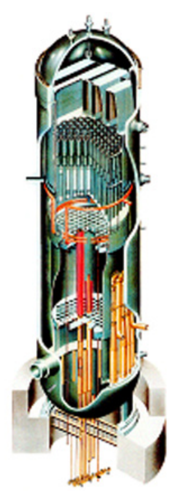
ATTACHMENT 7

BWRVIP-135, Revision 4: BWR Vessel Internals Project Integrated Surveillance Program (ISP) Data Source Book and Plant Evaluations (Non-Proprietary Version)

2021 TECHNICAL REPORT

BWRVIP-135, Revision 4: BWR Vessel and Internals Project

Integrated Surveillance Program (ISP) Data Source Book and Plant Evaluations



LICENSED MATERIAL

PREPARED UNDER THE NUCLEAR QA PROGRAM

LaSalle 1

Representative Surveillance Materials

The ISP Representative Surveillance Materials for the LaSalle 1 vessel target weld and plates are shown in the following table.

Table 2-52
Target Vessel Materials and ISP Representative Materials for LaSalle 1

Target Vessel Materials		ISP Representative Materials
Weld	1P3571	1P3571
Plate	C5978-2	C6345-1

Summary of Available Surveillance Data: Plate

The representative plate material C6345-1 is contained in the following ISP capsules:

LaSalle 1 Capsules

Specific surveillance data related to plate heat C6345-1 are summarized in Appendix A-7. Two capsules containing this plate heat have been tested. The Charpy V-notch surveillance results are as follows:

Table 2-53
T_{30} Shift Results for Plate Heat C6345-1

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)
LaSalle 1 300°	0.14	0.54	1.14	28.2
LaSalle 1 120°			3.66	32.7

The results given in Appendix A-7 show a fitted chemistry factor (CF) of [[(E)]], as compared to a value of 97.3°F from the chemistry tables in Reg. Guide 1.99, Rev. 2. The maximum scatter in the fitted data is within the 1-sigma value of 17°F for plates as given in Reg. Guide 1.99, Rev. 2.

Conclusions and Recommendations

Because the representative plate material is not the same heat number as the target plate in the LaSalle 1 vessel, the utility should use the chemistry factor from the Reg. Guide 1.99, Rev. 2 tables (Regulatory Position 1.1) to determine the projected ART value for the target vessel plate. However, surveillance plate heat C6345-1 is a plate heat in the LaSalle 1 vessel beltline; therefore, the surveillance data reported in Appendix A-7 should be considered in the evaluation of that vessel plate. Because there are two irradiated data sets for this plate that fall within the 1-

sigma scatter band, the ISP surveillance data should be used to revise the projected ART value for vessel plate heat C6345-1, with a reduced margin term (Regulatory Position 2.1). Recommended guidelines for evaluation of ISP surveillance data are provided in Section 3 of this Data Source Book.

Summary of Available Surveillance Data: Weld

The representative weld material 1P3571 is contained in the following ISP capsules:

LaSalle 1 Capsules

Specific surveillance data related to weld heat 1P3571 are presented in Appendix B-8, and the results are summarized below. Two capsules containing weld heat 1P3571 have been tested. The Charpy V-notch surveillance results are as follows:

Table 2-54
T_{30} Shift Results for Weld Heat 1P3571

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)
LaSalle 1 300°	0.21	0.75	1.14	36.6
LaSalle 1 120°			3.66	100.5

The results given in Appendix B-8 show a fitted chemistry factor (CF) of [[(E)]], compared to a value of 188.75°F 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 the same heat number as the target weld in the LaSalle 1 vessel, and because there are two valid irradiated data sets for this weld, the ISP surveillance data in Appendix B-8 should be used to revise the projected ART value for the target vessel weld. Recommended guidelines for use of ISP surveillance data are provided in Section 3 of this Data Source Book.

LaSalle 2

Representative Surveillance Materials

The ISP Representative Surveillance Materials for the LaSalle 2 vessel target weld and plates are shown in the following table.

Table 2-55
Target Vessel Materials and ISP Representative Materials for LaSalle 2

Target Vessel Materials		ISP Representative Materials
Weld	3P4966	402K9171, 411L3071
Plate	C9404-2	C3054-2

Summary of Available Surveillance Data: Plate

The representative plate material C3054-2 is contained in the following ISP capsules:

River Bend Capsules

Specific surveillance data related to plate heat C3054-2 are summarized in Appendix A-11. One capsule containing this plate heat has been tested. The Charpy V-notch surveillance results are as follows:

Table 2-56
T_{30} Shift Results for Plate Heat C3054-2

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)
River Bend 183°	0.08	0.67	11.6	44.0

No surveillance-based chemistry factor will be available until a second capsule is tested (see reference [1] for capsule test schedule).

Conclusions and Recommendations

Because the representative plate material is not the same heat number as the target plate in the LaSalle 2 vessel, the utility should use the chemistry factor from the Reg. 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.

Summary of Available Surveillance Data: Weld

The representative weld material 402K9171, 411L3071 is contained in the following ISP capsules:

Susquehanna 1 Capsules

Specific surveillance data related to weld heat 402K9171, 411L3071 are presented in Appendix B-14, and the results are summarized below. Two capsules containing weld heat 402K9171, 411L3071 have been tested. The Charpy V-notch surveillance results are as follows:

Table 2-57
T_{30} Shift Results for Weld Heat 402K9171, 411L3071

Capsule	Cu (wt%)	Ni (wt%)	Fluence (10^{17} n/cm^2, E > 1 MeV)	ΔT_{30} (°F)
Susquehanna 1 30°	0.02	0.95	1.64	20.4
Susquehanna 1 120°			5.75	42.9

The results given in Appendix B-14 show a fitted chemistry factor (CF) of [[(E)]], as compared to a value of 27.0°F from the chemistry tables in Reg. Guide 1.99, Rev. 2. The maximum scatter in the fitted data is [[(E)]], which 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 LaSalle 2 vessel, the utility should use the chemistry factor from the Reg. Guide 1.99, Rev. 2 tables to determine the projected ART value for the target vessel weld. Recommended guidelines for evaluation of ISP surveillance data are provided in Section 3 of this Data Source Book.

A-7 Plate Heat: C6345-1

Summary of Available Charpy V-Notch Test Data

The available Charpy V-notch test data sets for plate heat C6345-1 are listed in Table A-7-1. The source documents for the data are provided, and the capsule designations and fluence values are also provided for irradiated data sets.

Table A-7-1
ISP Capsules Containing Plate Heat C6345-1

Capsule	Fluence (E> 1 MeV, 10^{17} n/cm^2)	Reference
Unirradiated Baseline Data	—	Reference A-7-1 and A-7-2
LaSalle 1 300°	1.14	Reference A-7-9
LaSalle 1 120°	3.66	Reference A-7-9

The CVN test data for each set taken from the references noted above are presented in Tables A-7-7 through A-7-9. 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 Charpy energy data set have been generated using CVGRAPH, Version 5 [A-7-3] and the plots are provided in Figures A-7-1 through A-7-3.

Best Estimate Chemistry

Table A-7-2 details the best estimate average chemistry values for plate heat C6345-1 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 best estimate.

Table A-7-2
Best Estimate Chemistry of Available Data Sets for Plate Heat C6345-1

Cu (wt%)	Ni (wt%)	P (wt%)	S (wt%)	Si (wt%)	Specimen ID	Source
0.14	0.56	0.015	—	—	B-417	Reference A-7-2
0.14	0.47	—	—	—	B-417	Reference A-7-1
0.14	**0.515**	**0.015**	—	—	**Average B-417**	—
0.12	0.49	0.015	—	—	B-433	Reference A-7-2
0.14	0.57	—	—	—	B-433	Reference A-7-1
0.13	**0.53**	**0.015**	—	—	**Average B-433**	—
0.11	0.50	0.016	—	—	B-435	Reference A-7-2
0.18	0.60	—	—	—	B-435	Reference A-7-1
0.145	**0.55**	**0.016**	—	—	**Average B-435**	—
0.15	**0.56**	—	—	—	**B-411**	Reference A-7-2
0.13	**0.51**	—	—	—	**B-4J1**	Reference A-7-2
0.15	**0.57**	—	—	—	**B-436**	Reference A-7-2
0.15	**0.57**	—	—	—	**B-437**	Reference A-7-2
0.13	**0.50**	—	—	—	**B-4J5**	Reference A-7-2
0.13	0.50	—	—	—	B-4JC	Reference A-7-2
0.14	0.54	—	—	—	B-4JC	Reference A-7-1
0.135	**0.52**	—	—	—	**Average B-4JC**	—
0.15	0.58	—	—	—	B-4J6	Reference A-7-2
0.15	0.56	—	—	—	B-4J6	Reference A-7-1
0.15	**0.57**	—	—	—	**Average B-4J6**	—
0.14	**0.56**	—	—	—	**B-43B**	Reference A-7-2
0.13	**0.51**	—	—	—	**B-413**	Reference A-7-2
0.14	**0.55**	**0.011**	—	—	**CE**	Reference A-7-2
0.14	**0.54**	**0.014**	—	—	**←Best Estimate Average**	

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-7-4], Table 2 (base metal), is:

$CF_{(C6345-1)}$ = 97.3°F

Effects of Irradiation

The radiation induced transition temperature shifts for heat C6345-1 are shown in Table A-7-3. The T_{30} [30 ft-lb Transition Temperature], T_{50} [50 ft-lb Transition Temperature], and T_{35mil} [35 mil Lateral Expansion Temperature] index temperatures 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 A-7-4 compares the predicted shift with the measured ΔT_{30} (°F) taken from Table A-7-3.

Comparison of Actual vs. Predicted Decrease in USE

Table A-7-5 compares the actual percent decrease in upper shelf energy (USE) to the predicted decrease. The predicted decrease is estimated from Reg. Guide 1.99, Rev. 2, Figure 2; the measured percent decrease is calculated from the values presented in Table A-7-3.

Table A-7-3
Effect of Irradiation (E>1.0 MeV) on the Notch Toughness Properties of Plate Heat C6345-1

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)
LS1 C6345-1	300°	-37.0	-8.8	28.2	-15.7	20.2	35.9	-17.6	4.7	22.3	152.5	140.8	-11.7
	120°	-37.0	-4.3	32.7	-15.7	29.6	45.3	-17.6	9.5	27.1	152.5	157.4	4.9

Table A-7-4
Comparison of Actual Versus Predicted Embrittlement for Plate Heat C6345-1

Capsule Identity	Material	Fluence ($x10^{17}$ n/cm^2)	Measured Shift[1] °F	RG 1.99 Rev. 2 Predicted Shift[2] °F	RG 1.99 Rev. 2 Predicted Shift+Margin[2, 3] °F
LS1 300°	Plate Heat C6345-1 in LaSalle 1	1.14	28.2	11.7	23.3
LS1 120°		3.66	32.7	24.0	47.9

Notes:

1. See Table A-7-3, ΔT_{30}.
2. Predicted shift = CF × FF, where CF is a Chemistry Factor taken from tables from 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 0ºF), and σ_Δ is the standard deviation on ΔRT_{NDT} (28ºF for welds and 17ºF 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.

Table A-7-5
Comparison of Actual Versus Predicted Percent Decrease in Upper Shelf Energy (USE) for Plate Heat C6345-1

Capsule Identity	Material	Fluence ($x10^{17}$ n/cm^2)	Cu Content (wt%)	Measured Decrease in USE[1] (%)	RG 1.99 Rev. 2 Predicted Decrease in USE[2] (%)
LS1 300°	Plate Heat C6345-1 in LaSalle 1	1.14	0.14	7.7	8.0
LS1 120°		3.66		--[3]	10.5

Notes:

1. See Table A-7-3, (Change in USE)/(Unirradiated USE).
2. Calculated using equations in Regulatory Guide 1.162 [A-7-5] that accurately model the Charpy upper shelf energy decrease curves in Reg. Guide 1.99, Revision 2.
3. Value less than zero.

Credibility of Surveillance Data

The credibility of the surveillance data is determined according to the guidance of Reg. Guide 1.99, Rev. 2 and 10 CFR 50.61, as supplemented by the NRC staff [A-7-6].

The following evaluation is based on the available surveillance data for irradiated plate heat C6345-1. 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 Reg. Guide 1.99, Rev. 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 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-7-7].

> For plate material C6345-1, there are 2 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-7-4 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 A-7-6.

Table A-7-6
Best Fit Evaluation for Surveillance Plate Heat C6345-1

Material	Fitted CF (°F)	Capsule	FF	Measured ΔRT_{NDT} (30 ft-lb)[1] (°F)	Best Fit ΔRT_{NDT}[2] (°F)	Scatter of ΔRT_{NDT}[3] (°F)	<17°F (Base Metal) <28°F (Weld metal)
C6345-1	[[(E)]]	300	0.120	28.2	[[(E)]]	[[(E)]]	Yes
		120	0.246	32.7	[[(E)]]	[[(E)]]	Yes

1. See Table A-7-3, ΔT_{30}.
2. Best Fit shift = Fitted CF × FF, where Fitted CF is taken from Figure A-7-4 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. Scatter = Measured ΔRT_{NDT} – Best Fit ΔRT_{NDT}

Table A-7-6 shows that the scatter is within acceptable range for credible surveillance data. Therefore, plate heat C6345-1 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 [A-7-8] 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 plate heat C6345-1, 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 A-7-7
Unirradiated Charpy V-Notch Results for Surveillance Plate C6345-1 (LT)

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
1	-80	8.0	4.0	0
2	-80	6.0	4.0	0
3	-40	29.0	21.0	5
4	-40	15.0	13.0	0
5	-40	23.0	16.0	1
6	10	109.0	76.0	50
7	10	88.0	58.0	35
8	10	77.0	56.0	35
9	40	103.0	68.0	45
10	40	96.0	65.0	40
11	40	122.0	77.0	60
12	110	147.0	84.0	100
13	110	147.0	82.0	100
14	160	151.0	87.0	100
15	160	165.0	94.0	100

Table A-7-8
Charpy V-Notch Results for C6345-1 (LT) in LS1 300° Capsule

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
411	0	17.5	21.5	15
413	40	90.5	75.5	38
417	-40	18.5	13.5	8
433	-20	19.0	15.5	14
435	-80	6.0	8.0	4
436	300	138.5	95.0	100
437	80	98.0	78.0	58
43B	30	69.0	61.0	28
4J1	120	129.5	82.0	81
4J5	10	50.0	42.0	25
4J6	200	140.0	84.0	100
4JC	60	58.0	51.0	35

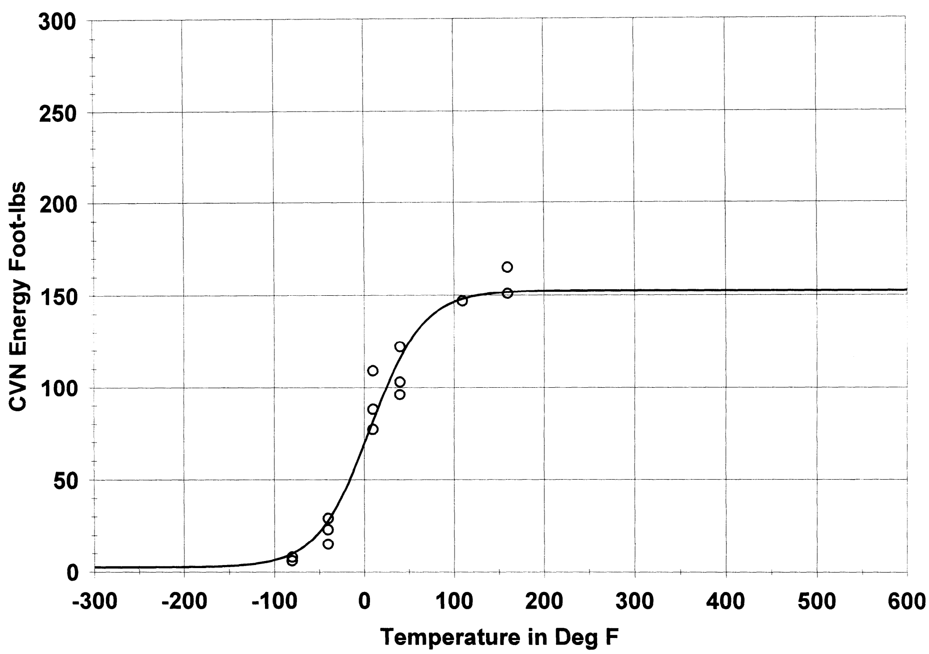
Table A-7-9
Charpy V-Notch Results for C6345-1 (LT) in LS1 120° Capsule

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
43A	-115.6	3.62	6	2.7
43J	-21.6	16.44	14	12.7
43C	2.5	55.55	48.5	28.3
434	27.5	71.86	56	37.6
43M	40.6	20.89	21	32.8
43K	68.5	96.81	80.5	63.2
4JA	85.6	47.8	42	41.6
43T	100	134.09	79.5	76.6
43D	124	128.45	87.5	91.8
415	204.3	152.64	96	100
412	269.4	161.09	95	100
43Y	367.9	158.46	84.5	100

Tanh Curve Fits of CVN Test Data for Plate Heat C6345-1

PLATE HEAT C6345-1 (LS1)

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 09/09/2002 08:30 AM
Page 1
Coefficients of Curve 1
A = 77.5 B = 75. C = 58.89 T0 = 6.92 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=152.5(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=-37.0 Deg F Temp@50 ft-lbs=-15.7 Deg F
Plant: LaSalle 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: UNIRRA Fluence: 0.0 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-80.00	8.00	9.95	-1.95
-80.00	6.00	9.95	-3.95
-40.00	29.00	27.83	1.17
-40.00	15.00	27.83	-12.83
-40.00	23.00	27.83	-4.83
10.00	109.00	81.42	27.58
10.00	88.00	81.42	6.58
10.00	77.00	81.42	-4.42
40.00	103.00	115.69	-12.69
40.00	96.00	115.69	-19.69
40.00	122.00	115.69	6.31

Figure A-7-1
Charpy Energy Data for Plate C6345-1 (LT) Unirradiated

PLATE HEAT C6345-1 (LS1)

Page 2
Plant: LaSalle 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: UNIRRA Fluence: 0.0 n/cm^2

Charpy V-Notch Data

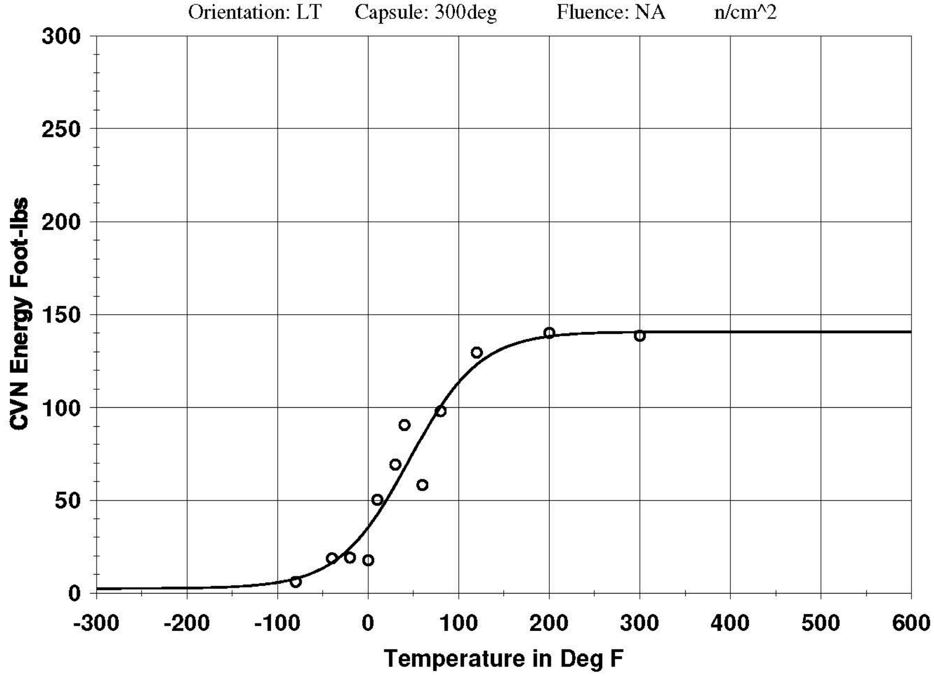
Temperature	Input CVN	Computed CVN	Differential
110.00	147.00	148.11	-1.11
110.00	147.00	148.11	-1.11
160.00	151.00	151.68	-.68
160.00	165.00	151.68	13.32

Correlation Coefficient = .980

Figure A-7-1 (continued)
Charpy Energy Data for Plate C6345-1 (LT) Unirradiated

Irradiated Plate Heat C6345-1 (LS1-300)

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 07/05/2011 01:56 PM
Page 1
Coefficients of Curve 1
A = 71.65 B = 69.15 C = 77.69 T0 = 45.27 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=140.8(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=-8.8 Deg F Temp@50 ft-lbs=20.2 Deg F
Plant: LASALLE 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: 300deg Fluence: NA n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
.00	17.50	35.37	-17.87
40.00	90.50	66.96	23.54
-40.00	18.50	16.35	2.15
-20.00	19.00	24.22	-5.22
-80.00	6.00	7.79	-1.79
300.00	138.50	140.60	-2.10
80.00	98.00	100.66	-2.66
30.00	69.00	58.23	10.77
120.00	129.50	123.18	6.32

Figure A-7-2
Charpy Energy Data for Plate C6345-1 (LT) in LS1 300° Capsule

Irradiated Plate Heat C6345-1 (LS1-300)

Page 2
Plant: LASALLE 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: 300deg Fluence: NA n/cm^2

Charpy V-Notch Data

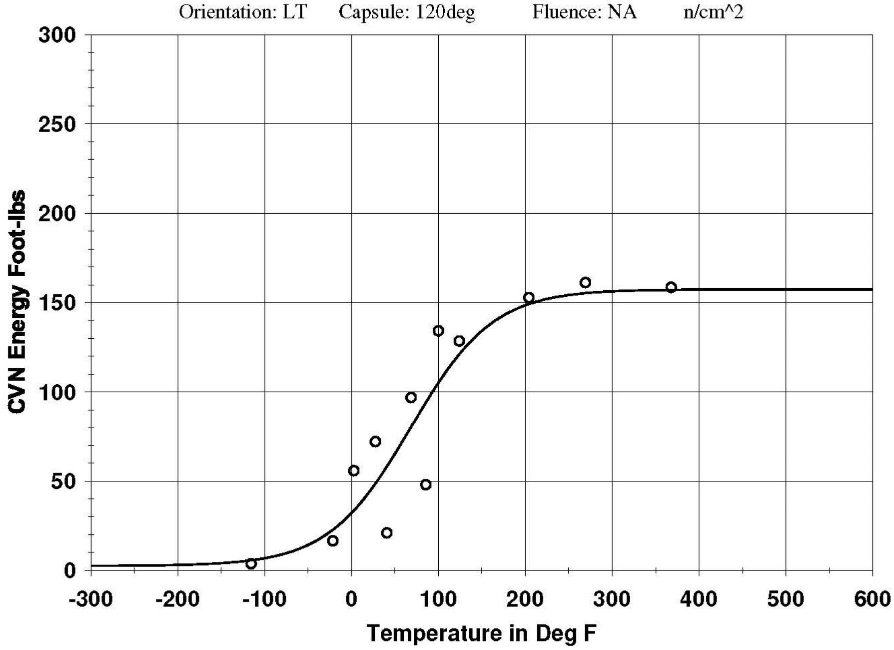
Temperature	Input CVN	Computed CVN	Differential
10.00	50.00	42.25	7.75
200.00	140.00	138.27	1.73
60.00	58.00	84.61	-26.61

Correlation Coefficient = .965

Figure A-7-2 (continued)
Charpy Energy Data for Plate C6345-1 (LT) in LS1 300° Capsule

Irradiated Plate Heat C6345-1 (LS1-120)

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 06/27/2011 07:19 PM
Page 1
Coefficients of Curve 1
A = 79.95 B = 77.45 C = 94.37 T0 = 68.01 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=157.4(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=-4.3 Deg F Temp@50 ft-lbs=29.6 Deg F
Plant: LASALLE 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: 120deg Fluence: NA n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-115.60	3.62	5.60	-1.98
-21.60	16.44	22.67	-6.23
2.50	55.55	33.43	22.12
27.50	71.86	48.61	23.25
40.60	20.89	58.07	-37.18
68.50	96.81	80.35	16.46
85.60	47.80	94.22	-46.42
100.00	134.09	105.24	28.85
124.00	128.45	121.17	7.28

Figure A-7-3
Charpy Energy Data for Plate C6345-1 (LT) in LS1 120° Capsule

Irradiated Plate Heat C6345-1 (LS1-120)

Page 2
Plant: LASALLE 1 Material: SA533B1 Heat: C6345-1
Orientation: LT Capsule: 120deg Fluence: NA n/cm^2

Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
204.30	152.64	149.23	3.41
269.40	161.09	155.26	5.83
367.90	158.46	157.13	1.33

Correlation Coefficient = .921

Figure A-7-3 (continued)
Charpy Energy Data for Plate C6345-1 (LT) in LS1 120° Capsule

[[

(E)]]

Figure A-7-4
Fitted Surveillance Results for LaSalle Unit 1 Plate Heat C6345-1

References

A-7-1. Letter from Commonwealth Edison Company to USNRC, "LaSalle County Nuclear Power Station Units 1 and 2 Response to October 25, 1995 NRC Request for Additional Information on LaSalle Unit 1 RPV Surveillance Material Testing and Analysis, Reactor Vessel Material Surveillance Program – Appendix H, NRC Docket Nos. 50-373 and 50-374," Commonwealth Edison Company, dated December 20, 1995.

A-7-2. "LaSalle Unit 1 RPV Surveillance Materials Testing and Analysis," T.A. Caine, R.G. Carey, and B.J. Branlund, GE Nuclear Energy, GE-NE-523-A166-1294, Revision 1, June 1995.

A-7-3. CVGRAPH, Hyperbolic Tangent Curve Fitting Program, Developed by ATI Consulting, Version 5.0.2, Revision 1, 3/26/02.

A-7-4. "Radiation Embrittlement of Reactor Vessel Materials," USNRC Regulatory Guide 1.99, Revision 2, May 1988.

A-7-5. "Format and Content of Report for Thermal Annealing of Reactor Pressure Vessels," USNRC Regulatory Guide 1.162, February 1996.

A-7-6. K. Wichman, M. Mitchell, and A. Hiser, USNRC, Generic Letter 92-01 and RPV Integrity Workshop Handouts, *NRC/Industry Workshop on RPV Integrity Issues,* February 12, 1998.

A-7-7. ASTM E-185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," American Society for Testing and Materials, July 1982.

A-7-8. *BWR Vessel and Internals Project: BWR Integrated Surveillance Program Plan (BWRVIP-78).* EPRI, Palo Alto, CA and BWRVIP: 1999, TR-114228.

A-7-9. *BWR Vessel and Internals Project, Testing and Evaluation of the LaSalle Unit 1 120° Surveillance Capsule (BWRVIP-250).* EPRI, Palo Alto, CA: 2011. 1022850.

B-8 Weld Heat: 1P3571

Summary of Available Charpy V-Notch Test Data

The available Charpy V-notch test data sets for weld heat 1P3571 are listed in Table B-8-1. The source documents for the data are provided, and the capsule designations and fluence values are also provided for irradiated data sets.

Table B-8-1
ISP Capsules Containing Weld Heat 1P3571

Capsule	Fluence (E> 1 MeV, 10^{17} n/cm^2)	Reference
Unirradiated Baseline Data	—	Reference B-8-1 and B-8-2
LaSalle 300°	1.14	Reference B-8-9
LaSalle 120°	3.66	Reference B-8-9

The CVN test data for each set taken from the references noted above are presented in Tables B-8-7 through B-8-9. 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-8-3] and the plots are provided in Figures B-8-1 through B-8-3.

Best Estimate Chemistry

Table B-8-2 details the best estimate average chemistry values for weld heat 1P3571 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 best estimate.

Table B-8-2
Best Estimate Chemistry of Available Data Sets for Weld Heat 1P3571

Cu (wt%)	Ni (wt%)	P (wt%)	S (wt%)	Si (wt%)	Specimen ID	Source
0.2	**0.73**	**—**	**—**	**—**	**44U**	Reference B-8-2
0.22	0.73	—	—	—	44M	Reference B-8-2
0.18	0.64	—	—	—	44M	Reference B-8-1
0.20	**0.685**	**—**	**—**	**—**	**Average 44M**	—
0.2	**0.74**	**—**	**—**	**—**	**4LD**	Reference B-8-2
0.2	0.75	0.017	—	—	443	Reference B-8-2
0.19	0.69	—	—	—	443	Reference B-8-1
0.195	**0.72**	**0.017**	**—**	**—**	**Average 443**	—
0.22	**0.75**	**—**	**—**	**—**	**444**	Reference B-8-2
0.2	0.76	0.016	—	—	44A	Reference B-8-2
0.18	0.7	—	—	—	44A	Reference B-8-1
0.19	**0.73**	**0.016**	**—**	**—**	**Average 44A**	—
0.22	**0.79**	**—**	**—**	**—**	**447**	Reference B-8-2
0.21	**0.8**	**—**	**—**	**—**	**45K**	Reference B-8-2
0.21	**0.8**	**—**	**—**	**—**	**45M**	Reference B-8-2
0.22	**0.8**	**—**	**—**	**—**	**45D**	Reference B-8-2
0.23	0.82	0.014	—	—	45E	Reference B-8-2
0.18	0.69	—	—	—	45E	Reference B-8-1
0.18	0.64	—	—	—	45E	Reference B-8-1
0.197	**0.717**	**0.014**	**---**	**---**	**Average 45E**	—
0.22	0.83	—	—	—	44F	Reference B-8-2
0.19	0.71	—	—	—	44F	Reference B-8-1
0.205	**0.77**	**—**	**—**	**—**	**Average 44F**	—
0.21	**0.78**	**0.015**	**—**	**—**	**CE**	Reference B-8-2
0.21	**0.75**	**0.016**	**—**	**—**	**🡐 Best Estimate Average**	

Calculation of Chemistry Factor (CF):

The Chemistry Factor (CF) associated with the best estimate chemistry, as determined Reg. Guide 1.99, Revision 2 [Reference B-8-4], Table 1 (weld metal), is:

$CF_{(1P3571)}$ = 188.75 °F

Effects of Irradiation

The radiation induced transition temperature shifts for heat 1P3571 are shown in Table B-8-3. The T_{30} [30 ft-lb Transition Temperature], T_{50} [50 ft-lb Transition Temperature], and T_{35mil} [35 mil Lateral Expansion Temperature] index temperatures 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-8-4 compares the predicted shift with the measured ΔT_{30} (°F) taken from Table B-8-3.

Comparison of Actual vs. Predicted Decrease in USE

Table B-8-5 compares the actual percent decrease in upper shelf energy (USE) to the predicted decrease. The predicted decrease is estimated from Reg. Guide 1.99, Rev. 2, Figure 2; the measured percent decrease is calculated from the values presented in Table B-8-3.

Table B-8-3
Effect of Irradiation (E>1.0 MeV) on the Notch Toughness Properties of Weld Heat 1P3571

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)
LS1 1P3571	300°	-50.6	-14.0	36.6	-7.6	31.4	39.0	-37.3	2.5	39.8	114.5	107.7	-6.8
	120°	-50.6	49.9	100.5	-7.6	87.3	94.9	-37.3	68.7	106.0	114.5	97.7	-16.8

Table B-8-4
Comparison of Actual Versus Predicted Embrittlement for Weld Heat 1P3571

Capsule Identity	Material	Fluence ($x10^{17}$ n/cm^2)	Measured Shift[1] °F	RG 1.99 Rev. 2 Predicted Shift[2] °F	RG 1.99 Rev. 2 Predicted Shift+Margin[2, 3] °F
LS1 300°	Weld Heat 1P3571 in LaSalle 1	1.14	36.6	22.6	45.2
LS1 120°		3.66	100.5	46.5	93.0

Notes:

1. See Table B-8-3, ΔT_{30}.
2. Predicted shift = CF × FF, where CF is a Chemistry Factor taken from tables from 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.

Table B-8-5
Comparison of Actual Versus Predicted Percent Decrease in Upper Shelf Energy (USE) for Weld Heat 1P3571

Capsule Identity	Material	Fluence ($x10^{17}$ n/cm^2)	Cu Content (wt%)	Measured Decrease in USE[1] (%)	RG 1.99 Rev. 2 Predicted Decrease in USE[2] (%)
LS1 300°	Weld Heat 1P3571 in LaSalle 1	1.14	0.21	5.9	12.1
LS1 120°		3.66		14.7	16.0

Notes:

1. See Table B-8-3, (Change in USE)/(Unirradiated USE).
2. Calculated using equations in Reg. Guide 1.162 [B-8-5] that accurately model the Charpy upper shelf energy decrease curves in Reg. Guide 1.99, Revision 2.

Credibility of Surveillance Data

The credibility of the surveillance data is determined according to the guidance of Reg. Guide 1.99, Rev. 2 and 10 CFR 50.61, as supplemented by the NRC staff [Ref. B-8-6]. The following evaluation is based on the available surveillance data for irradiated weld heat 1P3571. 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 Reg. 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 [B-8-7].

> For weld heat 1P3571, there are 2 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-8-4 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-8-6.

Table B-8-6
Best Fit Evaluation for Surveillance Weld Heat 1P3571

Material	Fitted CF (°F)	Capsule	FF	Measured ΔRT_{NDT} (30 ft-lb)[1] (°F)	Best Fit ΔRT_{NDT}[2] (°F)	Scatter of ΔRT_{NDT}[3] (°F)	<17°F (Base Metal) <28°F (Weld metal)
1P3571	[[(E)]]	300	0.120	36.6	[[(E)]]	[[(E)]]	Yes
		120	0.246	100.5	[[(E)]]	[[(E)]]	Yes

1. See Table B-8-3, ΔT_{30}.
2. Best Fit shift = Fitted CF × FF, where Fitted CF is taken from Figure B-8-4 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. Scatter = Measured ΔRT_{NDT} – Best Fit ΔRT_{NDT}

Table B-8-6 shows that the scatter is within acceptable range for credible surveillance data. Therefore, weld heat 1P3571 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 [B-8-8] 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 1P3571, 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-8-7
Unirradiated Charpy V-Notch Results for Surveillance Weld 1P3571

Spec ID	Temp (°F)	CVN (ft-lb)	Len (mils)	%Shear
1	-320	2.2	2	0
2	-150	3.4	3	1
3	-100	7.3	8	10
4	-75	14.9	14	10
5	-50	28	30	30
6	-35	32.9	39	30
7	-20	45.5	43	40
8	0	45.2	41	40
9	10	50.4	49	50
10	10	52.6	53	50
11	10	42.7	43	40
12	30	78.9	67	60
13	30	59.2	46	50
14	30	59.8	50	50
15	71	90.3	83	90
16	150	105	90	99
17	250	106.8	88	99
18	350	109.4	92	99
22	-200	3	3	3
23	-200	5.5	6	5
24	-200	7	6	5
25	-150	36	34	34
26	-150	15	16	17
27	-150	32	31	27
28	-100	11.5	13	9

Table B-8-7 (continued)
Unirradiated Charpy V-Notch Results for Surveillance Weld 1P3571

Spec ID	Temp (°F)	CVN (ft-lb)	Len (mils)	%Shear
29	-100	13	12	13
30	-100	20	18	14
31	-40	40	37	38
32	-40	41	37	43
33	-40	29.5	29	37
34	10	66	60	55
35	10	67	62	64
36	10	55.5	50	43
37	40	79	71	81
38	40	83	72	81
39	40	45	73	66
40	75	97.5	82	90
41	75	92	77	89
42	75	102.5	87	96
43	210	125	98	100
44	210	126.5	98	100
45	210	126	99	100
19*	10	79	—	—
20*	10	68	—	—
21*	10	64	—	—

* Lateral Expansion and %Shear not available for these data points.

Table B-8-8
Charpy V-Notch Results for 1P3571 in LS1 300° Capsule

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
443	-40	19.5	19.5	20
444	40	35	38	39
447	80	65.5	62	45
44A	-80	5.5	9.5	9
44F	120	89.5	71	93
44M	300	107	84	100
44U	0	41	39	32
45D	200	101	84	100
45E	-10	40	36	31
45K	20	48	37	43
45M	60	74	65	75
4LD	100	86.5	89	83

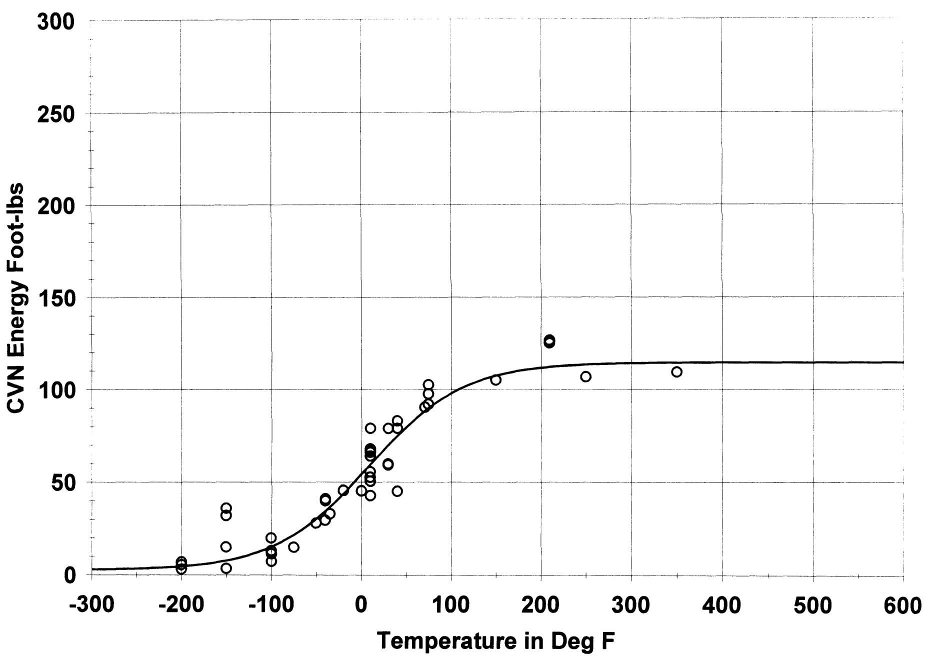
Table B-8-9
Charpy V-Notch Results for 1P3571 in LS1 120° Capsule

Spec ID	Temp (°F)	CVN (ft-lb)	LE (mils)	%Shear
44J	-138.6	2.46	0.5	2.5
45B	-50.8	9.17	8	10.7
45A	-14.9	25.3	20	17.9
441	38.8	20.57	18	28.7
45J	53.1	34.13	27.5	29.6
4LJ	68.3	31.28	27	28.6
45L	99.9	56.33	50.5	65.7
44Y	124.2	74.12	72	82.3
45T	148.6	79.58	69	87.8
44D	196.7	94.82	78	98.4
44C	270.3	106.09	75	100
45Y	348.8	92.06	72	100

Tanh Curve Fits of CVN Test Data for Weld Heat 1P3571

WELD HEAT 1P3571

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 09/09/2002 08:26 AM
Page 1
Coefficients of Curve 1
A = 58.5 B = 56. C = 105.25 T0 = 8.41 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=114.5(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=-50.6 Deg F Temp@50 ft-lbs=-7.6 Deg F
Plant: LaSalle 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: UNIRRA Fluence: 0.0 n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-320.00	2.20	2.72	-.52
-150.00	3.40	7.76	-4.36
-100.00	7.30	15.16	-7.86
-75.00	14.90	21.55	-6.65
-50.00	28.00	30.26	-2.26
-35.00	32.90	36.63	-3.73
-20.00	45.50	43.74	1.76
.00	45.20	54.03	-8.83
10.00	50.40	59.35	-8.95
10.00	52.60	59.35	-6.75
10.00	42.70	59.35	-16.65

Figure B-8-1
Charpy Energy Data for Weld 1P3571 Unirradiated

WELD HEAT 1P3571

Page 2
Plant: LaSalle 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: UNIRRA Fluence: 0.0 n/cm^2

Charpy V-Notch Data

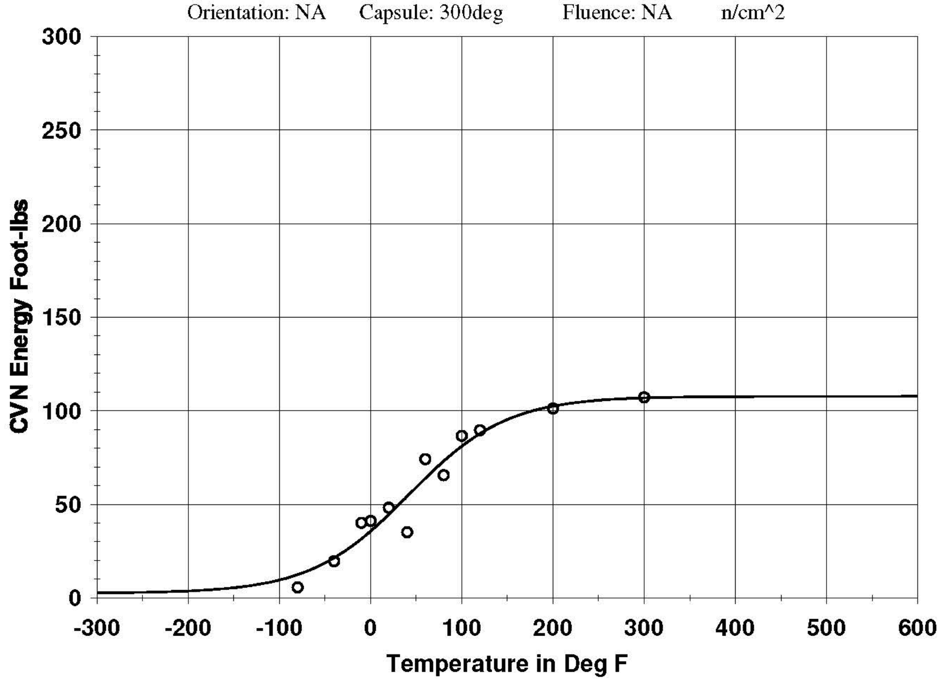
Temperature	Input CVN	Computed CVN	Differential
30.00	78.90	69.83	9.07
30.00	59.20	69.83	-10.63
30.00	59.80	69.83	-10.03
71.00	90.30	88.36	1.94
150.00	105.00	107.38	-2.38
250.00	106.80	113.38	-6.58
350.00	109.40	114.33	-4.93
-200.00	3.00	4.59	-1.59
-200.00	5.50	4.59	.91
-200.00	7.00	4.59	2.41
-150.00	36.00	7.76	28.24
-150.00	15.00	7.76	7.24
-150.00	32.00	7.76	24.24
-100.00	11.50	15.16	-3.66
-100.00	13.00	15.16	-2.16
-100.00	20.00	15.16	4.84
-40.00	40.00	34.42	5.58
-40.00	41.00	34.42	6.58
-40.00	29.50	34.42	-4.92
10.00	66.00	59.35	6.65
10.00	67.00	59.35	7.65
10.00	55.50	59.35	-3.85
40.00	79.00	74.82	4.18
40.00	83.00	74.82	8.18
40.00	45.00	74.82	-29.82
75.00	97.50	89.85	7.65
75.00	92.00	89.85	2.15
75.00	102.50	89.85	12.65
210.00	125.00	112.12	12.88
210.00	126.50	112.12	14.38
210.00	126.00	112.12	13.88
10.00	79.00	59.35	19.65
10.00	68.00	59.35	8.65
10.00	64.00	59.35	4.65

Correlation Coefficient = .959

Figure B-8-1 (continued)
Charpy Energy Data for Weld 1P3571 Unirradiated

Irradiated Weld Heat 1P3571 CVE (LS1-300)

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 07/05/2011 01:58 PM
Page 1
Coefficients of Curve 1
A = 55.1 B = 52.6 C = 107.57 T0 = 41.79 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=107.7(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=-14.0 Deg F Temp@50 ft-lbs=31.4 Deg F
Plant: LASALLE 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: 300deg Fluence: NA n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-40.00	19.50	21.37	-1.87
40.00	35.00	54.23	-19.23
80.00	65.50	73.04	-7.54
-80.00	5.50	12.40	-6.90
120.00	89.50	87.78	1.72
300.00	107.00	106.84	.16
.00	41.00	35.64	5.36
200.00	101.00	102.43	-1.43
-10.00	40.00	31.57	8.43

Figure B-8-2
Charpy Energy Data for Weld 1P3571 in LS1 300° Capsule

Irradiated Weld Heat 1P3571 CVE (LS1-300)

Page 2
Plant: LASALLE 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: 300deg Fluence: NA n/cm^2

Charpy V-Notch Data

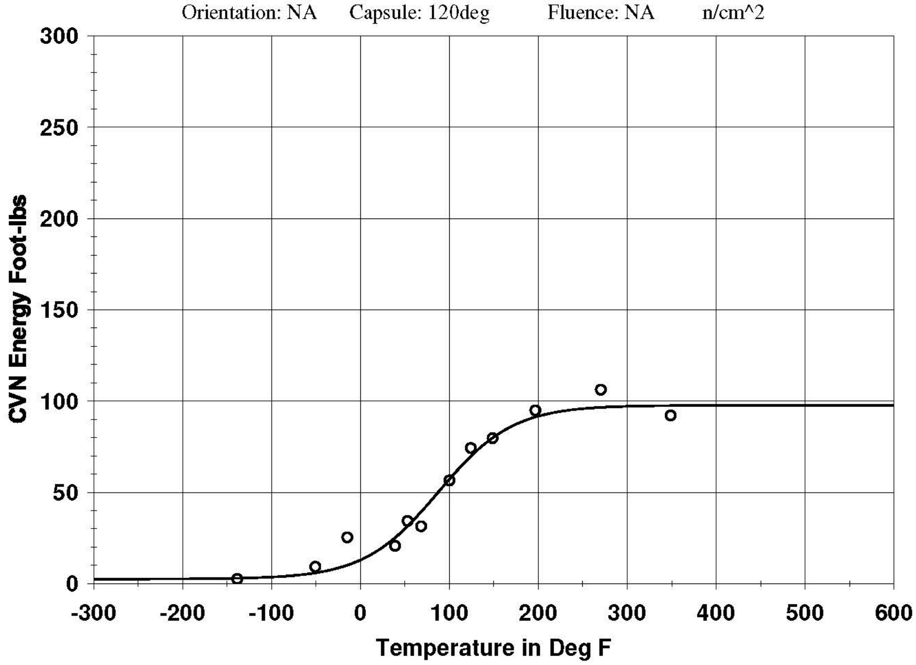
Temperature	Input CVN	Computed CVN	Differential
20.00	48.00	44.59	3.41
60.00	74.00	63.92	10.08
100.00	86.50	81.08	5.42

Correlation Coefficient = .969

Figure B-8-2 (continued)
Charpy Energy Data for Weld 1P3571 in LS1 300° Capsule

Irradiated Weld Heat 1P3571 CVE (LS1-120)

CVGRAPH 5.0.2 Hyperbolic Tangent Curve Printed on 06/27/2011 07:28 PM
Page 1
Coefficients of Curve 1
A = 50.08 B = 47.58 C = 83.36 T0 = 87.38 D = 0.00E+00
Equation is A + B * [Tanh((T-To)/(C+DT))]
Upper Shelf Energy=97.7(Fixed) Lower Shelf Energy=2.5(Fixed)
Temp@30 ft-lbs=49.9 Deg F Temp@50 ft-lbs=87.3 Deg F
Plant: LASALLE 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: 120deg Fluence: NA n/cm^2



Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
-138.60	2.46	2.92	-.46
-50.80	9.17	5.84	3.33
-14.90	25.30	10.03	15.27
38.80	20.57	25.12	-4.55
53.10	34.13	31.55	2.58
68.30	31.28	39.38	-8.10
99.90	56.33	57.17	-.84
124.20	74.12	69.83	4.29
148.60	79.58	79.85	-.27

Figure B-8-3
Charpy Energy Data for Weld 1P3571 in LS1 120° Capsule

Irradiated Weld Heat 1P3571 CVE (LS1-120)

Page 2
Plant: LASALLE 1 Material: SAW Heat: 1P3571
Orientation: NA Capsule: 120deg Fluence: NA n/cm^2

Charpy V-Notch Data

Temperature	Input CVN	Computed CVN	Differential
196.70	94.82	91.22	3.60
270.30	106.09	96.49	9.60
348.80	92.06	97.48	-5.42

Correlation Coefficient = .984

Figure B-8-3 (continued)
Charpy Energy Data for Weld 1P3571 in LS1 120° Capsule

[[

(E)]]

Figure B-8-4
Fitted Surveillance Results for LaSalle Unit 1 Weld Heat 1P3571

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