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July 9, 1992
IPN-92-031
JPN-92-037

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

Subject: **Indian Point 3 Nuclear Power Plant**
Docket No. 50-286
James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Response to Generic Letter 92-01, Revision 1

Dear Sir:

Nuclear Regulatory Commission (NRC) Generic Letter 92-01, Revision 1, asked licensees to provide information about reactor vessel integrity. Attachments I and II to this letter provide the requested information for the Power Authority's Indian Point 3 and James A. FitzPatrick Nuclear Power Plants. Since both plants are currently in outages, high workloads have delayed this submittal.

If you have any questions, please contact Mr. P. Kokolakis or Mr. J. A. Gray, Jr.

Very truly yours,

Ralph E. Beedle
Executive Vice President
Nuclear Generation

STATE OF NEW YORK
COUNTY OF WESTCHESTER

Subscribed and Sworn to before me
this 9th day of July, 1992

Geraldine Strand

Notary Public

GERALDINE STRAND
Notary Public, State of New York
No. 4891272
Qualified in Westchester County
Commission Expires Jan. 27, 1994

cc: See next page

A028.1

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50-286 INDIAN POINT PASNY

RESPONSE TO GENERIC LETTER 92-01
INDIAN POINT 3 NUCLEAR POWER PLANT

Rec'd w/ ltr dtd 7/9/92.....9207170089

Attachment I
Response to Generic Letter 92-01
Indian Point 3 Nuclear Power Plant

Docket No. 50-286
New York Power Authority

Question 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 E185-73, -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*

The IP3 surveillance program is in compliance with Appendix H to 10 CFR Part 50 to the extent possible given the date of design and fabrication of the reactor vessel and the development of the initial surveillance program. There are two specific cases where the program does not meet the recommendations of ASTM E185-73. These cases: the number of Charpy specimens and the selection of weld material are discussed further and are not considered to require an exemption.

The IP3 vessel was purchased to the 1965 ASME Code with summer 1965 addenda, E185-61 is applicable to that part of the surveillance program. For all surveillance capsules removed from the vessel, the recommendations of the applicable approved version of ASTM E185 has been used or will be used to the extent practical for the configuration of the specimens.

The key elements of ASTM E185-73 are those that define surveillance test materials, test specimens, and test capsules. The following is a summary of how the IP3 program relates to those recommendations.

With respect to surveillance test materials, the limiting beltline plate material (from lower shell plate B2803-3) is included in the program. This plate is limiting with respect to both projected end-of-life adjusted RT_{NDT} of 235°F and upper shelf energy of 56 ft-lb. In addition, specimens from beltline plates B2802-1, B2802-2 and B2802-3 are included in the IP3 Type I capsules. HAZ (Heat Affected Zone) specimens from a weld made with the limiting beltline plate (B2803-3) are included in the IP3 Type II capsules.

Regarding the beltline limiting weld material, the longitudinal and circumferential welds for the IP3 beltline were fabricated from two heats of weld wire with Linde 1092 flux. The weld surveillance material was fabricated from a different heat of weld wire than used in the beltline welds (the wire used for the surveillance program was that used in the IP3 nozzle shell longitudinal seams). Linde 1092 flux was used for the surveillance weld, as in the beltline welds. As shown in table VIII of this response, the surveillance weld has a projected end-of-life adjusted RT_{NDT} of 190°F, compared to 162°F for the intermediate/lower shell beltline limiting weld. Also, the corresponding surveillance weld RT_{NDT} shift is 189°F, compared to 203°F for the beltline weld, indicating that the material used in the surveillance program is representative material.

* Brackets [ ] denote references listed on page 8 of 8.

The surveillance test specimens fabricated from the materials noted above are described in tables II & III of this response. In addition to the base plate, HAZ (Heat Affected Zone) and weld materials described above, ASTM Reference Plate specimens are also included in the IP3 Type II capsules. In addition to the Charpy and tensile specimens required by E185-73, WOL fracture toughness specimens are included for base plate material from plate B2802-1 (Type I capsules) and for the surveillance weld metal (Type II capsules). For the beltline unirradiated plate materials, drop weight NDT tests were run in addition to Charpy tests required by E185-73 to determine RT_{NDT} values. Reference Temperatures were selected from either drop weight or 50 ft-lb. transition temperatures in accordance with ASME NB-2531. Unirradiated Charpy weld metal and HAZ tests were run in accordance with E185-73, as shown in Figures 1 through 7.

As shown in Tables II and III of this response, the number of surveillance capsules and amount of material included in the IP3 surveillance program exceeds that recommended by E185-73. However, only 8 Charpy specimens are in each IP3 capsule for each material when 12 are recommended by ASTM 185-73. The quantity of Charpy specimens is judged to be adequate because of the benefit from results obtained from the additional surveillance capsules, material and fracture toughness specimens. Also, surveillance results to date have shown good agreement with predictive data used as discussed later in this response.

In summary, recognizing the fact that the program was developed prior to the issuance of ASTM E185-73 and does not meet two of the recommendations of E185-73, the IP3 surveillance program is considered to compensate for those short-comings. The surveillance weld is considered representative of the limiting beltline weld, initial RT_{NDT} values are established, numerous beltline plate materials (including the limiting material) are in the program, an ASTM Reference Plate is in the program, both plate and weld fracture mechanics specimens are in the program, and 8 test capsules (rather than 5) are in the program. The program results to date represent credible surveillance test results, in accordance with Regulatory Guide 1.99, Revision 2 criteria.

Question 2.a.

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

> 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

Using Reg Guide 1.99 Rev. 2 the upper shelf energies (USE) of the beltline materials of the IP3 plant are not expected to be less than 50 ft-lb by the end of its licensed operating period. Therefore, request 2.a.above does not apply for IP3. A brief description of the USE evaluation supporting this conclusion follows.

USE data were taken during fabrication on the plates used in the IP3 beltline. Evaluation of these plates according to Reg. Guide 1.99, Revision 2 shows the USE at 32 effective full power years (EFPY) is 56 ft-lb (transverse specimens) for limiting shell plate B2803-3.[1] The NRC staff found the EOL USE of 56 ft-lb to be acceptable in the Safety Evaluation Report (dated August 28, 1991) that accompanied the letter issuing Amend. No. 109 to the IP3 Facility Operating License (FOL). USE data was taken for a vessel weldment representative of the reactor beltline region welds. Evaluation in accordance with Reg. Guide 1.99, Rev. 2 shows the USE at 32 effective full power years of the weld metal specimens is 76 ft-lbs.[1] Because the 32 EFPY USE for beltline plate and weld is predicted to be greater than 50 ft-lbs, no action pursuant to 10 CFR 50, Appendix G, paragraphs IV.A.1 or V.C. is required.

Question 2.b.1.

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

> 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

For the beltline plate materials, Charpy V-Notch impact tests were performed on the vessel plates at various temperatures between -100 and 210°F to obtain full Charpy V-notch transition curves. Charpy V-Notch impact tests were performed on weld metal and HAZ metal at various temperatures between -150 to 160°F to develop transition curves. Drop weight NDTT tests were performed on each plate by the fabricator. The Charpy specimen orientation for plates was both transverse and longitudinal and the test requirement was to meet 30 ft-lb at the specified temperature. The results of preirradiated charpy impact data for the IP3 reactor pressure vessel plate, weld metal and weld heat affected zone material are presented in Appendix A, Figures 1 through 7.[2] The unirradiated reference temperature for each beltline material is listed in Table V under column I.[3] The unirradiated RT_{NDT} was selected as the higher of the temperature at which 50 ft-lb and 35 Mils Lateral Expansion (MLE) was achieved minus 60 degrees <u>or</u> the drop weight nil-ductility temperature.

Question 2.b.2.

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

Response

For the beltline plate materials and surveillance materials heat treatment was not explicitly considered in the Appendix G analysis, because there are no requirements or methods provided which relate to heat treatment. However, implicit in the Appendix G analysis is the assumption that the Charpy data used to develop the RT_{NDT} values is representative of the beltline materials so heat treatment of the Charpy specimens should represent or bound that of the beltline materials.

The beltline plates were quenched (1550 - 1650°F for 4 hours with water quench) and tempered (1225 +25°F for 4 hours then air cooled). Specimen samples for the surveillance program were trimmed from the plates. The specimen samples and surveillance materials received a simulated post-weld heat treatment (PWHT) at 1150°F +25°F for 40 hours. The beltline material PWHT time and temperature was the same.[2]

Question 2.b.3

(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

The beltline consists of portions of the lower shell and the lower-intermediate shell. Each shell is formed from three plates, so the beltline includes portions of six plates, six vertical welds and one circumferential weld. All beltline plate and weld materials were considered in the Appendix G evaluation. The heat numbers are provided in Table I of Appendix A.

Question 2.b.4

(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

All plate materials used for specimens were beltline materials from the lower-intermediate and lower shell courses. The surveillance plate material was trimmed from the beltline plate listed in Tables II and III of Appendix A. The weld metal used in the surveillance samples is from a heat and lot

combination used in the vertical seams in the nozzle shell course of the vessel. The heat number of weld wire and flux lot number used to fabricate the surveillance weld is listed in Table IV[1] of Appendix A.

Question 2.b.5.

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

Response

The chemical composition of the IP3 reactor beltline region material is listed in Table V of Appendix A. The chemical composition of beltline surveillance material is listed in Table VI of Appendix A. A summary of material chemistry for seam welds in the IP3 vessel is presented in Table IV of Appendix A. The weld metal and HAZ Charpy specimens were fabricated from trim off pieces of lower-intermediate and lower shell courses and that were welded together with weld wire heat number W5214. All HAZ specimens were obtained from the weld heat-affected zone of plate B2803-3.

Question 2.b.6.

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

Response

The weld wire heat and flux lot numbers for the beltline region welds are the same as reported in the response to 2.b.3. However, the specific metal chemical composition reported was that developed by the Westinghouse Owner's Group (WOG). The data prepared by the WOG were mean values that are representative of the chemical content of the weld metal found in the beltline region of the IP3 vessel. Data for circumferential weld 9-042 (between the intermediate and lower shells) are actual metal chemistry values from the qualification weld.

Based on responses to Questions 2.b.1 through 2.b.6, the surveillance weld data provides the Authority with information needed to meet the objective of Appendix H to monitor toughness changes due to irradiation.

Question 3.a.

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

> 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

Operation of the IP3 beltline region below 525°F was not considered in the Appendix G analysis. Based on the steady state operating temperature of the coolant in the cold leg piping, which communicates directly, with the beltline region, the steady state temperature in the beltline region is greater than 535°F.

For the majority of the operating life of the plant the beltline temperature has been 535°F or higher. IP3 has operated at lower temperatures (T_{avg} below 525°F) in early fuel cycles when plant procedures would permit startup following a trip before the core xenon concentration reached its post-trip peak. Under such circumstances the reactor was brought on-line at a temperature below the normal hot zero power coolant temperature. A review performed of the plant computer logs determined the time the plant operated below 525°F to be no greater than eleven hours.

The time of operation at less than 525°F has been estimated to be much less than 0.1%. A conservative fluence value for the first four fuel cycles for the limiting beltline plate (45 degree azimuth) is 2.81E+18 n/cm^2 at the reactor vessel inner radius. The fluence accumulated below 525°F would be conservatively bounded by using the value of 2.81E+15 n/cm^2. The combination of low fluence and short time below 525°F level is not expected to affect beltline RT_{NDT} or USE predictions. Since surveillance specimens are exposed to the same temperature conditions as the beltline materials, temperature effects, if any, will be reflected in the surveillance results when the surveillance results are factored into the Appendix G analysis per Regulatory Guide 1.99, Revision 2.

Question 3.b.

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

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

Response

The IP3 reactor pressure vessel beltline pressure temperature limits are based upon the irradiation damage prediction methods of Regulatory Guide 1.99, Revision 2. This methodology is used to calculate the limiting material Adjusted Reference Temperature (ART). The IP3 surveillance program results were factored into beltline embrittlement predictions in accordance with Regulatory Guide 1.99, Revision 2. Table VIII presents the adjusted Reference Temperature between Regulatory Guide 1.99, Revision 1, Regulatory Guide 1.99, Revision 2, R.P. 1.1, and Regulatory Guide 1.99, Revision 2, R.P. 2.1. Since surveillance data has been taken, Regulatory Guide 1.99, Revision 2, R.P. 2.1 applies. Regulatory Guide 1.99, Revision 2, R.P.2.1 yields the lowest Adjusted Reference Temperature. The lower ART means that less vessel embrittlement is predicted.

Regulatory Guide 1.99, Revision 2 presents five criteria by which surveillance data are judged to be credible; i.e., acceptable for determining adjusted reference temperature (ART) following Regulatory Position 2.1 of the guide. Proving surveillance data is credible permits the use of measured

surveillance data in predicting vessel embrittlement. Reference [5] discusses the credibility criteria established in the Regulatory Guide 1.99, Revision 2. It concludes that all five criteria of the regulatory guide have been addressed, and the IP3 surveillance data have been shown to satisfy those criteria and, therefore, are credible for use in developing a plant specific relationship of reference temperature shift to neutron fluence in accordance with Regulatory Position 2.1.

Question 3.c.

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

> If a measured increase in reference temperature exceeds the mean-plus-two standard deviations predicted by 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 October 16, 1991, and for the end of its current license.

Response

No data from the IP3 surveillance program have exceeded the mean plus two standard deviations predicted by Regulatory Guide 1.99 Revision 2 for transition temperature. The data which has been obtained from Charpy impact tests from the three surveillance capsules to data are very consistent. Charpy impact test results are used to determine the shift in 30 ft-lb transition temperature. A comparison of the measured shift in 30 ft-lb transition temperature with Regulatory Guide 1.99, Revision 2 predictions are presented in Table VIII. The trend line established from a best fit to the shifts in RT_{NDT} for plate and weld metal is in agreement with Regulatory Guide 1.99 Revision 2. Figure 8 shows that all measured temperature shifts fall with in the permitted scatter band about the best fit trend line drawn in accordance with Regulatory Guide 1.99 Revision 2.

The trend lines for loss of upper shelf energy with fluence disagree with the correlations offered in the Regulatory Guide (see table IX Upper Shelf Energy decrease). For weld metal the measured decrease in USE exceeds the predictions for a weld with 0.15% copper content as shown in Figure 9. Despite these greater than predicated decreases for the EOL weld metal USE, the predicted EOL USE for the last surveillance coupon removed is still greater than 50 ft-lb.

The USE for the last surveillance capsule removed had a measured fluence of 1.07×10^{19} n/cm^2, which bounds the expected EOL fluence for ¼T. The limiting plate material exhibits a trend line indicative of saturation with measured values far less than predicted (Figure 9). Thus, although plate B2803-3 exhibited an extremely low initial upper shelf energy, the EOL upper shelf energy remains above the 50 ft-lb limit.

References

1. S. E. Yanichko, S. L. Anderson, L. Abertin, "Analysis of capsule Z from the New York Power Authority, Indian Point Unit 3 Reactor Vessel Radiation Surveillance Program," Westinghouse Electric Corporation, report WCAP-11815, dated March 1988.

2. S. E. Yanichko, J. A. Davidson, "Consolidated Edison Company of New York, Indian Point Unit No. 3 Reactor Vessel Radiation Surveillance Program," Westinghouse Electric Corporation, report WCAP-8475, dated January 1975.

3. S. E. Yanichko, S. L. Anderson, N. K. Ray, "Indian Point Unit 3 reactor Vessel Fluence and RT_{PTS} Evaluations for Consideration of Life Extension," Westinghouse Electric Corporation, report WCAP-11057 Revision 1, dated June 1989. (Not Docketed).

4. G. Licina, F. Copeland, "Evaluation of Capsule Z from the Indian Point 3 Reactor Pressure Vessel Surveillance Program," Structural Integrity Associates, report SIR-88-016 Revision 0, dated January 1989. (Not Docketed).

5. Combustion Engineering, Inc., "Final Report on Pressure-Temperature Limits for Indian Point Unit 3 Nuclear Power Plant," dated July 1990, which was submitted by letter, IPN-90-046, from John C. Brons to the NRC, entitled, "Proposed Changes to Technical Specifications Regarding Pressure-Temperature (P-T) Limits," dated August 31, 1990.

Appendix A

Indian Point 3 Nuclear Power Plant

Docket No. 50-286
New York Power Authority

TABLE I

Indian Point Unit 3 Reactor Vessel Beltline Region Material Properties

Plate Location and Number	Heat Number
Intermediate Shell Plate B2802-1	B5394-2
Intermediate Shell Plate B2802-2	A0516-2
Intermediate Shell Plate B2802-3	B5391-2
Lower Shell Plate B2803-1	A0495-2
Lower Shell Plate B2803-2	C1397-3
Lower Shell Plate B2803-3	A0512-2

Longitudinal Welds - 2-042 A, B, C and 3-042 A, B, C, Wire Heat 34B009, Flux Linde 1092

Circum. Weld 9-042 - Intermed. to Lower Shell, Wire Heat 132253, Flux Linde 1092

TABLE II

SPECIMEN IDENTIFICATION AND LOCATION IN THE INDIAN POINT UNIT NO. 3 IRRADIATION TEST CAPSULES TYPE I

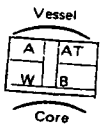
Specimen Type	Capsule W	Capsule T	Capsule X	Capsule U	Capsule Z
Charpy	A24,AT53 W32,B8	A32,AT61 W40,B16	A40,AT69 W48,N8	A48,AT77 W56,N16	A56,AT85 W64,T8
Tensile	AT52 B1 B7	AT60 B2 B15	AT68 N1 N7	AT76 N2 N15	AT84 T1 T7
and					
Charpy	A23 B1 W31	A31 B2 W39	A39 N1 W47	A47 N2 W55	A55 T1 W63
WOL	B6	B12	N6	N12	T6
WOL	B5	B11	N5	N11	T5
Charpy	A22,AT51 W30,B6	A30,AT59 W38,B14	A38,AT67 W46,N6	A46,AT75 W54,N14	A54,AT83 W62,T6
WOL	B4	B10	N4	N10	T4
WOL	B3	B9	N3	N9	T3
Charpy	A21,AT50 W29,B5	A29,AT58 W37,B13	A37,AT66 W45,N5	A45,AT74 W54,N14	A54,AT83 W62,T6
Charpy	A20,AT49 W28,B4	A28,AT57 W36,B12	A36,AT65 W44,N4	A44,AT73 W52,N12	A52,AT81 W60,T4
WOL	B2	B8	N2	N8	T2
WOL	B1	B7	N1	N7	T1
Charpy	A19,AT48 W27,B3	A27,AT56 W35,B11	A35,AT64 W43,N3	A43,AT72 W51,N11	A51,AT80 W59,T3
Tensile	A1,A2	A3,A4	A5,A6	A7,A8	A9,A10
Charpy	A18,AT47 W26,B2	A26,AT55 W34,B10	A34,AT63 W42,N2	A42,AT71 W50,N10	A50,AT79 W58,T2
Charpy	A17,AT46 W25,B1	A25,AT54 W33,B9	A33,AT62 W41,N1	A41,AT70 W49,N9	A49,AT78 W57,T1

TABLE II (cont)

SPECIMEN IDENTIFICATION AND LOCATION IN THE INDIAN POINT UNIT NO. 3 IRRADIATION TEST CAPSULES TYPE I

Specimen Numbering Code and Orientation

A - Plate B2803-3 (Longitudinal)
AT - Plate B2803-3 (Transverse)
B - Plate B2802-1 (Longitudinal)
N - Plate B2802-2 (Longitudinal)
T - Plate B2802-3 (Longitudinal)
W - Weld Metal (Transverse)



For Heat Numbers refer to Table I

TABLE III

SPECIMEN IDENTIFICATION AND LOCATION IN THF INDIAN POINT UNIT NO. 3 IRRADIATION TEST CAPSULES TYPE II

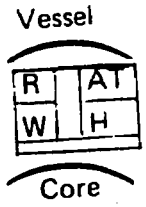
Specimen Type	Capsule V	Capsule Y	Capsule S
Charpy	R81AT29 W8,H8	R1 67AT37 W16,H16	R24,AT45 W24,H24
Charpy	R7,AT28 W7,H7	R1 5,AT36 W15,H15	R23,AT44 W23,H23
Tensile	AT1,AT2	AT3,AT4	AT5,AT6
WOL	W4	W8	W 12
Charpy	R6,AT27 W6,H6	R14,AT35 W14,H14	R22,AT43 W22,H22
WOL	W3	W7	W11
Charpy	R5,AT26 W5,H5	R1 3,AT34 W13,H13	R21 ,AT42 W21,H21
Dosimeter	47	48	49
Charpy	R4,AT25 W4,H4	R1 2,AT33 W12,H12	R20,AT41 W20,H20
WOL	W2	W6	W10
Charpy	R3,AT24 W3,H3	R11 ,AT32 W11,H11	R19,AT40 W19,H19
WOL	W1	W5	W9
Tensile	W1,W2	W3,W4	W5,W6
Charpy	R2,AT23 W2,H2	R1 0,AT31 W10,H10	R18,AT39 W18,H18
Charpy	R1 ,AT22 W1 ,H 1	R9,AT30 W9,H9	R1 7,AT38 W17,H 17

TABLE III (cont)

SPECIMEN IDENTIFICATION AND LOCATION IN THF INDIAN POINT UNIT NO. 3 IRRADIATION TEST CAPSULES TYPE II

Specimen Numbering Code and Orientation

AT - Plate B2803-3 (Transverse)
W - Weld Metal (Transverse)
H - Weld Heat Affected Zone
R - ASTM Reference (Longitudinal)



For Heat Numbers refer to Table I

TABLE IV

SUMMARY OF MATERIALS USED FOR SUBMERGED ARC WELD SEAMS IN THE INDIAN POINT UNIT 3 REACTOR VESSEL

Weld	Weld	Weld Wire		Wire	Flux		Cu	P	NI	RT_{NDT}
SeamLocations	Seam No.	Type	Heat No.	Heat No.	Type	Lot No.	(%)	(%)	(%)	°F
Nozzle Shell Longitudinal Seams	1-042 A,B & C	RACO	W5214	N7753A	Linde 1092	3692	.15	.019	1.02	-30
Nozzle Shell to Intermediate Shell Girth Seam	8-042	B4 Mod.	27204	None	Linde 1092	3724	.32	-	-	-56[a]
Intermediate Shell Longitudinal Seam[b]	2-042 A, B & C	RACO 3	34B009	N987A	Linde 1092	3708	.19	.012	1.00	-56[a]
Intermediate to Lower Shell Girth Seam[b]	9-042	B4 Mod.	13253	None	Linde 1092	3791	.27	.023	.74	-70
Lower Shell Longitudinal Seams[b]	3-042 A, B & C	RACO 3	34B009	N9867A	Linde 1092	3724	.19	.012	1.00	-56[a]
Surveillance Weld	--	RACO 3	W5214	N7753A	Linde 1092	3692	.15	.019	1.02	-30

a) Estimated based on 10CFR50, "Analysis of Potential Pressurized Thermal Shock Events," Federal Register Vol. 50, No. 141, July 23, 1985.

b) WCAP-11045, "Indian Point Unit 3 Reactor Vessel Fluence and RT_{PTS} Evaluations," January, 1986.

TABLE V

INDIAN POINT UNIT 3 REACTOR VESSEL BELTLINE REGION MATERIAL PROPERTIES

Plate Number	Cu (Wt.%)	Ni (Wt.%)	P (Wt.%)	I (°F)	Heat No.
Intermediate Shell Plate B2802-1	.20	.50	.010	5	B5394-2
Intermediate Shell Plate B2802-2	.22	.53	.015	-4	A0516-2
Intermediate Shell Plate B2802-3	.20	.49	.011	17	B5391-2
Lower Shell Plate B2803-1	.19	.47	.012	49	A0495-2
Lower Shell Plate B2803-2	.22	.52	.011	-5	C1397-3
Lower Shell Plate B2803-3	.24	.52	.012	74	A0512-2

Longitudinal Welds - 2-042 A, B, C and 3-042 A, B, B, Wire Heat 34B009, Flux Linde 1092

WOG Data Base	.19	.52	.012	-56

Circum. Weld 9-042 - Intermed. to Lower Shell, Wire Heat 13253, Flux Linde 1092

Weld Qualification Value	.27	.74	.023	-70
WOG Data Base Mean	.25	.72	.02	-54

I = Unirradiated Reference Temperature

TABLE VI

CHEMICAL COMPOSITION OF THE INDIAN POINT UNIT NO. 3 REACTOR VESSEL SURVEILLANCE MIATERIALS

Chemical Composition (wt %)

	Intermediate Shell Course Plate			Lower Shell Course Plate	As Deposited
Element	B2802-1	B2802-2	B2802-3	B2803-3	Weld Metal
C	0.22	0.19	0.20	0.22	0.08
Mn	1.41	1.33	1.32	1.30	1.18
P	0.010	0.015	0.011	0.012	0.019
S	0.023	0.019	0.025	0.024	0.016
Si	0.28	0.21	0.26	0.28	0.17
Ni	0.50	0.53	0.49	0.52	1.02
Cr	0.08	0.09	0.08	0.08	0.04
Mo	0.46	0.48	0.50	0.45	0.53
Cu	0.18	0.20	0.19	0.24	0.15
A1	0.036	0.027	0.042	0.03	<0.01
V	<0.01	<0.01	<0.01	<0.01	<0.01
Sn	0.014	0.017	0.014	<0.01	0.007
Cb	<0.01	<0.01	<0.01	<0.01	<0.01
Zr	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	<0.01	<0.01	<0.01	<0.01	<0.01

All other elements (except Fe) were < 0.01%

TABLE VII

CHEMICAL COMPOSITION AND HEAT TREATMENT OF CORRELATION MONITOR MATERIAL HSST PLATE 02

(Composition (Wt.%)

	C	Mn	P	S	Si	Ni	Mo	Cu
Ladle	0.22	1.45	0.011	0.019	0.22	0.62	0.53	---
Check	0.22	1.48	0.012	0.018	0.25	0.68	0.52	0.14

- Heat Treatment History

  1675 ± 25°F - 4 hours - Air-cooled
  1600 ± 25°F - 4 hours - Water-quenched
  1225 ± 25°F - 4 hours - Furnace-cooled
  1150 ± 25°F - 40 hours - Furnace-cooled to 600°F

TABLE VIII

COMPARISON OF METHODS USED TO PREDICT ADJUSTED REFERENCE TEMPERATURE (°F) FOR INDIAN POINT-3 REACTOR VESSEL (WELD METAL AND LIMITING PLATE)

RT_{NDT} CONSIDERATIONS AFTER 5.55 EFPY AT 1/4T LOCATION
(1.87×10^{18} n/cm^2, E > 1 MeV)*

		PLATE (B2803-3 T)	WELD Surveillance	WELD Int./Lower Shell
Initial RT_{NDT}		+74	-30	-70
SHIFT	Reg. Guide 1.99 Revision 1	95	71	132
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	88	106	114
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	90	119	128
MARGIN	Reg. Guide 1.99 Revision 1	N/A	N/A	N/A
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	35	57	57
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	19	29	29
ADJUSTED RT_{NDT}	Reg. Guide 1.99 Revision 1	169	41	62
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	197	133	100
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	182	118	87

*NOTE: All fluences at Axial & Azimuthal peak locations as given in WCAP 11815 [14] with attenuation to 1/4T per [4].

TABLE VIII (continued)

RT_{NDT} CONSIDERATIONS AT PROJECTED END OF LIFE (22.5 EFPY) AT 1/4T LOCATION
(6.44×10^{18} n/cm^2, E > 1 MeV)*

		PLATE (B2803-3 T)	WELD Surveillance	WELD Int./Lower Shell
Initial RT_{NDT}		+74	-30	-70
SHIFT	Reg. Guide 1.99 Revision 1	176	132	245
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	140	168	181
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	142	189	203
MARGIN	Reg. Guide 1.99 Revision 1	N/A	N/A	N/A
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	35	57	57
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	19	29	29
ADJUSTED RT_{NDT}	Reg. Guide 1.99 Revision 1	250	102	175
	Reg. Guide 1.99 Rev. 2, R. P. 1.1	249	195	167
	Reg. Guide 1.99 Rev. 2, R. P. 2.1	235	190	162

*NOTE: All fluences at Axial & Azimuthal peak locations as given in WCAP 11815 [14] with attenuation to 1/4T per [4].

TABLE IX
COMPARISON OF MEASURED VERSUS PREDICTED 30 ft-lb TEMPERATURE INCREASES AND UPPER SHELF DECREASES FOR INDIAN POINT UNIT 3 REACTOR VESSEL MATERIALS BASED ON THE PREDICTION METHODS OF REGULATORY GUIDE 1. 99 PROPOSED REVISION 2

Material	Capsule	Fluence (10^{19} n/cm^2)	30 ft-lb Transition Temp Increase (°F)		Upper Shelf Energy Decrease (ft-lb)	
			Measured	R.G. 1.99 Rev. 2 Predicition[a]	Measured	R.G. 1.99 Rev. 2 Predication [b]
B2802-1 (Long.)	T	0.292	89	82	13	27
B2802-3 (Long.)	Z	1.07	150	133	22	37
B2803-3 (Long.)	T	0.292	137	106	9	25.5
B2803-3 (Long.)	Z	1.07	170	163	23	35
B2803-3 (Trans.)	T	0.292	118	106	9	16.5
B2803-3 (Trans.)	Y	0.805	150	150	10	21
B2803-3 (Trans.)	Z	1.07	155	163	11	22
Weld Metal	T	0.292	143	137	29	27.5
Weld Metal	Y	0.805	180	193	52	34
Weld Metal	Z	1.07	220	210	44	36.5
Correlation Mat'l	Y	0.805	140	96	25	26.5
HAZ Metal	Y	0.805	150	-	36	-

a) Based on average copper and nickel content reported in Tables VI and VII.

b) Based on average copper content reported in Tables VI and VII.

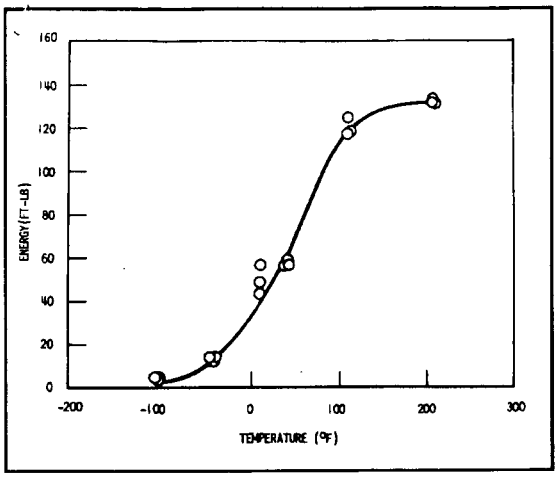


Figure 1 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point Unit No. 3 Reactor Pressure Vessel Shell Plate B2802-1 (Longitudinal Orientation)

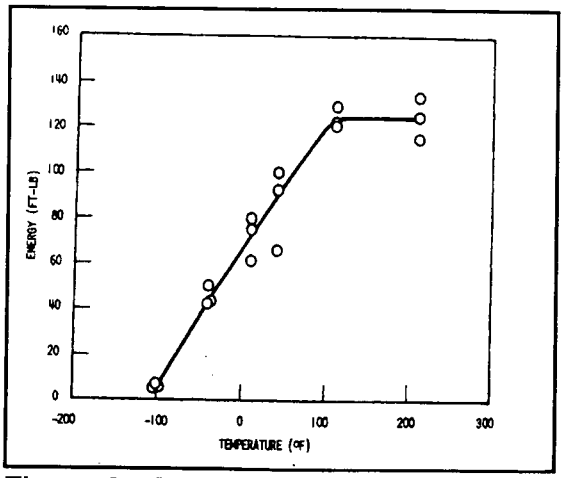


Figure 2 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point Unit No. 3 Reactor Pressure Vessel Shell Plate B2802-2 (Longitudinal Orientation)

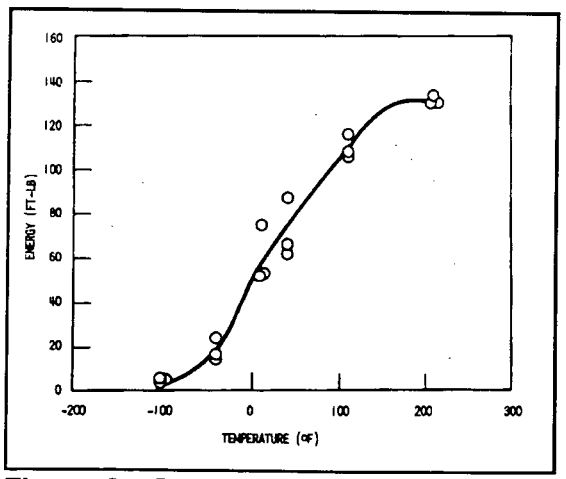


Figure 3 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point Unit No. 3 Reactor Pressure Vessel Shell Plate B2802-3 (Longitudinal Orientation)

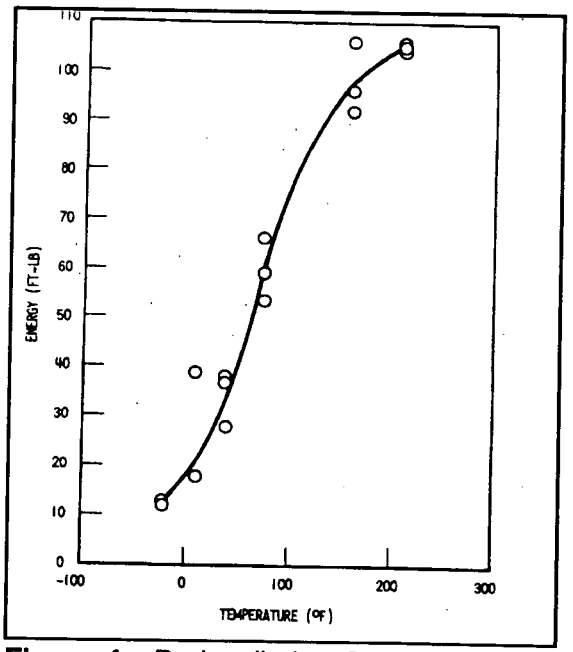


Figure 4 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point Unit No. 3 Reactor Pressure Vessel Shell Plate B2803-3 (Longitudinal Orientation)

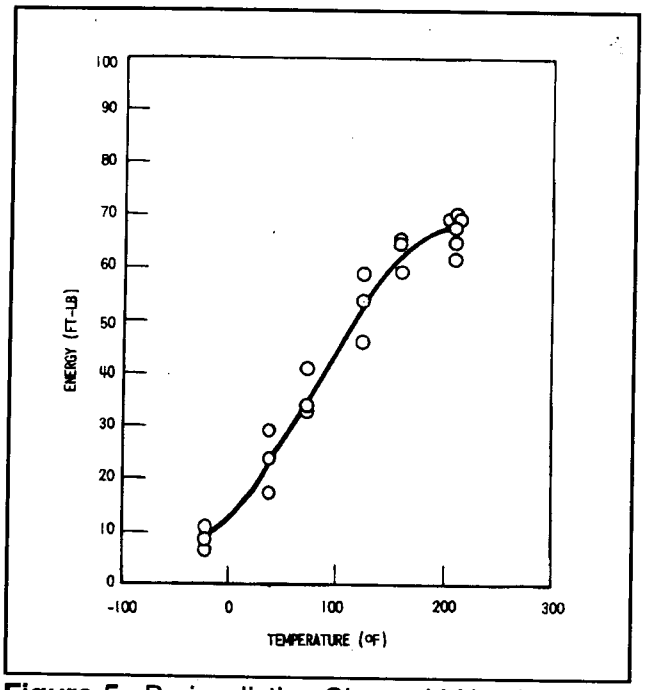


Figure 5 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point No. 3 Reactor Pressure Vessel Shell Plate B2803-3 (Transverse Orientation)

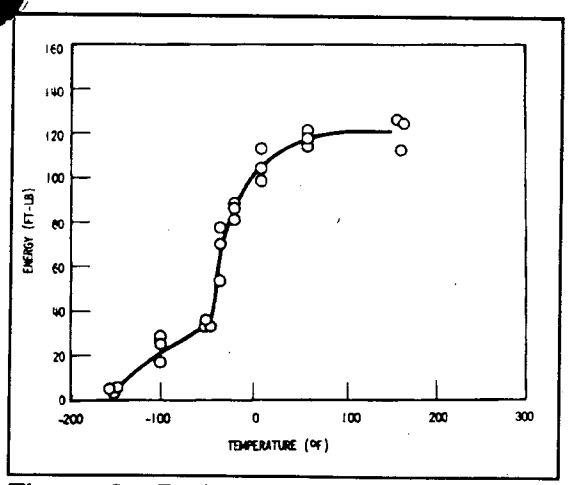


Figure 6 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point No. 3 Reactor Pressure Vessel Weld Metal

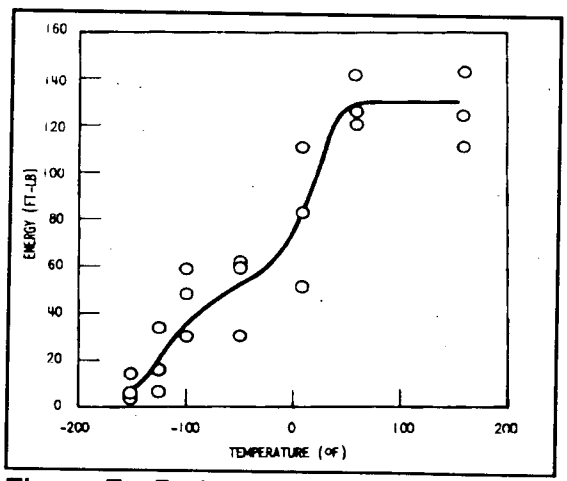


Figure 7 - Preirradiation Charpy V-Notch Impact Energy for the Indian Point Unit No. 3 Reactor Pressure Vessel Weld Heat Affected Zone Metal

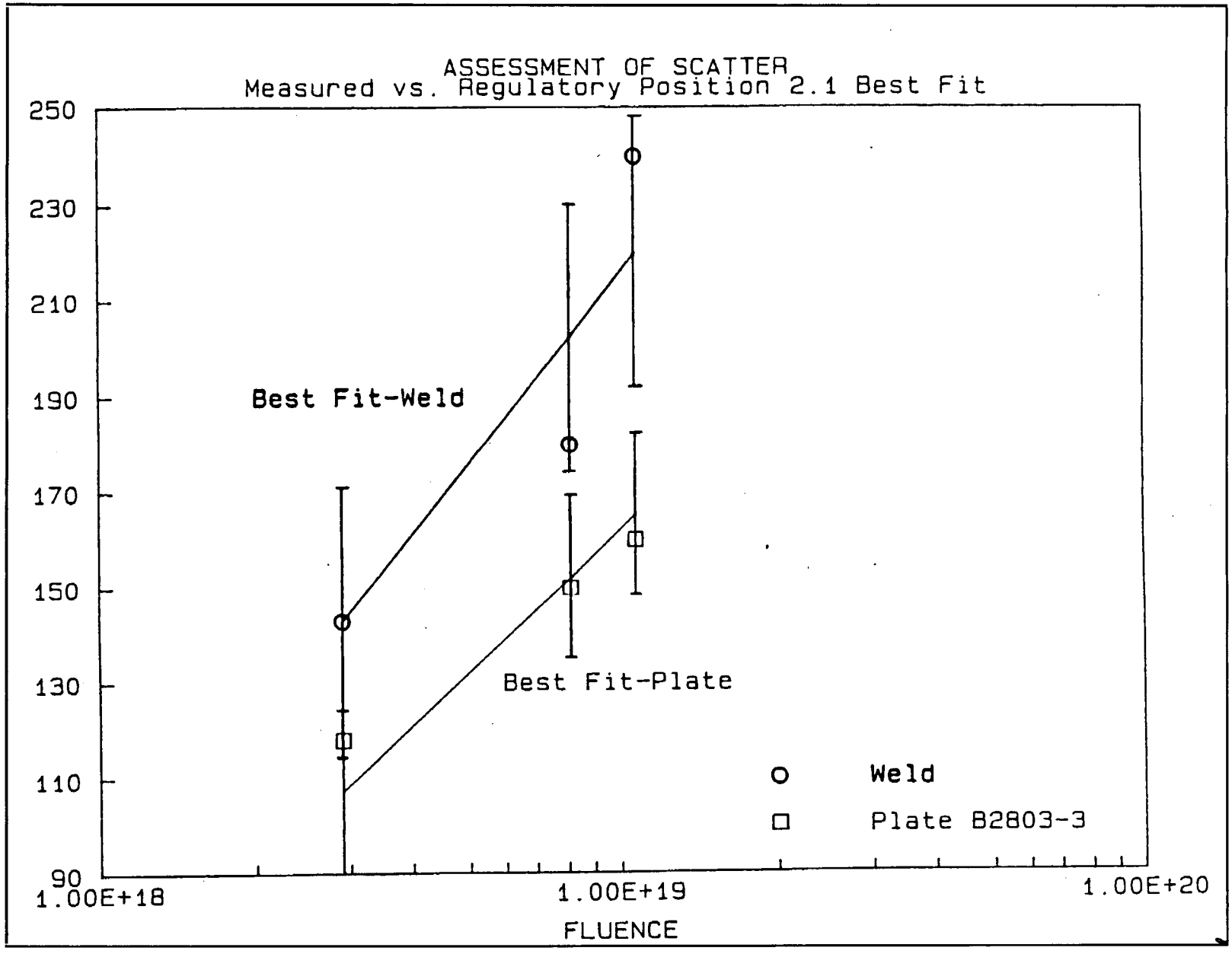


Figure 8 - Assessment of Scatter in Reference Temperature for Indian Point-3

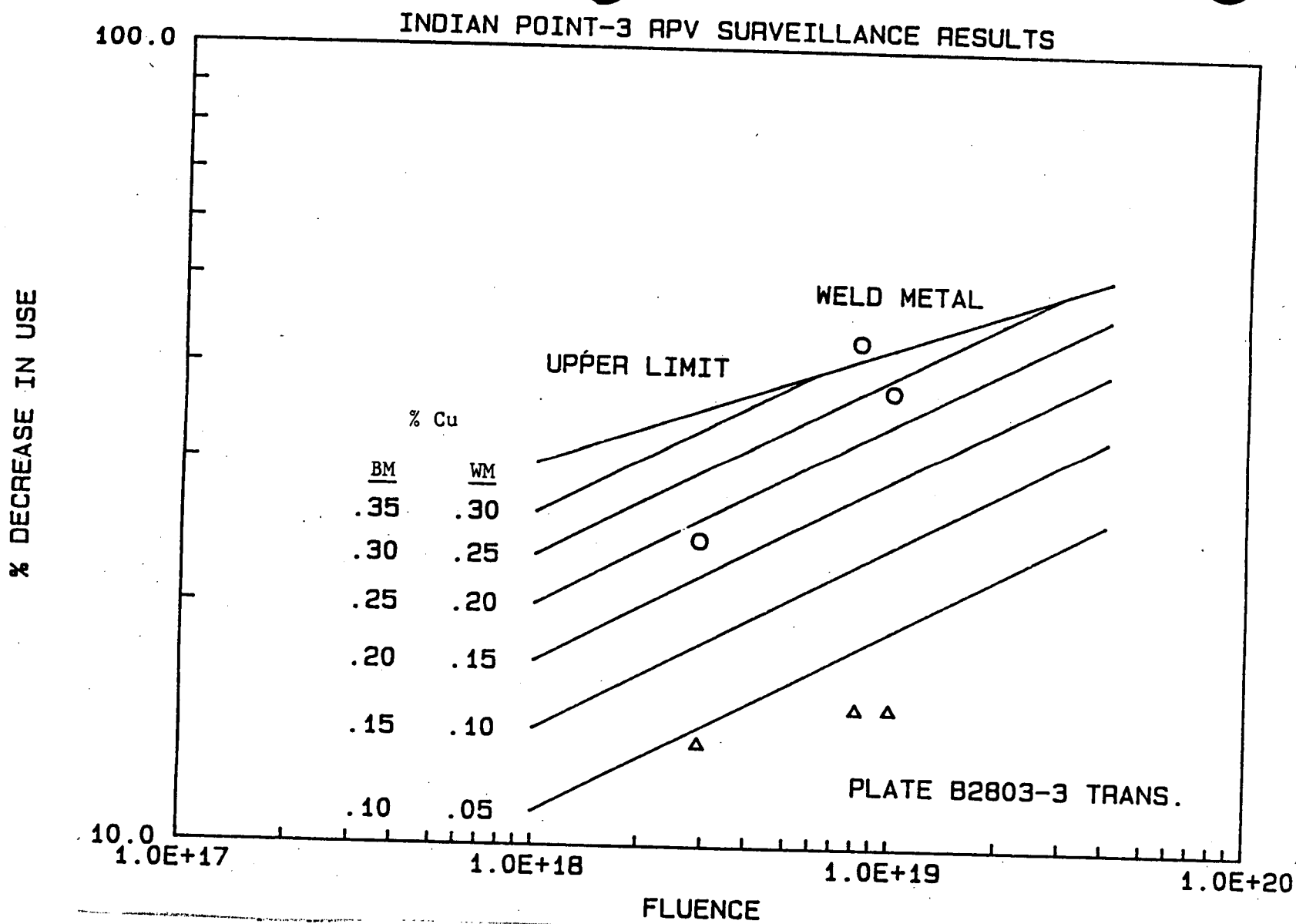


Figure 9 - Trend Lines for Reference Temperature Shifts per Reg. Guide 1.99.

Attachment II
Response to Generic Letter 92-01
James A. FitzPatrick Nuclear Power Plant

Docket No. 50-333
New York Power Authority

Question 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 E185-73, -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

The JAF surveillance program is considered to be in compliance with Appendix H to 10 CFR Part 50 as follows. Paragraph B.1 of Appendix II states that the part of the surveillance program conducted prior to the first capsule withdrawal must meet the requirements of the edition of ASTM 185 that is current on the issue date of the ASME Code to which the reactor vessel was purchased. Since the FitzPatrick vessel was purchased to the 1965 ASME Code with winter 1966 addenda, E185-66 is the applicable standard for the development of the surveillance program.

Appendix H further states that for each capsule withdrawal after July 26, 1983, the test procedures and reporting requirements must meet ASTM E185-82 requirements to the extent practical for the configuration of the specimens in the capsule. ASTM E185-82 applies to first surveillance capsule pulled from the FitzPatrick vessel (April 1985) and all untested capsules at this time.

Finally, Appendix H, paragraph B.1, states that for each capsule withdrawal prior to July 26, 1983 either the 1973, 1979, or the 1982 edition of ASTM E185 maybe used. No capsule was removed prior to April 1985 so this requirement does not apply.

While the Fitzpatrick surveillance program does not meet all requirements of E185-73, it does meet the intent of the most significant requirements as detailed further in response to questions 2 and 3 below. The FitzPatrick vessel contains two surveillance capsules and one additional reconstituted surveillance capsule. Each capsule contains three Charpy specimens and 3 flux wires. Each of the four tensile specimens tubes contains eight specimens. A more complete description of the FitzPatrick surveillance program is presented in Reference 1.

With respect to surveillance test materials, test specimens were taken from the material used in the beltline region of the vessel but are not the most limiting plate

as determined by initial reference temperature. With regard to weld metal the data which is available indicates that it is representative as required by E185-66.

In spite of being designed prior to the existence of Appendix H, the FitzPatrick surveillance program meets the objective of Appendix H to "monitor changes in the fracture toughness properties of ferritic materials in the reactor vessel beltline region...resulting from exposure of these material to neutron irradiation and the thermal environment."

Since the surveillance program was designed in accordance with the requirements of ASTM E185-66 which was the edition of the ASME Code current when the vessel was purchased, the FitzPatrick vessel surveillance program meets Appendix H per paragraph II.B.1. An exemption request is not necessary.

NYPA is a member of the BWROG Supplemental Surveillance Program (SSP) Committee. The objective of that committee is to develop supplemental surveillance data which will allow the Authority to better understand the extent of beltline embrittlement with increasing fluence. The testing being undertaken by the SSP committee will greatly increase the BWR surveillance data base. Description of the SSP test program and hardware are presented in the Committee's Phase 1 report and Phase 2 Progress report. These reports are being prepared for submittal to the NRC in July of 1992.

Question 2.a

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

> 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

The upper shelf energies (USE) of the beltline materials at the FitzPatrick plant are not expected to be less than 50 ft-lb by the end of its licensed operating period (32 EFPY). The USE at end of life (EOL) is predicted using Regulatory Guide 1.99, Revision 2 guidance. The minimum plate USE is 89 ft-lb longitudinal at EOL. Branch Technical Position BPT 5-2 recommends 65% of the longitudinal USE as an estimate of transverse USE, so at EOL the USE would be 58 ft-lb transverse. Therefore, question 2a does not apply to the FitzPatrick plant. A brief description of the USE evaluation supporting this conclusion follows.

USE data were taken during fabrication on the plates used in the FitzPatrick vessel beltline. Evaluation of these plate specimens in accordance with Regulatory Guide 1.99, Revision 2, shows the USE at 32 effective full power years (EFPY) to be above 50 ft-lb. The beltline submerged arc welds only had fabrication Charpy tests performed at 10°F, so USE data are not available. The surveillance weld metal specimens were fabricated with the same weld procedure that was used in the longitudinal seam welds, therefore Charpy test results used in determining USE are representative of beltline welds. Conservative estimates for USE were made using results of tests on specimens from the first removed surveillance capsule. The weld USE is established for an intermediate fluence. The intermediate value is used to predict the original unirradiated USE, and an EOL value is then calculated.

The Authority recognizes the need for a better quantitative approach to USE evaluations on beltline weld metal. Therefore, the Authority will participate in the BWROG RPV Fracture Toughness Committee which tasked GE with developing USE estimation methods for plants with incomplete data.

Question 2.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

As stated in the response to Question 1, the FitzPatrick vessel was constructed to the Winter 1966 Addenda of the 1965 ASME Code. For the beltline plate materials, Charpy and dropweight tests were performed. The Charpy specimen orientation was longitudinal and the test requirement was to meet 30 ft-lb at the specified temperature. In order to demonstrate fracture toughness equivalent to Appendix G requirements, a GE procedure described in Reference 2 was used to adjust the 30 ft-lb longitudinal Charpy data to determine the temperature T_{50T} at which an equivalent 50 ft-lb transverse Charpy energy could be expected. The unirradiated RT_{NDT} was then selected as the higher of (T_{50T}-60°F) or the dropweight nil-ductility temperature (NDT). For the beltline plate the RT_{NDT} for the limiting combination of test temperature and Charpy energy from Table I in Appendix A is 24°F.

For the beltline weld materials, only Charpy tests were performed. The specimens were cut transverse to the weld length and the test requirement was 30 ft-lb at the specified temperature. As with the plate, the GE procedure was used to adjust the 30 ft-lb Charpy data to determine T_{50T} and to account for the lack of dropweight testing. For vessel weld material, the Charpy V-Notch results are usually limiting in establishing RT_{NDT}. The 50 ft-lb test temperature is

established as follows. There are typically three energy values at a given test temperature. The lowest energy Charpy value is adjusted by adding 2°F per ft-lb energy to 50 ft-lb. For example, the limiting beltline weld Charpy V-Notch energy from Table I in Appendix A is 36 ft-lb at 10°F for weld 2-233. The corresponding transverse 50 ft-lb temperature is

$$T_{50T} = T_{50L} = 10°F + [(50-36)\ \text{ft-lb} \times 2°F/\text{ft-lb}] = 38°F$$

The unirradiated RT_{NDT} was determined from the procedure as the higher of either (T_{50T}-60°F) or -50°F.

Charpy data, dropweight test results and estimated RT_{NDT} values for the beltline materials are shown in Table I of Appendix A. The Charpy results are shown graphically on Figure 1.

Question 2.b.2

The heat treatment received by all beltline and surveillance materials.

Response

For the beltline plate materials and surveillance materials heat treatment was not explicitly considered in the Appendix G analysis, as there are no requirements or methods provided which relate to heat treatment. However, implicit in the Appendix G analysis is the assumption that the Charpy data used to develop the RT_{NDT} values is representative of the beltline materials so heat treatment of the Charpy specimens should represent or bound that of the beltline materials.

After the beltline plates were quenched and tempered, specimen samples and plate used in the surveillance program were trimmed from the plates. The specimen samples and surveillance materials received a simulated post-weld heat treatment (PWHT) at 1150°F ±25°F for 40 hours. The beltline material PWHT temperature was the same, but the beltline PWHT time was typically 6 hours. The additional PWHT time for the specimens was intended to cover the possibility of future vessel repairs requiring subsequent PWHT. Since PWHT tends to reduce the fracture toughness of the material, the Charpy specimens and surveillance program materials provide a bounding representation of the vessel beltline materials.

Question 2.b.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

The beltline consists of portions of the lower shell and lower-intermediate shell. Each shell is formed from three plates, so the beltline includes portions of six plates, six vertical welds, and one circumferential weld. All beltline plate and weld materials were considered in the Appendix G evaluation. The requested information is provided in Table II of Appendix A. An arrangement of the vessel plates and welds is provided in Figure 2 in the same attachment.

Question 2.b.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

Appendix G includes by reference in paragraph III.A, Appendix H, which includes by reference "the requirements of the edition of ASTM E185 that is current on the issue date of the ASME code to which the reactor vessel was purchased." For Fitzpatrick, this is E185-66, which required that "test specimens shall be taken from materials used in the irradiated region." E185 further states that "Samples shall represent one heat of the base metal and one butt weld if a weld occurs in the irradiated region". All materials used for specimens were beltline materials from the lower intermediate shell course. The surveillance plate material was trimmed from the beltline plate G-3414-2, heat number C3278-2.

The weld metal and heat affected zone (HAZ) Charpy specimens were fabricated from pieces trimmed off G-3414-1 and G-3414-2. Specific wire heat number and flux lot data for the surveillance weld are not available. The specification for the surveillance weld required that it be made with the same procedure as the longitudinal beltline weld 1-233.

Since surveillance weld records are not available, the Authority can not prove that a beltline weld material was used. However, the data which is available on the surveillance weld indicates that it is representative as required by E185-66.

Question 2.b.5

The chemical composition, in particular the weight in percent of copper, nickel, phosphorous, and sulfur for each beltline and surveillance material.

Response

Chemical compositions weight percent data for beltline materials are shown in Table II of Appendix A. The values for the limiting beltline plate are 0.13% Cu, 0.015 % P, 0.60% Ni, 0.017% S. For the surveillance weld, the values 0.31% Cu, 0.015% P and 0.72% Ni were reported. Because chemistry results of the beltline weld are unavailable in the as deposited condition several chemistry estimates for the longitudinal welds were made. Available industry sources were used to collect data from other plants on the longitudinal weld heats in the FitzPatrick beltline. These results were compared, and the most conservative chemistry estimate was used to determine irradiation effect in the beltline region. Chemical composition weight percent data for the beltline welds are shown in Table III of Appendix A. Beltline plate and weld material chemistry were used in accordance with Regulatory Guide 1.99, Revision 2 guidance, to determine the limiting beltline material, the adjusted reference temperature versus EFPY for the material, and the predicted plate USE at 32 EFPY.

Question 2.b.6

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

Response

This does not apply. The weld metal and HAZ Charpy specimens were fabricated from reactor vessel trim off plate that were welded together with a weld identical to longitudinal seam weld 1-233 in the beltline region.

Question 3.a

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

> 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

Operation with the FitzPatrick Plant beltline region below 525°F was not considered in the Appendix G analysis because the steady state operating temperature of the coolant in the beltline region is slightly greater. Based on the temperature of the coolant in the recirculation suction piping, which draws water directly from the beltline region, the steady state temperature in the beltline region is greater than 527°F.

Only during startup and low power operation, without feedwater heating, which occurs when feedwater heaters are out of service or when the turbine is off line and the reactor steam is routed through the turbine bypass, does the beltline experience coolant less than 525°F when the core is critical. The time of operation in these transient conditions has been estimated to be less than 5%, and the associated temperatures for most of that time are 515°F or higher. The FitzPatrick plant 32 EFPY estimated fluence is 1.7E+18 n/cm2 at the 1/4 T position in Reference 3, so the fluence accumulated below 525°F would be about 8.5E+16 n/cm2. This combination of low fluence and small deviation from the 525°F level is not expected to affect beltline RT_{NDT} or USE predictions. Since surveillance specimens are exposed to the same temperature conditions as the beltline materials, temperature effects, if any, will be reflected in the surveillance results. When the surveillance results are factored into the Appendix G analysis per Regulatory Guide 1.99, Revision 2, temperature effects are accounted for inherently.

The BWROG supplemental surveillance data will be collected periodically over the next 8 years. The capsules will include eutectic temperature monitors with which to determine the approximate maximum irradiation temperature. The data will include results of some PWR materials and HSST-02 standard material. The data should provide additional insight into temperature effect differences between the BWR and PWR environments.

Question 3.b

How [licensee's] surveillance results on the predicted amount of embrittlement were considered.

Response

Surveillance results were factored into beltline embrittlement predictions when Regulatory Guide 1.99, Revision 1, was used. However, Revision 2, paragraph C.2, requires credible data from two surveillance capsules before adjustments to the prediction methods are made, and only one capsule has been tested. Therefore, the beltline predictions are based on Revision 2 methods without consideration of surveillance results.

Question 3.c

If a measured increase in reference temperature exceeds the mean-plus-two standard deviations predicted by 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

Measured increases in reference temperature and measured decrease in USE based on the first surveillance capsule are provided in Appendix B. Discussion of the comparisons with Regulatory Guide 1.99, Revision 2 predictions follows.

Measured increases in reference temperature from the first surveillance capsule were within the mean-plus-two-sigma prediction for the plate. Original Charpy curve data for the weld metal is unavailable. Since only one surveillance result is available, the effect of the measured increases on the beltline predictions has not been considered as allowed by paragraph C.2 of the Regulatory Guide.

REFERENCES

1. General Electric Report, "Information on Reactor Vessel Material Surveillance Program," dated May 2, 1978.

2. General Electric Report MDE-49-0386, "FitzPatrick RPV Surveillance Materials Testing and Fracture Toughness Analysis," dated, April 1986, with attachment, "Use of Regulatory Guide 1.99, Proposed Revision 2 to Predict Irradiation Shift."

3. General Electric Report SASR 89-50, DRF 137-0010, "Implementation of Regulatory Guide 1.99, Revision 2," dated June 1989.

APPENDIX A

Table I

RESULTS OF FABRICATION TEST PROGRAM FOR SELECTED RPV LOCATIONS

			Tensile								
Location	Ident. Number	Heat Number	Yield (ksi)	UTS (ksi)	Total Elong (%)	Area Reduc. (%)	Test Temp. (°F)	Charpy Energy (ft-lb)	NDT (°F)	T_{50T} -60 (°F)	RT_{NDT} (°F)
Lower Shell Plates	G-3415-1R G-3415-3 G-3415-2	C3394-1 C3376-2 C3103-2	67.8 67.0 66.1	88.5 88.3 89.5	27.5 27.0 26.3	69.8 68.6 69.3	10 40 10	53,71,52 43,51,49 41,48,49	-10 -10 -10	-20 24 -2	-10 24 -2
Lower-Intermediate Shell Plates	G-3413-7 G-3414-2 G-3414-1	C3368-1 C3278-1 C3301-1	65.3 67.7 70.9	86.5 89.3 92.6	27.0 27.0 26.5	67.7 69.8 67.9	10 10 10	61,55,45 45,77,58 60,63,49	-50 -30 -40	-10 -10 -18	-10 -10 -18
Longitudinal Weld	2-233	Ht. 27204 Lot 3774	78.9	93.5	24.0	66.1	10	49,48,36	n/a	-22	-22
Girth Weld	1-240	Ht. 305414 Lot 3947	72.1	87.7	25.5	66.8	10	82,66,80	n/a	-50	-50
Upper Shell Plate	G-3413-5	C-3229-2	68.9	90.5	27.3	68.0	10	50,68,82	-10	-20	-10
Vessel Flange	G-3401	2V595	63.6	85.4	28.5	73.0	10	117,94,117	10	-20	10
Head Flange	G-3402	4P-1885	70.9	92.3	25.5	70.5	10	66,87,96	30	-20	30
Top Head Torus	G-3411-1	C3055-1	70.6	92.6	26.0	70.6	10	98,73,118	-10	-20	-10
Recirc. Inlet	G-3436-9	E21VW-104J5	75.8	93.8	26.0	71.5	10	73,116,118	30	-20	30
Closure Bolts	G-3134-1	37385	153.3	168.0	15.0	47.3	10	39,40,39	n/a	LST =	70°F

Table II

CHEMICAL COMPOSITION OF RPV BELTLINE MATERIALS

Composition by Weight Percent

Identification	Heat / Lot No.	C	Mn	P	S	Si	Ni	Mo	Cu
Lower Plates:									
G-3415-1R	C3394-1	0.21	1.32	0.015	0.017	0.26	0.56	0.47	0.11
G-3415-3	C3376-2	0.22	1.33	0.015	0.017	0.22	0.60	0.48	0.13
G-3415-2	C3103-2	0.23	1.36	0.012	0.016	0.26	0.60	0.47	0.14
Lower-Intermediate Plates:									
G-3413-7	C3368-1	0.21	1.31	0.015	0.018	0.23	0.54	0.46	0.12
G-3414-2	C3278-2	0.20	1.26	0.011	0.016	0.23	0.60	0.48	0.13
G-3414-1	C3301-1	0.20	1.35	0.009	0.015	0.27	0.60	0.48	0.18
Lower Longitudinal Welds:									
2-233 A,B,C	Heat 27204, Flux 1092, Lot 3774	←			N/A				→
	Heat 12008, Flux 1092, Lot 3774	←			N/A				→
	Heat 8018 Lot EOAG	0.064	0.81	0.008	0.015	0.17	1.04	0.26	N/A
Lower-Intermediate Longitudinal Welds:									
1-233 A,B,C	Heat 13253, Flux 1092, Lot 3374	←			N/A				→
	Heat 12008, Flux 1092, Lot 3774	←			N/A				→
	Heat 8018 Lot EOAG				See above				
	Heat 8018 Lot LODG	0.081	1.02	0.009	0.011	0.49	0.93	0.21	N/A

Table II (Continued)

CHEMICAL COMPOSITION OF RPV BELTLINE MATERIALS

Composition by Weight Percent

Identification	Heat / Lot No.	C	Mn	P	S	Si	Ni	Mo	Cu
Lower to Lower-Int. Girth Weld: 1-240	Heat 305414, Flux 1092, Lot 3947	0.14	1.45	0.012	0.010	0.18	0.59	0.51	0.33
	Heat 8018 Lot BOBJ	0.080	1.03	0.012	0.012	0.40	0.91	0.24	0.02
	Heat 8018 Lot AOFJ	0.079	1.04	0.011	0.012	0.42	0.93	0.23	0.03

Tab[illegible]III

WEIGHT PERCENT DATA FOR THE BELTLINE WELDS

COMPONENT	I.D.	HEAT OR HEAT/ LOT	%Cu	%Ni	CF	16 Delta	EFPY RTndt	Margin	16 EFPY Shft	16 EFPY	Notes
WELDS: Lower Long.	2-233	27204 &12008/ 1092 Lot 3774	0.25 0.19	0.99 0.97	241 216	-22 -22	82.2 73.7	56.0 56.0	138.2 129.7	116.2 107.7	a b
Low-Int Long.	1-233	13253 &12008/ 1092 Lot 3774	0.26 0.22	0.87 0.84	224 206	-50 -50	85.8 78.9	56.0 56.0	141.8 134.9	91.8 84.9	c d
Lower to Low -Int Girth	1-240	305414/1092 Lot 3947	0.33	0.59	204	-50	78.1	56.0	134.1	84.1	
Surveillance Weld Chem.			0.31	0.72	216						e

NOTES TO TABLE III

a. Chemistry based on analytical combination of separate chemistry data for 27204 and 12008.

b. Chemistry recorded for Mihama Unit 1 surveillance weld, tandem 27204 and 12008 with 1092 Flux Lot 3724.

c. Chemistry based on analytical combination of separate chemistry data for 13253 and 12008.

d. Chemistry recorded in Maine Yankee PTS submittal for average of 8 test of 13253 and 12008 with three lots of 1092 Flux: 3774, 3791 and 3833.

e. Chemistry recorded in [2] for FitzPatrick surveillance weld. Note that Rev. 2 CF of 216 is lower than those assumed from analytical combinations.

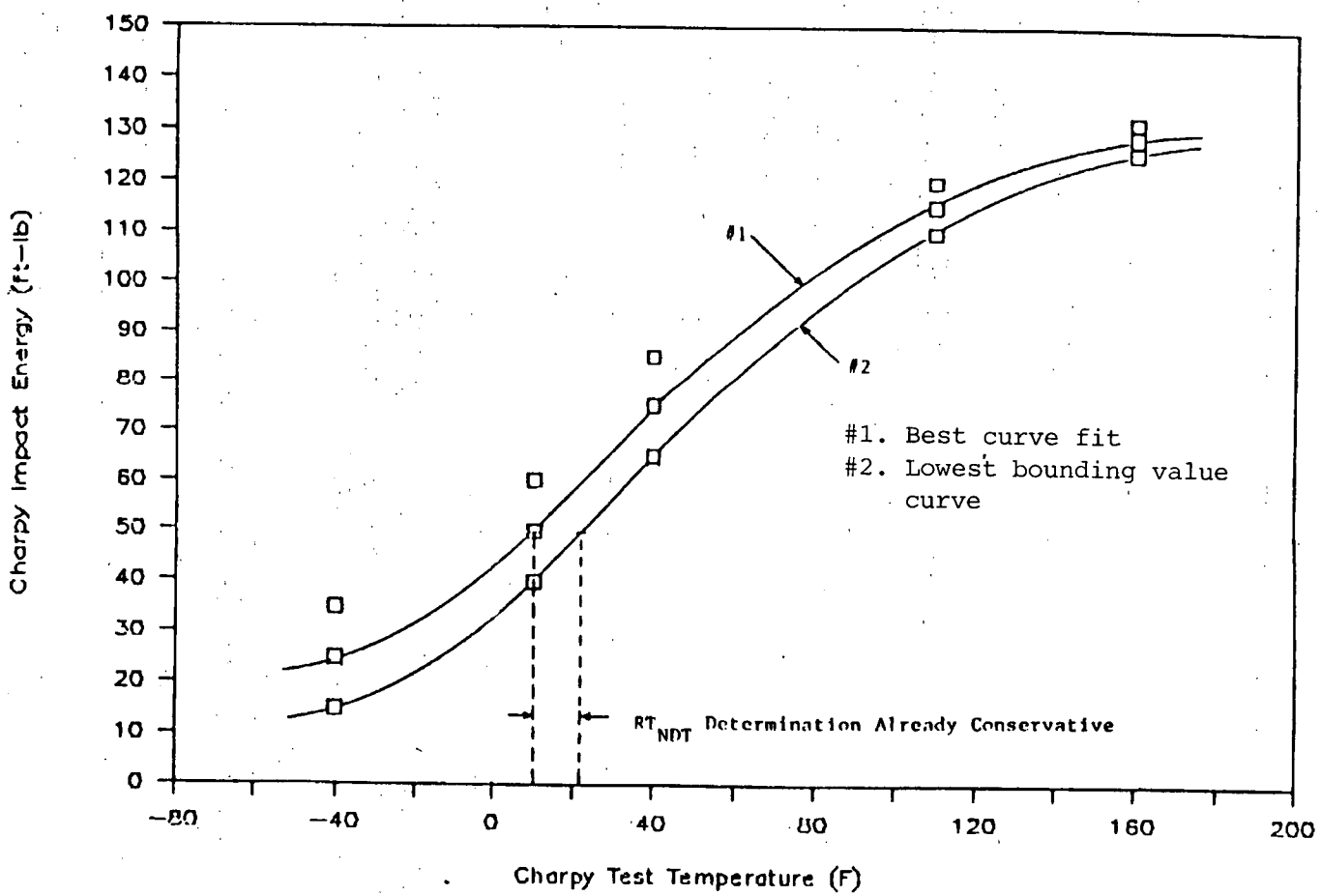


Figure 1. Comparison of Surveillance Data Fit and RT_{NDT} Approach

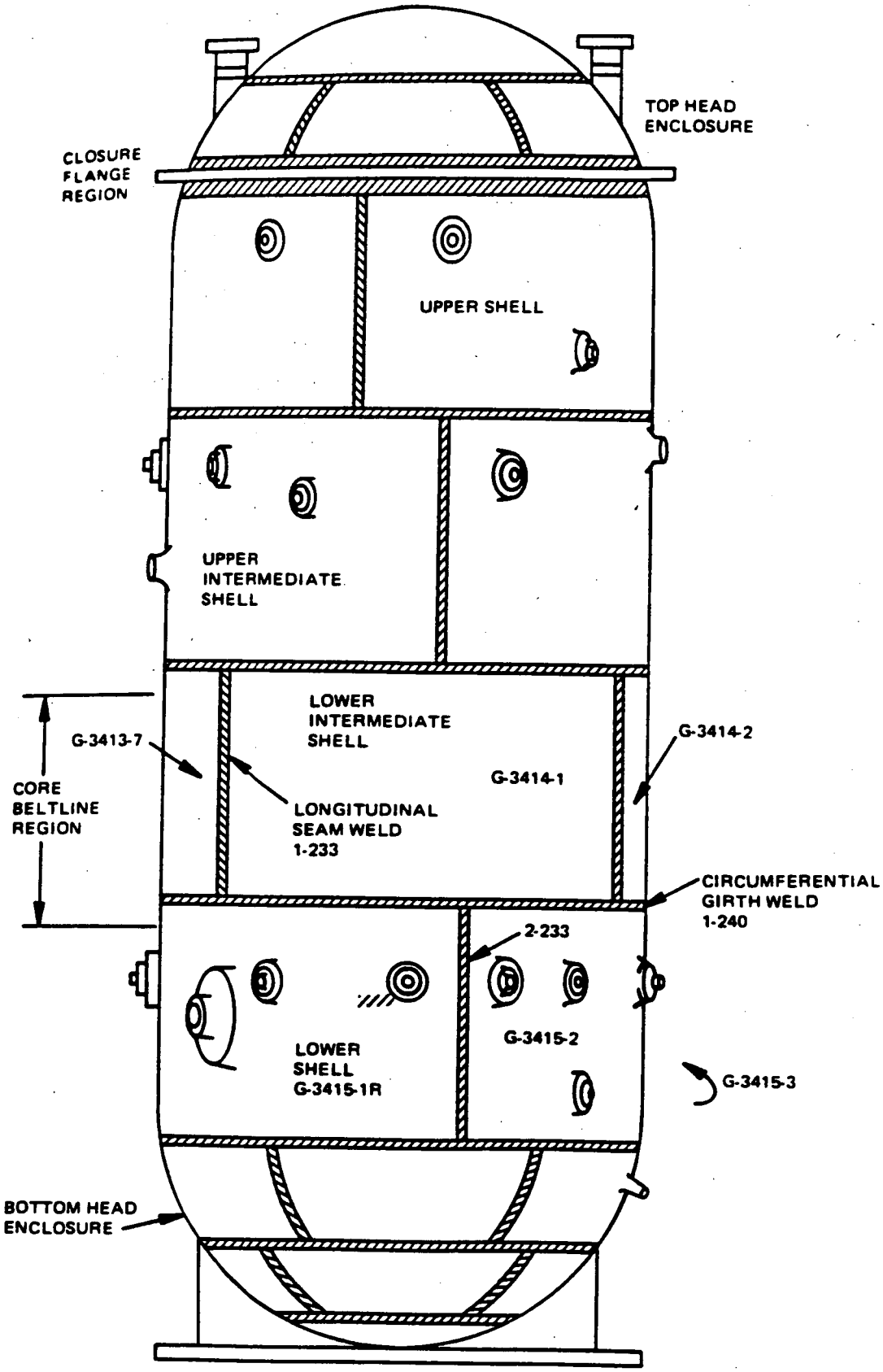


Figure. 2 Schematic of the RPV Showing Arrangement of Vessel Plates and Welds

APPENDIX B

COMPARISON OF SURVEILLANCE RESULTS WITH REG. GUIDE 1.99, REVISION 2 PREDICTIONS

COMPARISON OF SURVEILLANCE RESULTS
WITH REG. GUIDE 1.99, REVISION 2 PREDICTIONS

(Fluence = 2.7×10^{17} n/cm2)

REFERENCE TEMPERATURE INCREASE

Plate:

%Cu = 0.13 Predicted $\Delta RT_{NDT} = 19^{\circ}F$

%Ni = 0.60 Predicted $\Delta RT_{NDT} + 2\sigma = 38^{\circ}F$

Measured Shift = $23^{\circ}F$

Weld:

No measured shift is available for weld metal

USE DECREASE

Plate:

Unirradiated USE = 85 ft-lb

Irradiated USE = 79 ft-lb

Measured Decrease in USE = 6 ft-lb

Predicted Decrease in USE = 8% = 6.8 ft-lb

Weld:

Unirradiated USE for weld is not available

Surveillance Coupon Irradiated USE = 82 ft-lb