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SUBJECT: Forwards response to NRC 970313 RAI on pressurized thermal shock submittals for plant RV beltline matls per 10CFR50.61.

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FPL
Florida Power & Light Company, 6501 South Ocean Drive, Jensen Beach, FL 34957

May 16, 1997

L-97-136
10 CFR 50.4

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

RE: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
NRC TAC Nos. M95484 and M95485
Request for Additional Information - Response
10 CFR 50.61 - Pressurized Thermal Shock Evaluation

The attached provides the response to the NRC request for additional information (RAI), dated March 13, 1997, on the 10 CFR 50.61 pressurized thermal shock (PTS) submittals for the St. Lucie Unit 1 and 2 reactor vessel (RV) beltline materials. The attached response supports the FPL conclusion that the 10 CFR 50.61 values of $RT_{PTS}$ for each of the reactor vessel beltline material remain below the regulatory limits through the end of license (EOL). A change to a generic initial $RT_{NDT}$ value (material property) for a nonlimiting RV weld for St. Lucie Unit 2 is also provided at the NRC's request.

The 10 CFR 50.61(b)(1) PTS evaluations were submitted by Florida Power and Light Company (FPL) letter, L-96-112, on May 14, 1996, and supplemented by FPL letters, L-96-233 and L-97-10, on September 23, 1996, and January 14, 1997, respectively . The supplements were submittted in response the NRC requests on August 27, 1996, and October 15, 1996. The evaluations determined that the projected reference temperature ($RT_{PTS}$) at EOL for the reactor vessel beltline materials of each reactor vessel is acceptable. FPL originally requested NRC approval of these evaluations by April 1, 1997, to support design of the fuel for St. Lucie Unit 1 Cycle 15. However, due to outage schedule changes for Cycle 15, FPL was able to revise the requested approval date to April 1, 1998. This date supports the fuel design for St. Lucie Unit 1 Cycle 16.

This letter does not contain any new regulatory commitments. Please contact us should you need any additional information to support your assessment.

Very truly yours,

J. A. Stall
Vice President
St. Lucie Plant

JAS/GRM



A001

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, St. Lucie Plant

**Response to Nrc Supplemental
Request for Additional Information
St. Lucie Units 1 and 2
Pressurized Thermal Shock Evaluation**

The Nuclear Regulatory Commission staff requested additional information from Florida Power and Light Company on the pressurized thermal shock evaluation[1] [2]. The questions and the responses are as stated below:

**Question 1:**

The licensee's response to Question 2 of the staff's Request for Additional Information (RAI) provided the basis for determining initial $RT_{NDT}$ ($RT_{NDT(U)}$) values for several weld wire heats. The licensee's responses with respect to three of the five heats were acceptable. However, the following information is necessary to complete our evaluation of the remaining two heats:

a) The limiting weld in the St. Lucie 1 reactor vessel beltline is fabricated from weld wire heat 305424. This heat of weld wire was also used to fabricate the Beaver Valley 1 surveillance weld and welds in the LaSalle 1 reactor vessel beltline. The licensee's response 2 to the RAI indicated that the LaSalle and St. Lucie 1 Charpy data were not used to assess the $RT_{NDT(U)}$ for the St. Lucie 1 vessel. Explain the effect on the value of $RT_{NDT(U)}$ that would result from including the Charpy data from St. Lucie 1 and LaSalle 1. Verify whether the $RT_{NDT(U)}$ value for heat 305424 remains drop weight controlled (i.e., does the lower bound Charpy curve become controlling).

b) With regard to heat 83642, St. Lucie 2 reported an $RT_{NDT(U)}$ value of -80°F; and Beaver Valley 2 reported a value of -30°F. The response stated that an $RT_{NDT(U)}$ of -80°F would be used for the St. Lucie 2 weld. Provide the basis for selecting the non-conservative value of -80°F. If justification cannot be provided, use a generic value in which plus or minus 2 sigma would bound the St. Lucie 2 and the Beaver Valley 2 data points.

**Response to Question 1a:**

The $RT_{NDT(U)}$ was determined from drop weight test results of -60°F NDTT and compared to a full Charpy curve from data produced as part of the initial property testing for The Beaver Valley Unit 1 (BV-1) surveillance program[3]. This was the only measured drop weight and complete Charpy data available for weld wire heat 305424 with Linde 1092 flux. This weld heat and flux combination was also used to fabricate the St. Lucie Unit 1 and LaSalle Unit 1 vessel beltline welds. Three Charpy tests were performed at +10°F for the weld heat, 305424 with the same Linde 1092 flux, used to fabricate the St. Lucie Unit 1 and LaSalle Unit 1 vessel beltline welds. These three Charpy test data[4] of 82, 87, and 92 ft-lbs were reported (No lateral expansion or shear data was recorded) for both the St. Lucie Unit 1 and LaSalle Unit 1 vessel beltline welds. The available industry Charpy Data[3,4] for Heat 305424 is presented in the table below:

**Charpy Impact Data for Heat 305424 with Linde 1092 lot 3889 Flux**

| Specimen # /Source | Test Temp. (°F) | Impact Energy (ft-lb) | Lat. Exp. (mils) | % Shear |
|---|---|---|---|---|
| 1 / BV-1 | -150°F | 4 | 0 | 50 |
| 2 / BV-1 | -150°F | 2.5 | 0 | 40 |
| 3 / BV-1 | -150°F | 2 | 0 | 25 |
| 4 / BV-1 | -60°F | 37 | 28 | 35 |
| 5 / BV-1 | -60°F | 27 | 22 | 35 |
| 6 / BV-1 | -60°F | 26 | 22 | 30 |
| 7 / BV-1 | -25°F | 88 | 68 | 85 |
| 8 / BV-1 | -25°F | 77 | 58 | 70 |
| 9 / BV-1 | -25°F | 75 | 59 | 70 |
| 10 / BV-1 | 0°F | 80 | 57 | 75 |
| 11 / BV-1 | 0°F | 66.5 | 47 | 50 |
| 12 / BV-1 | 0°F | 88 | 60 | 75 |
| 13 / BV-1 | 100°F | 100 | 78 | 95 |
| 14 / BV-1 | 100°F | 108.5 | 81 | 99 |
| 15 / BV-1 | 100°F | 117.5 | 88.5 | 100 |
| 16 / BV-1 | 210°F | 110 | 84 | 100 |
| 17 / BV-1 | 210°F | 103.5 | 82 | 100 |
| 18 / BV-1 | 210°F | 122 | 93 | 100 |
| 1/ 10°F Data | +10°F | 82 | NR | NR |
| 2/ 10°F Data | +10°F | 87 | NR | NR |
| 3/ 10°F Data | +10°F | 92 | NR | NR |

Figure 1 shows a plot of the 18 BV-1 baseline surveillance Charpy data points using a hyperbolic tangent curve fit. Figure 2 shows a plot of the 18 BV-1 baseline surveillance Charpy data points with the 3 Charpy tests at +10°F using a hyperbolic tangent curve fit. Comparison of these two graphs in Figures 1 and 2 show that the three +10°F Charpy data points; have little effect on the baseline surveillance data; are above a lower bound Charpy curve that would be drawn through 66.5 ft-lb data point at 0°F; and that at NDTT (60°F) plus 60°F, or 0°F, the drop weight temperature is still controlling for determination of $RT_{NDT(U)}$ by meeting the not less than 50 ft-lb requirement of NB-2331.

**Response to Question 1b:**

The $RT_{NDT(U)}$ of -80°F reported for heat 83642/Linde 0091/Lot 3536 as stated previously is a St. Lucie 2 (SL-2) plant specific value that meets the requirements of NB-2331. The Beaver Valley 2 (BV-2) $RT_{NDT(U)}$ of -30°F and generic $RT_{NDT(U)}$ value of -56°F have been considered by calculating the effect these values of $RT_{NDT(U)}$ have on EOL $RT_{PTS}$. The EOL $RT_{PTS}$ results of using these different $RT_{NDT(U)}$ values as compared to the St. Lucie Unit 2 limiting material are presented in the table below:

| MATERIAL LOCATION & (CODE NO.) Data Source | HEAT# /LOT# | Chem. Factor (CF) | Init. $RT_{NDT}$ | Margin | EOL Fluence n/cm² | $\Delta RT_{PTS}$ | EOL $RT_{PTS}$ | PTS Limit |
|---|---|---|---|---|---|---|---|---|
| Int. Shell Axial Welds (101-124 A,B,C) SL-2 Specific $RT_{NDT(U)}$ | 83642 /3536 | 30.7 | -80°F | 56°F | 2.76E19 | 39°F | 15°F | 270°F |
| Int. Shell Axial Welds (101-124 A,B,C) Generic $RT_{NDT(U)}$ | 83642 /3536 | 30.7 | -56°F | 66°F | 2.76E19 | 39°F | 49°F | 270°F |
| Int. Shell Axial Welds (101-124 A,B,C) BV-2 $RT_{NDT(U)}$ | 83642 /3536 | 30.7 | -30°F | 56°F | 2.76E19 | 39°F | 65°F | 270°F |
| Int. Shell Plate(M-605-2) SL-2 Limiting Material | B3416-2 | 91.5 | +10°F | 34°F | 2.76E19 | 116°F | 160°F | 270°F |

The above table shows that even using the most limiting Beaver Valley Unit 2 $RT_{NDT(U)}$ value of -30°F to calculate EOL $RT_{PTS}$ values for the St. Lucie 2 intermediate shell axial welds, this material is over 200°F below the 10CFR50.61 PTS screening limit and 95°F below the most limiting St. Lucie Unit 2 plate material. However, since there is a large difference in these two $RT_{NDT(U)}$ test values and to ease the NRC review, the conservative generic value of -56°F with the larger margin term will be used for calculations of EOL $RT_{PTS}$. This change will be noted in Table 1 and Table 2 from Attachment B pages B-4 and B-5, respectively of the original PTS submittal[1]. These changes will not result in making this weld material limiting for EOL $RT_{PTS}$ or pressure temperature limit curves.

**Question 2:**

The licensee's response to Question 3 of the RAI stated that "the fluence at the St. Lucie 1 limiting weld...has been updated." The fluence value was 1.20 E19n/cm² in the original submittal. Table 3 of the response to the RAI shows a value of 1.06 E19n/cm². Provide supporting documentation that justifies the decrease in the fluence value for St. Lucie 1. This includes an explanation of the analysis that was used to determine the revised fluence.

**Response to Question 2:**

The fluence value of 1.20 E19n/cm$^2$ at 11.27 effective full power years (EFPY) for St. Lucie Unit 1 was the result of a typographical error. The data was mistakenly taken from data for the St. Lucie Unit 2 which utilized a vessel maximum fluence for all calculations since the Unit 2 vessel is less radiation sensitive. This typographical error did not result in a change to end of license (EOL) $RT_{PTS}$ calculations because the correct St. Lucie Unit 1 EOL fluence data was used for the $RT_{PTS}$ projections. This incorrect fluence data (flux/fluence rate) was only used as a comparison with the St. Lucie Unit 1 and Beaver Valley Unit 1 surveillance capsules. The correct fluence for the St. Lucie Unit 1 vessel limiting weld is 1.06 E19n/cm$^2$ as was reported in the RAI Response[2].

The methodology to determine the St. Lucie reactor vessel neutron flux (E≥1.0MeV) is based on computations of a computer codes package. The codes package consists of the transport code, DOT4.3, and the core physics code, SIMULATE3. A linkage code, SORREL, has been used to connect DOT4.3 and SIMULATE3. A synthesis 3-D flux technique is used to provide the flux at the vessel wall. The basic nuclear data is based on the BUGLE-80 cross section library. Use of the codes package and the synthesis 3-D flux technique will generate the cycle specific flux data in question. A product of the computed cycle specific flux and the plant cycle operation time provides the plant specific and cycle specific vessel fluence (E≥1.0MeV) in question.

The fluence methodology has been extensively benchmarked against the measured data taken from several in-vessel and ex-vessel neutron dosimetry measurements conducted at Turkey Point Units 3 and 4 and St. Lucie Units 1 and 2 since 1984.

**Question 3:**

Where applicable, update the $RT_{PTS}$ Tables as described in the response to the RAI. Specifically, Tables 1 and 2 from Attachment B pages B-4 and B-5, respectively and Table 3 of Attachment A, page A-13.

**Response to Question 3:**

Changes have been made to Tables 1 and 2 from Attachment B pages B-4 and B-5, respectively of the original PTS submittal[1] as indicated in the response to question 1b above. The bolded changes also include those changes that were provided in a response to a previous NRC request for additional information[2].
There are no additional changes to Table 3 of Attachment A, page A-13 other than those provided in reference 2.

TABLE 1: St. Lucie Unit 2 Reactor Vessel Beltline Material Initial Properties

| MATERIAL LOCATION & (CODE NO.) | HEAT NO | FLUX TYPE/LOT | % Cu | % Ni | INITIAL $RT_{NDT}$ (°F) |
|---|---|---|---|---|---|
| Lower Shell Plate(M-4116-1) | B-8307-2 | NA | 0.06 | 0.57 | +20 |
| Lower Shell Plate(M-4116-2)° | A-3131-1 | NA | 0.07 | 0.6 | +20 |
| Lower Shell Plate(M-4116-3) | A-3131-2 | NA | 0.07 | 0.6 | +20 |
| Inter. Shell Plate (M-605-1) | A-8490-2 | NA | 0.11 | 0.61 | +30 |
| Inter. Shell Plate (M-605-2) | B-3416-2 | NA | 0.13 | 0.62 | +10 |
| Inter. Shell Plate(M-605-3) | A-8490-1 | NA | 0.11 | 0.61 | 0 |
| **Inter. Shell Axial Welds (101-124 A,B,C)** | 83642 | Linde 0091 /3536 | 0.04 | 0.07 | **-56** (Generic)** |
| **Inter. Shell Axial Welds (101-124C)** | **83637** | **Linde 0091 /1122** | 0.04 | 0.07 | -50 |
| Lower Shell Axial (101-142 A,B,C) | 83637 | Linde 0091/1122 | 0.05 | 0.1 | -50 |
| **Inter. to Lower Shell Girth Weld (101-171)** | **3P7317** | **Linde 124/0951** | **0.07** | **0.08** | **-80** |
| **Inter. to Lower Shell Girth Weld (101-171)** | **83637** | **Linde 124/0951** | **0.07** | **0.08** | **-70** |
| **Surveillance Weld represents Weld (101-171)** | **83637** | **Linde 124/0951** | **0.07** | **0.08** | **-50*** |

* This most limiting value applicable for weld 101-171.

**** This conservative generic value used instead of measured data.**

**Changes to original submittal[1] table show in bold**

Table 2: St. Lucie Unit 2 Reactor Vessel Beltline Material EOL $RT_{PTS}$ Values.

| MATERIAL LOCATION & (CODE NO.) | HEAT NO | % Cu | % Ni | Chemistry Factor (CF) | Initial $RT_{NDT}$ | Margin | EOL Fluence n/cm² | $\Delta RT_{PTS}$ | EOL $RT_{PTS}$ | PTS Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| Lower Shell Plate(M-4116-1) | B-8307-2 | 0.06 | 0.57 | 37.0 | +20°F | 34°F | 2.76E19 | 47°F | 101°F | 270°F |
| Lower Shell Plate(M-4116-2) | A-3131-1 | 0.07 | 0.60 | 44.0 | +20°F | 34°F | 2.76E19 | 56°F | 110°F | 270°F |
| Lower Shell Plate(M-4116-3) | A-3131-2 | 0.07 | 0.60 | 44.0 | +20°F | 34°F | 2.76E19 | 56°F | 110°F | 270°F |
| Inter. Shell Plate (M-605-1) | A-8490-2 | 0.11 | 0.61 | 74.15 | +30°F | 34°F | 2.76E19 | 94°F | 158°F | 270°F |
| Inter. Shell Plate (M-605-2) | B-3416-2 | 0.13 | 0.62 | 91.5 | +10°F | 34°F | 2.76E19 | 116°F | 160°F | 270°F |
| Inter. Shell Plate (M-605-3) | A-8490-1 | 0.11 | 0.61 | 74.15 | 0°F | 34°F | 2.76E19 | 94°F | 128°F | 270°F |
| Inter. Shell Axial Welds (101-124 A,B,C) | 83642 Linde 0091 Lot 3536 | 0.04 | 0.07 | 30.7 | -56°F | 66°F | 2.76E19 | 39°F | 49°F | 270°F |
| Inter. Shell Axial Weld (101-124C) | 83637 Linde 0091 Lot 1122 | 0.04 | 0.07 | 30.7 | -50°F | 56°F | 2.76E19 | 39°F | 45°F | 270°F |
| Lower Shell Axial Welds (101-142 A,B,C) | 83637 Linde 0091 Lot 1122 | 0.05 | 0.10 | 37.5 | -50°F | 56°F | 2.76E19 | 48°F | 54°F | 270°F |
| **Inter. to Lower Shell Girth Weld(101-171)** | **83637 Linde 124 Lot 0951** | 0.07 | 0.08 | 41.2 | -70°F | 56°F | 2.76E19 | 52°F | 38°F | 300°F |
| **Inter. to Lower Shell Girth Weld(101-171)** | **3P7317 Linde 124 Lot 0951** | 0.07 | 0.08 | 41.2 | -80°F | 56°F | 2.76E19 | 52°F | 28°F | 300°F |
| **Inter. to Lower Shell** Surveillance weld | **83637 Linde 124 Lot 0951** | 0.07 | 0.08 | 41.2 | -50°F** | 56°F | 2.76E19 | 52°F | 58°F | 300°F |

**** Limiting property for the inter. to lower shell girth weld 101-171. Changes to original submittal[1] table show in bold**

## Linde1092 Heat 305424/ Lot 3889 baseline

CVGRAPH 4.1 Hyperbolic Tangent Curve Printed at 14:12:08 on 03-31-1997
Page 1
Coefficients of Curve 1

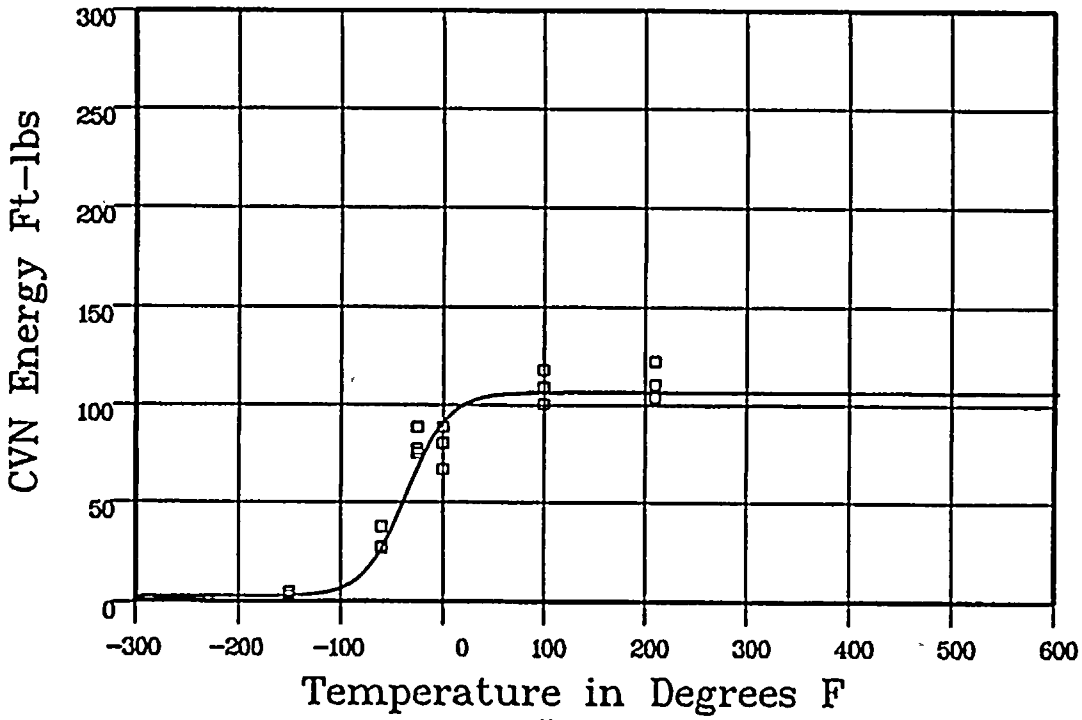
| A = 54.1 | B = 51.09 | C = 40.85 | T0 = -40.31 |
|---|---|---|---|

Equation is: CVN = A + B * [ tanh((T - T0)/C) ]

Upper Shelf Energy: 106 Temp. at 30 ft-lbs: -60.8 Temp. at 50 ft-lbs: -43.5 Lower Shelf Energy: 2.21

Material: WELD Heat Number: 305424/lot3889 Orientation:

Capsule: init Total Fluence: 0




Data Set(s) Plotted
Plant: BV1 Cap: init Material: WELD Ori: Heat #: 305424/lot3889

### Charpy V-Notch Data

| Temperature | Input CVN Energy | Computed CVN Energy | Differential |
|---|---|---|---|
| -150 | 2 | 2.69 | -.69 |
| -150 | 4 | 2.69 | 1.3 |
| -150 | 2.5 | 2.69 | -.19 |
| -60 | 26 | 30.87 | -4.87 |
| -60 | 37 | 30.87 | 6.12 |
| -60 | 27 | 30.87 | -3.87 |
| -25 | 75 | 72.69 | 2.3 |
| -25 | 88 | 72.69 | 15.3 |
| -25 | 77 | 72.69 | 4.3 |

**** Data continued on next page ****

**Figure 1:** Plot of Weld Heat 305424 with Linde 1092 lot 3889 Baseline Charpy Data from the Beaver Valley Unit 1 Surveillance Program.

# Linde1092 Heat 305424/ Lot 3889 baseline

Page 2

Material: WELD     Heat Number: 305424/lot3889     Orientation:

Capsule: init     Total Fluence: 0

## Charpy V-Notch Data (Continued)

| Temperature | Input CVN Energy | Computed CVN Energy | Differential |
|---|---|---|---|
| 0 | 88 | 93.33 | -5.33 |
| 0 | 80 | 93.33 | -13.33 |
| 0 | 66.5 | 93.33 | -26.83 |
| 100 | 117.5 | 105.89 | 11.6 |
| 100 | 100 | 105.89 | -5.89 |
| 100 | 108.5 | 105.89 | 2.6 |
| 210 | 122 | 106 | 15.99 |
| 210 | 110 | 106 | 3.99 |
| 210 | 103.5 | 106 | -2.5 |

SUM of RESIDUALS = 0

**Figure 1 Continued:** Plot of Weld Heat 305424 with Linde 1092 lot 3889 Baseline Charpy Data from the Beaver Valley Unit 1 Surveillance Program.

## Linde Ht 305424/Lot3889 baseline w/ 10F

CVGRAPH 4.1 Hyperbolic Tangent Curve Printed at 14:26:11 on 03-31-1997
Page 1
Coefficients of Curve 1

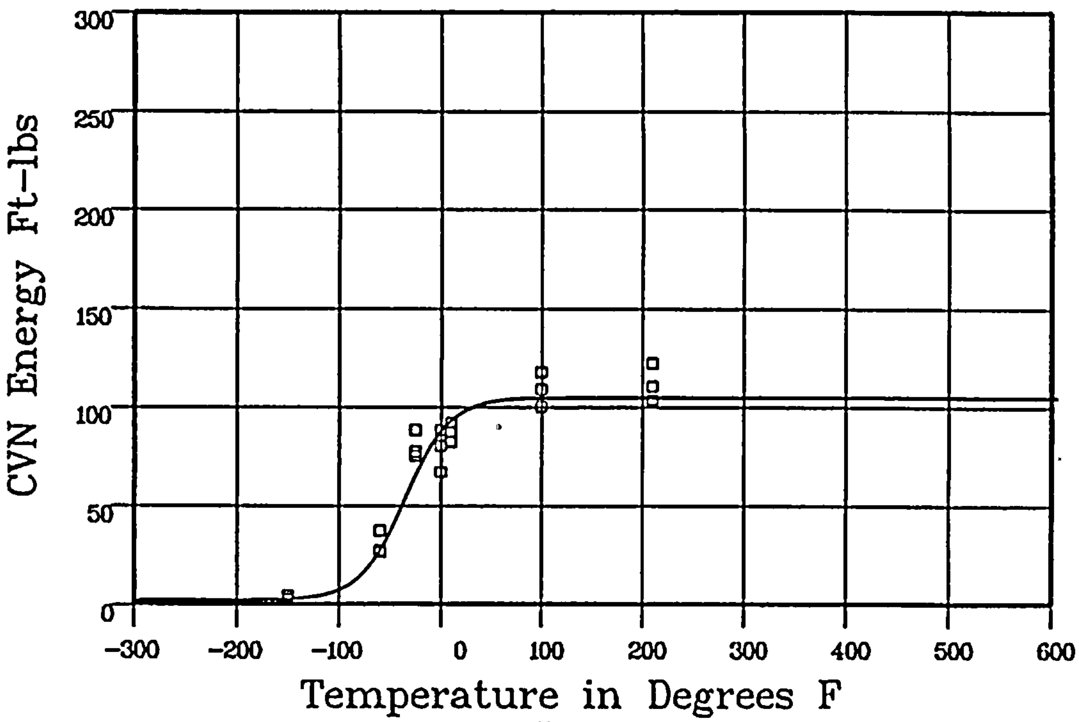
| A = 53.28 | B = 51.23 | C = 43.77 | T0 = -40 |
|---|---|---|---|

Equation is: CVN = A + B * [ tanh((T - T0)/C) ]

Upper Shelf Energy: 104.51 Temp. at 30 ft-lbs: -61.4 Temp. at 50 ft-lbs: -42.8 Lower Shelf Energy: 2.04

Material: WELD Heat Number: 305424/lot3889 Orientation:

Capsule: init Total Fluence: 0




Data Set(s) Plotted
Plant: BV1 Cap: init Material: WELD Ori: Heat #: 305424/lot3889

Charpy V-Notch Data

| Temperature | Input CVN Energy | Computed CVN Energy | Differential |
|---|---|---|---|
| -150 | 2 | 2.71 | -.71 |
| -150 | 4 | 2.71 | 1.28 |
| -150 | 2.5 | 2.71 | -.21 |
| -60 | 26 | 31.37 | -5.37 |
| -60 | 37 | 31.37 | 5.62 |
| -60 | 27 | 31.37 | -4.37 |
| -25 | 75 | 70.18 | 4.81 |
| -25 | 88 | 70.18 | 17.81 |
| -25 | 77 | 70.18 | 6.81 |

**** Data continued on next page ****

**Figure 2:** Plot of Weld Heat 305424 with Linde 1092 lot 3889 Baseline Charpy Data from the Beaver Valley Unit 1 Surveillance Program with 10°F Data.

## Linde Ht 305424/Lot3889 baseline w/ 10F

Page 2

Material: WELD Heat Number: 305424/lot3889 Orientation:

Capsule: init Total Fluence: 0

### Charpy V-Notch Data (Continued)

| Temperature | Input CVN Energy | Computed CVN Energy | Differential |
|---|---|---|---|
| 0 | 88 | 90.31 | -2.31 |
| 0 | 80 | 90.31 | -10.31 |
| 0 | 66.5 | 90.31 | -23.81 |
| 10 | 87 | 95.04 | -8.04 |
| 10 | 82 | 95.04 | -13.04 |
| 10 | 92 | 95.04 | -3.04 |
| 100 | 100 | 104.34 | -4.34 |
| 100 | 108.5 | 104.34 | 4.15 |
| 100 | 117.5 | 104.34 | 13.15 |
| 210 | 103.5 | 104.51 | -1.01 |
| 210 | 122 | 104.51 | 17.48 |
| 210 | 110 | 104.51 | 5.48 |

SUM of RESIDUALS = 0

**Figure 2 Continued:** Plot of Weld Heat 305424 with Linde 1092 lot 3889 Baseline Charpy Data from the Beaver Valley Unit 1 Surveillance Program with 10°F Data.

1. FPL Letter, L-96-112, "St. Lucie Unit 1 and 2 Docket No. 50-335 and 50-389, 10 CFR 50.61 Evaluation of Pressurizer Thermal Shock of Reactor Vessel Beltline Materials", W.H. Bohlke to NRC, May 14, 1996.

2. FPL Letter, L-97-10, "St. Lucie Unit 1 and 2 Docket No. 50-335 and 50-389, Request for Additional Information (RAI) - Response, 10 CFR 50.61 - Pressurized Thermal Shock Evaluation", J. A. Stall to NRC, January 14, 1997.

3. "Duquesne Light Co. Beaver Valley Unit 1 Reactor Vessel Radiation Surveillance Program", Westinghouse Electric Corp., October 1974, WCAP-8457.

4. "Atypical Weld Material In Reactor Pressure Vessel Welds" CE Response to I&E Bulletin 78-12, June 8, 1979, Section VIII, Page 22.