Progress Energy

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JUN 0 9 2003

SERIAL: BSEP 03-0100
TSC-2002-09

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Docket Nos. 50-325 and 50-324/License Nos. DPR-71 and DPR-62
Response to Request for Additional Information
Core Flow Operating Range Expansion
(NRC TAC No. MB6692 and MB6693)

Reference: Letter from Mr. John S. Keenan to the U. S. Nuclear Regulatory Commission (Serial: BSEP 02-0169), "Request for License Amendments - Core Flow Operating Range Expansion," dated November 12, 2002

Ladies and Gentlemen:

On November 12, 2002, Progress Energy Carolinas, Inc. requested a revision to the Technical Specifications (TSs) for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2. The proposed license amendments revise TSs, as necessary, to support an expansion of the core flow operating range (i.e., Maximum Extended Load Line Limit Analysis Plus (MELLLA+)).

On May 20, 2003, the NRC provided a verbal request for additional information (RAI) concerning the evaluation of the impact of MELLLA+ on the reactor pressure vessel. The response to this RAI is enclosed.

Please refer any questions regarding this submittal to Mr. Edward T. O'Neil, Manager - Support Services, at (910) 457-3512.

Sincerely,

John S. Keenan

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A001

MAT/mat

Enclosure:

Response to Request for Additional Information (RAI) 2

John S. Keenan, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, and agents of Carolina Power & Light Company.

Dean S. Mason
Notary (Seal)

My commission expires: August 29, 2004

cc:

U. S. Nuclear Regulatory Commission, Region II
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Response to Request for Additional Information (RAI) 2

Background

On November 12, 2002 (i.e., Serial: BSEP 02-0169), Progress Energy Carolinas, Inc. requested a revision to the Technical Specifications (TSs) for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2. The proposed license amendments revise TSs, as necessary, to support an expansion of the core flow operating range (i.e., Maximum Extended Load Line Limit Analysis Plus (MELLLA+)).

On May 20, 2003, the NRC provided a verbal request for additional information (RAI) concerning the evaluation of the impact of MELLLA+ on the reactor pressure vessel. The response to this RAI follows.

NRC Question 2-1

Please provide an evaluation of the upper shelf energy (USE) and confirm that the USE and the reference temperature (ART) were established consistent with Regulatory Guide 1.99, Revision 2.

Response to NRC Question 2-1

Section 3.2.1 of GE Nuclear Energy Report NEDC-33063, "Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus," dated November 2002 (i.e., M+SAR), states that the effect of the MELLLA+ operating range on fluence for the Brunswick Steam Electric Plant (BSEP) is negligible. However, a conservative 1% increase in fluence was assumed to demonstrate that the BSEP Pressure-Temperature curves are unaffected by Maximum Extended Load Line Limit Analysis Plus (MELLLA+). Further, an evaluation of the ART and USE was performed assuming the 1% increase in fluence. The evaluation was performed consistent with Regulatory Guide 1.99, Revision 2.

As discussed below, the impact on ART and USE is negligible. The ART increases by 0.4°F for the limiting material, and the USE Equivalent Margin Analysis (EMA) remains within the bounds defined by 10 CFR 50 Appendix G

An evaluation was performed to determine the impact of MELLLA+ on the Reactor Pressure Vessel (RPV) Fracture Toughness for BSEP Units 1 and 2. The basis for the MELLLA+ evaluation was the Extended Power Uprate (EPU) evaluation.

Although MELLLA+ has no effect on the fluence used in EPU, as a conservative assumption, a 1% increase is evaluated for MELLLA+. Further, the ART and USE are evaluated using this conservatively increased fluence. The scope of evaluation for USE excluded the N16 nozzle; therefore, the limiting beltline plate and weld materials were evaluated. This evaluation was performed to the requirements of Regulatory Guide 1.99, Revision 2.

The calculation for USE uses the rounded 1/4T fluence obtained from the ART tables. It may also be noted that, while the 54 effective full power years (EFPY) percent decrease limit values were not approved by the NRC at the time the original evaluation was performed for BSEP, BWRVIP-74 has been approved at this time. Therefore, the 60-year life USE EMA comparison is based upon the currently approved limits.

Attached are the ART and USE tables for BSEP Units 1 and 2 for both 40- and 60-year life EFPYs including the 1% increase over the EPU fluence. For convenience, both EPU and MELLLA+ ART and USE EMA tables are provided. As can be seen by the results, the impact is negligible. The ART increases by 0.4°F for the limiting material, and the USE EMA remains within the bounds defined by 10 CFR 50 Appendix G.

Table 1: Brunswick Unit 1 32 EFPY EPU ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.50

32 EFPY Peak I.D. fluence = 2.2E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.50

32 EFPY Peak I.D. fluence = 2.5E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.50

32 EFPY Peak I.D. fluence = 7.7E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.5E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.5E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4535-2	0.12	0.58	83	34	1.6E+18	43	0	17	34	77	111
	C4550-1	0.11	0.60	74	10	1.6E+18	38	0	17	34	72	82
Lower-Intermediate Shell	C4487-1	0.12	0.56	82	10	1.8E+18	45	0	17	34	79	89
	B8496-1	0.19	0.58	140	10	1.8E+18	76	0	17	34	110	120
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	1.6E+18	35	0	18	35	70	80
F1, F2	S3986	0.050	0.96	68	10	1.8E+18	37	0	18	37	74	84
Girth												
FG	1P4218	0.06	0.87	82	10	1.6E+18	42	0	21	42	85	95
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	48	5.5E+17	38	0	17	34	72	120

Table 2: Brunswick Unit 1 32 EFPY MELLLA+ ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.50

32 EFPY Peak I.D. fluence = 2.2E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.50

32 EFPY Peak I.D. fluence = 2.5E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.50

32 EFPY Peak I.D. fluence = 7.7E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.6E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.6E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4535-2	0.12	0.56	83	34	1.6E+18	43	0	17	34	77	111
	C4550-1	0.11	0.60	74	10	1.6E+18	38	0	17	34	72	82
Lower-Intermediate Shell	C4487-1	0.12	0.56	82	10	1.8E+18	45	0	17	34	79	89
	B8496-1	0.19	0.58	140	10	1.8E+18	76	0	17	34	110	120
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	1.6E+18	35	0	18	35	70	80
F1, F2	S3986	0.050	0.96	68	10	1.8E+18	37	0	18	37	74	84
Girth												
FG	1P4218	0.06	0.87	82	10	1.6E+18	42	0	21	42	85	95
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	48	5.6E+17	38	0	17	34	72	120

Table 3: Brunswick Unit 1 50 EFPY EPU ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.50

50 EFPY Peak I.D. fluence = 4.1E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 2.9E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 2.9E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.50

50 EFPY Peak I.D. fluence = 4.4E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 3.2E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 3.2E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.50

50 EFPY Peak I.D. fluence = 1.4E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 9.8E+17 n/cm^2
50 EFPY Peak 1/4 T fluence = 9.8E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	50 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	50 EFPY Shift °F	50 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4535-2	0.12	0.58	83	34	2.9E+18	55	0	17	34	89	123
	C4550-1	0.11	0.60	74	10	2.9E+18	49	0	17	34	83	93
Lower-Intermediate Shell	C4487-1	0.12	0.56	82	10	3.2E+18	56	0	17	34	90	100
	B8496-1	0.19	0.58	140	10	3.2E+18	96	0	17	34	130	140
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	2.9E+18	45	0	23	45	90	100
F1, F2	S3986	0.050	0.96	68	10	3.2E+18	47	0	23	47	93	103
Girth												
FG	1P4218	0.06	0.87	82	10	2.9E+18	54	0	27	54	109	119
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	48	9.8E+17	51	0	17	34	85	133

Table 4: Brunswick Unit 1 50 EFPY MELLLA+ ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.50

50 EFPY Peak I.D. fluence = 4.1E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 2.9E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 2.9E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.50

50 EFPY Peak I.D. fluence = 4.4E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 3.2E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 3.2E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.50

50 EFPY Peak I.D. fluence = 1.4E+18 n/cm^2
50 EFPY Peak 1/4 T fluence = 9.9E+17 n/cm^2
50 EFPY Peak 1/4 T fluence = 9.9E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	50 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	50 EFPY Shift °F	50 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4535-2	0.12	0.58	83	34	2.9E+18	55	0	17	34	89	123
	C4550-1	0.11	0.60	74	10	2.9E+18	49	0	17	34	83	93
Lower-Intermediate Shell	C4487-1	0.12	0.56	82	10	3.2E+18	56	0	17	34	90	100
	B8496-1	0.19	0.58	140	10	3.2E+18	96	0	17	34	130	140
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	2.9E+18	45	0	23	45	91	101
F1, F2	S3986	0.050	0.96	68	10	3.2E+18	47	0	23	47	93	103
Girth												
FG	1P4218	0.06	0.87	82	10	2.9E+18	55	0	27	55	109	119
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	48	9.9E+17	51	0	17	34	85	133

Table 5: Brunswick Unit 2 32 EFPY EPU ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.47

32 EFPY Peak I.D. fluence = 2.2E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.47

32 EFPY Peak I.D. fluence = 2.4E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.7E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.7E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.47

32 EFPY Peak I.D. fluence = 7.0E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.0E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.0E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_i	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4500-2	0.15	0.54	107	10	1.6E+18	55	0	17	34	89	99
	C4550-2	0.11	0.60	74	10	1.6E+18	38	0	17	34	72	82
Lower-Intermediate Shell	C4489-1	0.12	0.60	83	10	1.7E+18	45	0	17	34	79	89
	C4521-2	0.12	0.57	82	10	1.7E+18	44	0	17	34	78	88
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	1.6E+18	35	0	17	35	70	80
F1, F2	S3986	0.050	0.96	68	10	1.7E+18	37	0	18	37	73	83
Girth												
FG	3P4000	0.02	0.90	27	10	1.6E+18	14	0	7	14	28	38
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	40	5.0E+17	36	0	17	34	70	110

Table 6: Brunswick Unit 2 32 EFPY MELLLA+ ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.47

32 EFPY Peak I.D. fluence = 2.2E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.6E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.47

32 EFPY Peak I.D. fluence = 2.4E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 1.8E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.47

32 EFPY Peak I.D. fluence = 7.1E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.1E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 5.1E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4500-2	0.15	0.54	107	10	1.6E+18	55	0	17	34	89	99
	C4550-2	0.11	0.60	74	10	1.6E+18	38	0	17	34	72	82
Lower-Intermediate Shell												
	C4489-1	0.12	0.60	83	10	1.8E+18	45	0	17	34	79	89
	C4521-2	0.12	0.57	82	10	1.8E+18	44	0	17	34	78	88
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	1.6E+18	35	0	18	35	70	80
F1, F2	S3986	0.050	0.96	68	10	1.8E+18	37	0	18	37	73	83
Girth												
FG	3P4000	0.02	0.90	27	10	1.6E+18	14	0	7	14	28	38
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	40	5.1E+17	36	0	17	34	70	110

Table 7: Brunswick Unit 2 48 EFPY EPU ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.47

48 EFPY Peak I.D. fluence = 3.8E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 2.8E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 2.8E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.47

48 EFPY Peak I.D. fluence = 4.1E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 3.0E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 3.0E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.47

48 EFPY Peak I.D. fluence = 1.2E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 8.9E+17 n/cm^2
48 EFPY Peak 1/4 T fluence = 8.9E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	48 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	48 EFPY Shift °F	48 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4500-2	0.15	0.54	107	10	2.8E+18	69	0	17	34	103	113
	C4550-2	0.11	0.60	74	10	2.8E+18	48	0	17	34	82	92
Lower-Intermediate Shell	C4489-1	0.12	0.60	83	10	3.0E+18	55	0	17	34	89	99
	C4521-2	0.12	0.57	82	10	3.0E+18	55	0	17	34	89	99
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	2.8E+18	44	0	22	44	88	98
F1, F2	S3986	0.050	0.96	68	10	3.0E+18	45	0	23	45	91	101
Girth												
FG	3P4000	0.02	0.90	27	10	2.8E+18	18	0	9	18	35	45
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	40	8.9E+17	48	0	17	34	82	122

Table 8: Brunswick Unit 2 48 EFPY MELLLA+ ART Table

Lower Shell and Girth Weld

Thickness in inches = 5.47

48 EFPY Peak I.D. fluence = 3.9E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 2.8E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 2.8E+18 n/cm^2

Lower-Intermediate Shell

Thickness in inches = 5.47

48 EFPY Peak I.D. fluence = 4.2E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 3.0E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 3.0E+18 n/cm^2

N16 Nozzle

Thickness in inches= 5.47

48 EFPY Peak I.D. fluence = 1.2E+18 n/cm^2
48 EFPY Peak 1/4 T fluence = 8.9E+17 n/cm^2
48 EFPY Peak 1/4 T fluence = 8.9E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	48 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	48 EFPY Shift °F	48 EFPY ART @ 1/4T °F
PLATES:												
Lower Shell												
	C4500-2	0.15	0.54	107	10	2.8E+18	70	0	17	34	104	114
	C4550-2	0.11	0.60	74	10	2.8E+18	48	0	17	34	82	92
Lower-Intermediate Shell	C4489-1	0.12	0.60	83	10	3.0E+18	56	0	17	34	90	100
	C4521-2	0.12	0.57	82	10	3.0E+18	55	0	17	34	89	99
WELDS:												
Vertical Weld												
G1, G2	S3986	0.050	0.96	68	10	2.8E+18	44	0	22	44	89	99
F1, F2	S3986	0.050	0.96	68	10	3.0E+18	46	0	23	46	91	101
Girth												
FG	3P4000	0.02	0.90	27	10	2.8E+18	18	0	9	18	35	45
NOZZLES:												
N16A, N16B	Q2Q1VW	0.16	0.82	123	40	8.9E+17	49	0	17	34	83	123

Table 9: Brunswick Unit 1 USE EMA Plate 32 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions
40-Year Life (32 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4487-1):

%Cu	=	0.11	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	9.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat B8496-1):

%Cu	=	0.19	
32 EFPY 1/4T Fluence	=	1.8E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	19	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

19.0% $\leq$ 21%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 10: Brunswick Unit 1 USE EMA Plate 32 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions and MELLLA+
40-Year Life (32 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4487-1):

%Cu	=	0.11	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	9.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat B8496-1):

%Cu	=	0.19	
32 EFPY 1/4T Fluence	=	1.8E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	19	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

19.0% $\leq$ 21%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 11: Brunswick Unit 1 USE EMA Weld 32 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions
40-Year Life (32 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat S3986):

%Cu	=	0.052	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	8.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat 1P4218):

%Cu	=	0.06	
32 EFPY 1/4T Fluence	=	1.6E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	13	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

13.0% $\leq$ 34%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 12: Brunswick Unit 1 USE EMA Weld 32 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions and MELLLA+
40-Year Life (32 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat S3986):

%Cu	=	0.052	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	8.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat 1P4218):

%Cu	=	0.06	
32 EFPY 1/4T Fluence	=	1.6E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	13	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

13.0% $\leq$ 34%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 13: Brunswick Unit 1 USE EMA Plate 50 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions
60-Year Life (50 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4487-1):

%Cu	=	0.11	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	9.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat B8496-1):

%Cu	=	0.19	
50 EFPY 1/4T Fluence	=	3.2E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	22	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

22.0% $\leq$ 23.5%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 14: Brunswick Unit 1 USE EMA Plate 50 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions and MELLLA+
60-Year Life (50 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4487-1):

%Cu	=	0.11	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	9.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat B8496-1):

%Cu	=	0.19	
50 EFPY 1/4T Fluence	=	3.2E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	22	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

22.0% $\leq$ 23.5%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 15: Brunswick Unit 1 USE EMA Weld 50 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions
60-Year Life (50 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat S3986):

%Cu	=	0.052	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	8.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat 1P4218):

%Cu	=	0.06	
50 EFPY 1/4T Fluence	=	2.9E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

15.5% $\leq$ 39%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 16: Brunswick Unit 1 USE EMA Weld 50 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 1
Including Extended Power Uprate Conditions and MELLLA+
60-Year Life (50 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat S3986):

%Cu	=	0.052	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	8.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat 1P4218):

%Cu	=	0.06	
50 EFPY 1/4T Fluence	=	2.9E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

15.5% $\leq$ 39%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 17: Brunswick Unit 2 USE EMA Plate 32 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions
40-Year Life (32 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4489-1):

%Cu	=	0.12	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	10	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat C4500-2):

%Cu	=	0.15	
32 EFPY 1/4T Fluence	=	1.6E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	16	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

16.0% $\leq$ 21%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 18: Brunswick Unit 2 USE EMA Plate 32 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions and MELLLA+
40-Year Life (32 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4489-1):

%Cu	=	0.12	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	10	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat C4500-2):

%Cu	=	0.15	
32 EFPY 1/4T Fluence	=	1.6E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	16	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

16.0% $\leq$ 21%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 19: Brunswick Unit 2 USE EMA Weld 32 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions
40-Year Life (32 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat Unknown):

%Cu	=	0.183	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat S3986):

%Cu	=	0.05	
32 EFPY 1/4T Fluence	=	1.7E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	12.5	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

12.5% $\leq$ 34%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 20: Brunswick Unit 2 USE EMA Weld 32 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions and MELLLA+
40-Year Life (32 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat Unknown):

%Cu	=	0.183	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat S3986):

%Cu	=	0.05	
32 EFPY 1/4T Fluence	=	1.8E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	13	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

13.0% $\leq$ 34%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 21: Brunswick Unit 2 USE EMA Plate 48 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions
60-Year Life (48 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4489-1):

%Cu	=	0.12	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	10	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat C4500-2):

%Cu	=	0.15	
48 EFPY 1/4T Fluence	=	2.8E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	18	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

18.0% $\leq$ 23.5%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 22: Brunswick Unit 2 USE EMA Plate 48 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions and MELLLA+
60-Year Life (48 EFPY)

BWR/3-6 PLATE

Surveillance Plate USE (Heat C4489-1):

%Cu	=	0.12	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	10	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Plate USE (Heat C4500-2):

%Cu	=	0.15	
48 EFPY 1/4T Fluence	=	2.8E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	18	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

18.0% $\leq$ 23.5%

Therefore, vessel plates are bounded by Equivalent Margin Analysis

Table 23: Brunswick Unit 2 USE EMA Weld 48 EFPY for EPU

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions
60-Year Life (48 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat Unknown):

%Cu	=	0.183	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat S3986):

%Cu	=	0.05	
48 EFPY 1/4T Fluence	=	3.0E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	14.5	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

14.5% $\leq$ 39%

Therefore, vessel welds are bounded by Equivalent Margin Analysis

Table 24: Brunswick Unit 2 USE EMA Weld 48 EFPY for MELLLA+

Equivalent Margin Analysis
Plant Applicability Verification Form
for Brunswick Unit 2
Including Extended Power Uprate Conditions and MELLLA+
60-Year Life (48 EFPY)

BWR/2-6 WELD

Surveillance Weld USE (Heat Unknown):

%Cu	=	0.183	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Rev. 2, Figure 2)

Limiting Beltline Weld USE (Heat S3986):

%Cu	=	0.05	
48 EFPY 1/4T Fluence	=	3.0E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	14.5	(RG 1.99, Rev. 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Rev. 2, Position 2.2)

14.5% $\leq$ 39%

Therefore, vessel welds are bounded by Equivalent Margin Analysis