ATTACHMENT 7 to JAFP-08-0067

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant

BWR Vessels and Internals Project
"Integrated Surveillance Program (ISP) Data for FitzPatrick"
(Excerpted from BWRVIP-135, Revision 1)
July, 2008
(Non-proprietary Version)

Proprietary Information
Withhold from Public Disclosure
Pursuant to 10 CFR 2.390(a)(4)

ATTACHMENT 7 to JAFP-08-0067 CONTENTS

1)	**FitzPatrick BWRVIP-135 Excerpt (Non-proprietary Version)** **Cover Page** **BWRVIP-135 Pages 2-22 thru 2-23** **BWRVIP-135 Pages A-18-1 thru A-18-7** **BWRVIP-135 Pages B-13-1 thru B-13-6**	**16 Pages**

Attachments 2, 6, and 8 contain proprietary information as described in 10 CFR 2.390. When separated from these attachments this letter and its contents are non-proprietary.

BWR Vessel and Internals Project

Integrated Surveillance Program (ISP) Data for FitzPatrick

July 2008

Proprietary information is marked with margin bars

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FitzPatrick

Representative Surveillance Materials

The ISP Representative Surveillance Materials for the FitzPatrick vessel target weld and plates are shown in the following table.

Table 2-31
Target Vessel Materials and ISP Representative Materials for FitzPatrick

Target Vessel Materials		ISP Representative Materials
Weld		
Plate		

Summary of Available Surveillance Data: Plate

The representative plate material ------- is contained in the following ISP capsules:

Specific surveillance data related to plate heat ------- are summarized in Appendix A-7. One capsule containing this plate heat has been tested. The Charpy V-notch surveillance results are as follows:

Table 2-32
T_{30} Shift Results for Plate Heat -------

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)

No surveillance-based chemistry factor will be available until a second capsule is tested in 2010.

Conclusions and Recommendations

Because the representative plate material is not the same heat number as the target plate in the FitzPatrick vessel, the utility should use the chemistry factor from the Regulatory Guide 1.99, Rev. 2 tables (Regulatory Position 1.1) to determine the projected ART value for the target vessel plate. Recommended guidelines for evaluation of ISP surveillance data are provided in Section 3 of this Data Source Book.

Although the FitzPatrick surveillance plate ------- is not the representative plate material for the FitzPatrick plant, test data for the heat are available both from tested FitzPatrick surveillance capsules and from Supplemental Surveillance Program (SSP) capsules. The irradiated data for ------- from the -----------------------capsules and SSP Capsules --------------- have been evaluated in Appendix A-18. The surveillance data should be considered when a revised ART is calculated for heat -------. However, scatter in the surveillance data exceeds credibility criteria. Also, the fitted CF-------, based on surveillance data) is higher than the Table CF -------, from the Reg. Guide 1.99 Rev. 2 tables). Therefore, the higher (fitted) CF should be used, along with a full margin term (the reduced margin term normally permitted with a surveillance-based CF should *not* be used because credibility criteria are not satisfied).

Summary of Available Surveillance Data: Weld

The representative weld material -------- is contained in the following ISP capsules:

------- was recently identified as heat -----. Specific surveillance data related to weld heat ------- are presented in Appendix B-12 and the results are summarized below. Two capsules containing weld heat ------- have been tested. The Charpy V-notch surveillance results are as follows:

Table 2-33
T_{30} Shift Results for Weld Heat -------

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)

The results given in Appendix B-12 show a fitted chemistry factor (CF) of -------, as compared to a value of ------- from the chemistry tables in Reg. Guide 1.99, Rev. 2. The maximum scatter in the fitted data is well within the 1-sigma value of 28°F for welds as given in Reg. Guide 1.99, Rev. 2.

Conclusions and Recommendations

Because the representative weld material is not the same heat number as the target weld in the FitzPatrick vessel, the utility should use the chemistry factor from the Regulatory Guide 1.99, Rev. 2 tables to determine the projected ART value for the target vessel weld. However, ISP surveillance data for weld ------- (which has been identified as heat ------------------), provided in Appendix B-13, should be used to evaluate the ART for FitzPatrick vessel weld------. Recommended guidelines for evaluation of ISP surveillance data are provided in Section 3 of this Data Source Book.

A-18 Plate Heat -------

Summary of Available Charpy V-Notch Test Data

The available Charpy V-notch test data sets for plate heat -------- are listed in Table A-18-1. The source documents for the data are provided, and the capsule designation and fluence values are also provided for irradiated data sets.

Table A-18-1
ISP Capsules Containing Plate Heat -------

Capsule	Fluence (E> 1 MeV, 10^{17} n/cm^2)	Reference

The CVN test data for each set taken from the references noted above are presented in Tables A-18-7 through A-18-16. The BWRVIP ISP uses the hyperbolic tangent (tanh) function as a statistical curve-fit tool to model the transition temperature toughness data. Tanh curve plots for each data set have been generated using CVGRAPH, Version 5 [A-18-5] and the plots are provided in Figures A-18-1 through A-18-10.

Best Estimate Chemistry

Table A-18-2 details the best estimate average chemistry values for plate heat ------- surveillance material. Chemical compositions are presented in weight percent. If there are multiple measurements on a single specimen, those are first averaged to yield a single value for that specimen, and then the different specimens are averaged to determine the heat best estimate.

Table A-18-2
Best Estimate Chemistry of Available Data Sets for Plate Heat -------

Cu (wt%)	Ni (wt%)	P (wt%)	S (wt%)	Si (wt%)	Specimen ID	Source

Calculation of Chemistry Factor (CF):

The Chemistry Factor (CF) associated with the best estimate chemistry, as determined from U.S. NRC Regulatory Guide 1.99, Revision 2 [A-18-7], Table 2 (base metal), is:

CF ----------------

Effects of Irradiation

The radiation induced transition temperature shifts for heat ------- are shown in Table A-18-3. The T_{30} [30 ft-lb Transition Temperature], T_{50} [50 ft-lb Transition Temperature], and T_{35mil} [35 mil Lateral Expansion Temperature] have been determined for each Charpy data set, and each irradiated set is compared to the baseline (unirradiated) index temperatures. The change in Upper Shelf Energy (USE) is also shown. The unirradiated and irradiated values are taken from the CVGRAPH fits presented at the end of this sub-appendix (only CVN energy fits are presented).

Comparison of Actual vs. Predicted Embrittlement

A predicted shift in the 30 ft-lb transition temperature (ΔT_{30}) is calculated for each irradiated data set using the Reg. Guide 1.99, Rev. 2, Regulatory Position 1.1 method. Table A-18-4 compares the predicted shift with the measured ΔT_{30} (°F) taken from Table A-18-3.

Decrease in USE

Table A-18-5 shows the percent decrease in upper shelf energy (USE). The measured percent decrease is calculated from the values presented in Table A-18-3.

Table A-18-3
Effect of Irradiation (E>1.0 MeV) on the Notch Toughness Properties of Plate Heat ——

Material Identity	Capsule ID	T_{30}, 30 ft-lb Transition Temperature			T_{50}, 50 ft-lb Transition Temperature			T_{35mil}, 35 mil Lateral Expansion Temperature			CVN Upper Shelf Energy (USE)		
		Unirrad (°F)	Irrad (°F)	ΔT_{30} (°F)	Unirrad (°F)	Irrad (°F)	ΔT_{50} (°F)	Unirrad (°F)	Irrad (°F)	ΔT_{35mil} (°F)	Unirrad (ft-lb)	Irrad (ft-lb)	Change (ft-lb)

Table A-18-4
Comparison of Actual Versus Predicted Embrittlement for Plate Heat ——

Capsule Identity	Material	Fluence (x10^{18} n/cm^2)	Fluence Factor	Measured Shift[1] °F	RG 1.99 Rev. 2 Predicted Shift[2] °F	RG 1.99 Rev. 2 Predicted Shift+Margin[2, 3] °F

Notes:

1. See Table A-18-3, ΔT_{30}.
2. Predicted shift = CF × FF, where CF is a Chemistry Factor taken from tables from USNRC Reg. Guide 1.99, Rev. 2, based on each material's Cu/Ni content, and FF is Fluence Factor, $f^{0.28-0.10 \log f}$, where f = fluence (10^{19} n/cm^2, E > 1.0 MeV).
3. Margin = $2\sqrt{(\sigma_i^2 + \sigma_\Delta^2)}$, where σ_i = the standard deviation on initial RT_{NDT} (which is taken to be 0°F), and σ_Δ is the standard deviation on ΔRT_{NDT} (28°F for welds and 17°F for base materials, except that σ_Δ need not exceed 0.50 times the mean value of ΔRT_{NDT}). Thus, margin is defined as 34°F for plate materials and 56°F for weld materials, or margin equals shift (whichever is less), per Reg. Guide 1.99, Rev. 2.

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Table A-18-5
Percent Decrease in Upper Shelf Energy (USE) for Plate Heat ——

Capsule Identity	Material	Fluence ($x10^{18}$ n/cm^2)	Cu Content (wt%)	Measured Decrease in USE[1] (%)

Notes:

1. See Table A-18-3, (Change in USE)/(Unirradiated USE).

Credibility of Surveillance Data

The credibility of the surveillance data is determined according to the guidance of Regulatory Guide 1.99, Rev. 2 and 10 CFR 50.61, as supplemented by the NRC staff [A-18-8]. The following evaluation is based on the available surveillance data for irradiated plate heat -------. The applicability of this evaluation to a particular BWR plant must be confirmed on a plant-by-plant basis to verify there are no plant-specific exceptions to the following evaluation.

Per Regulatory Guide 1.99, Revision 2 and 10 CFR 50.61, there are 5 criteria for the credibility assessment.

Criterion 1: Materials in the capsules should be those judged most likely to be controlling with regard to radiation embrittlement.

In order to satisfy this criterion, the representative surveillance material heat number must match the material in the vessel.

Criterion 2: Scatter in the plots of Charpy energy versus temperature for the irradiated and unirradiated conditions should be small enough to permit the determination of the 30 ft-lb temperature and upper shelf energy unambiguously.

Plots of Charpy energy versus temperature for the unirradiated and irradiated condition are presented in Figures A-18-1 through A-18-10. Based on engineering judgment, the scatter in these plots is small enough to permit the determination of the 30 ft-lb temperature and the upper shelf energy. Hence, this criterion is met.

Criterion 3: When there are two or more sets of surveillance data from one reactor, the scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 normally should be less than 17°F for plates. Even if the fluence range is large (two or more orders of magnitude), the scatter should not exceed twice that value. Even if the data fail this criterion for use in shift calculations, they may be credible for determining decrease in upper shelf energy if the upper shelf can be clearly determined, following the definition given in ASTM E185-82 [A-18-9].

For plate material -------, there are surveillance capsule data sets currently available. The functional form of the least squares fit method as described in Regulatory Position 2.1 is utilized to determine a best-fit line for this data and to determine if the scatter of these ΔRT_{NDT} values about this line is less than 17°F for plates. Figure A-18-11 presents the best-fit line as described in Regulatory Position 2.1 utilizing the shift prediction routine from CVGRAPH, Version 5.0.2.

The scatter of ΔRT_{NDT} values about the functional form of the best-fit line drawn as described in Regulatory Position 2.1 is presented in Table A-18-6.

Table A-18-6
Best Fit Evaluation for Surveillance Plate Heat -------

Material	Fitted CF (°F)	Capsule	FF	Measured ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)	<17°F (Base Metal) <28°F (Weld metal)

Note:

1. --------
   ----
2. -------

Table A-18-6 indicates that the scatter is *not* within acceptable range for credible surveillance data. Therefore, plate heat ------- *does not* meet this criterion.

Criterion 4: The irradiation temperature of the Charpy specimens in the capsule should match the vessel wall temperature at the cladding/base metal interface within + / - 25°F.

BWRVIP-78 [A-18-11] established the similarity of BWR plant environments in the BWR fleet. The annulus between the wall and the core shroud in the region of the surveillance capsules contains a mix of water returning from the core and feedwater. Depending on feedwater temperature, this annulus region is between 525°F and 535°F. This location of specimens with respect to the reactor vessel beltline is designed so that the reactor vessel wall and the specimens experience equivalent operating conditions such that the temperature will not differ by more than 25°F. Any plant-specific exceptions to this generic analysis should be evaluated.

Criterion 5: The surveillance data for the correlation monitor material in the capsule should fall within the scatter band of the database for that material.

Few ISP capsules contain correlation monitor material. Generally, this criterion is not applicable.

For plate heat -------, the applicable credibility criteria are *not* satisfied. However, because the fitted CF is higher than the CF from the Reg. Guide 1.99 Rev. 2 tables, this higher CF must be used, but the reduced margin term normally permitted with a surveillance-based CF should *not* be used.

B-13 Weld Heat: ------------------

Summary of Available Charpy V-Notch Test Data

The available Charpy V-notch test data sets for weld heat ------- are listed in Table B-13-1. The source documents for the data are provided, and the capsule designations and fluence values are also provided for irradiated data sets.

Table B-13-1
ISP Capsules Containing Weld Heat -------

Capsule	Fluence (E> 1 MeV, 10^{17} n/cm^2)	Reference

------- has been identified as a tandem submerged arc weld fabricated with weld wire Heats ----- and ----- and ---------------------- [Reference B-13-9].

The CVN test data for each set taken from the references noted above are presented in Tables B-13-7 through B-13-9. The BWRVIP ISP uses the hyperbolic tangent (tanh) function as a statistical curve-fit tool to model the transition temperature toughness data. Tanh curve plots for each data set have been generated using CVGRAPH, Version 5 [Reference B-13-3] and the plots are provided in Figures B-13-1 through B-13-3.

Best Estimate Chemistry

Table B-13-2 details the best estimate average chemistry values for weld heat --------- surveillance material. Chemical compositions are presented in weight percent. If there are multiple measurements on a single specimen, those are first averaged to yield a single value for that specimen, and then the different specimens are averaged to determine the heat best estimate.

Table B-13-2
Best Estimate Chemistry of Available Data Sets for Weld Heat -------

Cu (wt%)	Ni (wt%)	P (wt%)	S (wt%)	Si (wt%)	Specimen ID	Source

Calculation of Chemistry Factor (CF):

The Chemistry Factor (CF) associated with the best estimate chemistry, as determined from U.S. NRC Regulatory Guide 1.99, Revision 2 [Reference B-13-5], Table 1 (weld metal), is:

CF -------------------

Effects of Irradiation

The radiation induced transition temperature shifts for heat ------- are shown in Table B-13-3. The T_{30} [30 ft-lb Transition Temperature], T_{50} [50 ft-lb Transition Temperature], and T_{35mil} [35 mil Lateral Expansion Temperature] have been determined for each Charpy data set, and each irradiated set is compared to the baseline (unirradiated) index temperatures. The change in Upper Shelf Energy (USE) is also shown. The unirradiated and irradiated values are taken from the CVGRAPH fits presented at the back of this sub-appendix (only CVN energy fits are presented).

Comparison of Actual vs. Predicted Embrittlement

A predicted shift in the 30 ft-lb transition temperature (ΔT_{30}) is calculated for each irradiated data set using the Reg. Guide 1.99, Rev. 2, Regulatory Position 1.1 method. Table B-13-4 compares the predicted shift with the measured ΔT_{30} (°F) taken from Table B-13-3.

Decrease in USE

Table B-13-5 shows the percent decrease in upper shelf energy (USE). The measured percent decrease is calculated from the values presented in Table B-13-3.

Table B-13-3
Effect of Irradiation (E>1.0 MeV) on the Notch Toughness Properties of Weld Heat ——

Material Identity	Capsule ID	T_{30}, 30 ft-lb Transition Temperature			T_{50}, 50 ft-lb Transition Temperature			T_{35mil}, 35 mil Lateral Expansion Temperature			CVN Upper Shelf Energy (USE)		
		Unirrad (°F)	Irrad (°F)	ΔT_{30} (°F)	Unirrad (°F)	Irrad (°F)	ΔT_{50} (°F)	Unirrad (°F)	Irrad (°F)	ΔT_{35mil} (°F)	Unirrad (ft-lb)	Irrad (ft-lb)	Change (ft-lb)

Table B-13-4
Comparison of Actual Versus Predicted Embrittlement for Weld Heat ——

Capsule Identity	Material	Fluence ($x10^{18}$ n/cm^2)	Measured Shift1 °F	RG 1.99 Rev. 2 Predicted Shift² °F	RG 1.99 Rev. 2 Predicted Shift+Margin²˒³ °F

Notes:

1. See Table B-13-3, ΔT_{30}.
2. Predicted shift = CF × FF, where CF is a Chemistry Factor taken from tables from USNRC Reg. Guide 1.99, Rev. 2, based on each material's Cu/Ni content, and FF is Fluence Factor, $f^{0.28-0.10 \log f}$, where f = fluence (10^{19} n/cm^2, E > 1.0 MeV).
3. Margin = $2\sqrt{(\sigma_i^2 + \sigma_\Delta^2)}$, where σ_i = the standard deviation on initial RT_{NDT} (which is taken to be 0°F), and σ_Δ is the standard deviation on ΔRT_{NDT} (28°F for welds and 17°F for base materials, except that σ_Δ need not exceed 0.50 times the mean value of ΔRT_{NDT}). Thus, margin is defined as 34°F for weld materials and 56°F for weld materials, or margin equals shift (whichever is less), per Reg. Guide 1.99, Rev. 2.

Table B-13-5
Percent Decrease in Upper Shelf Energy (USE) for Weld Heat ------

Capsule Identity	Material	Fluence ($x10^{18}$ n/cm^2)	Cu Content (wt%)	Measured Decrease in USE[1] (%)

Notes:

1. See Table B-13-3, (Change in USE)/(Unirradiated USE).

Credibility of Surveillance Data

The credibility of the surveillance data is determined according to the guidance of Regulatory Guide 1.99, Rev. 2 and 10 CFR 50.61, as supplemented by the NRC staff [Reference B-13-6] The following evaluation is based on the available surveillance data for irradiated weld heat --------. The applicability of this evaluation to a particular BWR plant must be confirmed on a plant-by-plant basis to verify there are no plant-specific exceptions to the following evaluation.

Per Regulatory Guide 1.99, Revision 2 and 10 CFR 50.61, there are 5 criteria for the credibility assessment.

Criterion 1: Materials in the capsules should be those judged most likely to be controlling with regard to radiation embrittlement.

> In order to satisfy this criterion, the representative surveillance material heat number must match the material in the vessel.

Criterion 2: Scatter in the plots of Charpy energy versus temperature for the irradiated and unirradiated conditions should be small enough to permit the determination of the 30 ft-lb temperature and upper shelf energy unambiguously.

> Plots of Charpy energy versus temperature for the unirradiated and irradiated condition are presented in this sub-appendix. Based on engineering judgment, the scatter in these plots is small enough to permit the determination of the 30 ft-lb temperature and the upper shelf energy. Hence, this criterion is met.

Criterion 3: When there are two or more sets of surveillance data from one reactor, the scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 normally should be less than 28°F for welds. Even if the fluence range is large (two or more orders of magnitude), the scatter should not exceed twice that value. Even if the data fail this criterion for use in shift calculations, they may be credible for determining decrease in upper shelf energy if the upper shelf can be clearly determined, following the definition given in ASTM E185-82 [Reference B-13-7].

> For weld material -------, there are surveillance capsule data sets currently available. The functional form of the least squares fit method as described in Regulatory Position 2.1 is utilized to determine a best-fit line for this data and to determine if the scatter of these ΔRT_{NDT} values about this line is less than 28°F for welds. Figure B-13-4 presents the best-fit line as described in Regulatory Position 2.1 utilizing the shift prediction routine from CVGRAPH, Version 5.0.2.
>
> The scatter of ΔRT_{NDT} values about the functional form of the best-fit line drawn as described in Regulatory Position 2.1 is presented in Table B-13-6.

Table B-13-6
Best Fit Evaluation for Surveillance Weld Heat -------

Material	Fitted CF (°F)	Capsule	FF	Measured ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)	<17°F (Base Metal) <28°F (Weld metal)

Table B-13-6 indicates that the scatter is within acceptable range for credible surveillance data. Therefore, weld heat ------- meets this criterion.

Criterion 4: The irradiation temperature of the Charpy specimens in the capsule should match the vessel wall temperature at the cladding/base metal interface within +/- 25°F.

BWRVIP-78 [Reference B-13-8] established the similarity of BWR plant environments in the BWR fleet. The annulus between the wall and the core shroud in the region of the surveillance capsules contains a mix of water returning from the core and feedwater. Depending on feedwater temperature, this annulus region is between 525°F and 535°F. This location of specimens with respect to the reactor vessel beltline is designed so that the reactor vessel wall and the specimens experience equivalent operating conditions such that the temperature will not differ by more than 25°F. Any plant-specific exceptions to this generic analysis should be evaluated.

Criterion 5: The surveillance data for the correlation monitor material in the capsule should fall within the scatter band of the database for that material.

Few ISP capsules contain correlation monitor material. Generally, this criterion is not applicable.

For weld heat -------, these criteria are satisfied (or not applicable). The surveillance data are nominally credible because the scatter criterion is met. Prior to application of the data, a plant should verify that no plant-specific exceptions to these criteria exist.

Table B-13-7
Unirradiated Charpy V-Notch Results for Surveillance Weld -------

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
1				
2				
3				
4				
5				
6				
7				
8				
9				

* Percent shear not determined.