of Reference (b)
[2]Maine Yankee Values are obtained from References (b) - (j)

TABLE 2
Comparison of Upper-Shelf Energy Values
USNRC Staff[1] versus Maine Yankee[2]

Plant Name	Beltline Ident.	Heat No.	Material Type	1/4T USE at EOL/EFPY		1/4T Neutron Fluence at EOL/EFPY	Unirrad. USE		Method of Determin. Unirrad. USE		Comments
				NRC	MY		NRC	MY	NRC	MY	
Maine Yankee	Int. Shell Plate D-8406-1	B-7955-1	A 533B-1	80	87	1.073E19	115		Direct		NRC's 1/4 T USE at EOL/EFPY appears to be based on a decrease in USE by 30%. See Section II.B.2.a.
EOL: 10/21/2008	Int. Shell Plate D-8406-2	B-7955-2	A 533B-1	62	63	1.073E19	84	86	65%		MY's Int. USE based on average of 2 test results with ≥95% shear (137 and 129 ft-lbs). NRC's value appears to include a 3rd test with only 90% shear (122 ft-lbs).
	Int. Shell Plate D-8406-3	C-3982-5	A 533B-1	71		1.073E19	90		65%		
	Lower Shell Plate D-8407-1	B-8330-1	A 533B-1	57		1.073E19	86		65%		
	Lower Shell Plate D-8407-2	B-8330-2	A 533B-1	56		1.073E19	82		65%		
	Lower Shell Plate D-8407-3	B-8324-1	A 533B-1	64		1.073E19	82		65%		
	Circ. Weld 9-203	IP3571	Linde 1092, SAW	56	61	1.073E19	105	107	Surv. Weld		NRC Value of 105 ft-lbs appears to be based on fit rather than average of all tests with ≥ 95% shear (107 ft-lbs). Maine Yankee's 1/4 T USE at EOL has been determined using a conservative decrease in USE (43%) obtained from R.G. 1.99, Rev. 2. The NRC Staff's Value (47%) appears overly conservative. See Sections II.B.2.b.
	Axial Welds 2-203 A,B,C	51989	Linde 124, SAW	53	59	8.82E18	75*	63.5	NRC Generic	CE Generic	See Sections I.B and II.B.2.c.
	Axial Welds 3-203 A,B,C	13253 and 12008	Linde 1092, SAW	70	81	8.82E18	107*	124	Sister Plant	Direct	MY has identified measurements results for the same weld wire heat and flux lot. See Sections I.C and II.B.2.c.

[1]USNRC Staff Values are obtained from Enclosure 2, "Pressurized Thermal Shock Table", of Reference (b)
[2]Maine Yankee Values are obtained from References (b) - (j)