Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

Exelon Nuclear

RS-10-046

10 CFR 50.55a

March 12, 2010

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

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket No. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket No. STN 50-454 and STN 50-455

Subject: Request for Relief from ASME Code Case N-729-1 Requirements for Examination of Reactor Vessel Head Penetration Welds

In accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), Exelon Generation Company, LLC (EGC) is requesting NRC approval of a relief request for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2. This relief request is for the third ten-year Inservice Inspection interval. The details of this request are enclosed in Attachment 1. The attached relief request evaluates the proposed alternatives and concludes it provides an acceptable level of quality and safety.

EGC requests approval of this relief request by March 14, 2011, in support of the Byron Station, Unit 2, spring 2011 refueling outage (B1R17).

There are no regulatory commitments contained in this letter. If you have any questions, please contact Ms. Jean M. Smith at (630) 657-2813.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachment: 10 CFR 50.55a Relief Request

ATTACHMENT

10 CFR 50.55a Relief Request

1. ASME CODE COMPONENT(S) AFFECTED:

Code Class:	1
Reference:	ASME Code Case N-729-1/10 CFR 50.55a(g)(6)(ii)(D)
Item Number:	B4.20
Description:	UNS N06600 Nozzles and UNS N06082 or UNS W86182 partial-penetration welds in head
Drawing Numbers:	185282E Revision 1 (typical configuration)

2. APPLICABLE CODE EDITION AND ADDENDA:

The current code of record for the Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, Inservice Inspection (ISI) third ten-year interval is the ASME Code Section XI, 2001 Edition through the 2003 Addenda, as augmented by ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1," (i.e., Reference 1) as amended and noticed in the Federal Register (73 FR 52730, September 10, 2008).

3. APPLICABLE CODE REQUIREMENT:

10 CFR 50.55a(g)(6)(ii)(D)(1) requires that examinations of the reactor vessel head be performed in accordance with ASME Code Case N-729-1 subject to the conditions specified in paragraphs 10 CFR 50.55a(g)(6)(ii)(D)(2) through (6).

Paragraph -2500 of Code Case N-729-1 states, in part:

> If obstructions or limitations prevent examination of the volume or surface required by Fig. 2 for one or more nozzles, the analysis procedure of Appendix I shall be used to demonstrate the adequacy of the examination volume or surface for each such nozzle. If Appendix I is used, the evaluation shall be submitted to the regulatory authority having jurisdiction at the plant site.

Figure 2 in the ASME Code Case, as referenced by paragraph -2500, requires that the volumetric or surface examination coverage distance below the toe of the J-groove weld (i.e., dimension "a") be 1.5 inches for incidence angle, θ, less than or equal to 30 degrees; one inch for incidence angle, θ, greater than 30 degrees; or to the end of the tube, whichever is less. These coverage requirements are applicable to Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, reactor vessel head penetrations as follows:

Penetration Nos.	Incidence Angle, θ (degrees)	Required Coverage, "a" (inches)
1 to 37	≤ 30	1.5
38 to 78	> 30	1.0

4. REASON FOR REQUEST:

Due to the physical configuration and limitations of the examination equipment associated with certain reactor head penetration nozzles, the full examination volume required by ASME Code Case N-729-1 Table 1 cannot be achieved for Item B4.20. The bottom end of the Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, reactor vessel head control rod drive mechanism (CRDM) penetrations are externally (i.e., outside diameter, or OD) threaded, internally (i.e., inside diameter, or ID) tapered, and have an ultrasonic testing corner shadow zone produced by the thread relief. The shadow zone precludes ultrasonic or eddy current data acquisition in the lower nozzle area. For several of the penetrations, this geometric limitation reduces the lower coverage inspection distance from the bottom of the J-groove weld fillet to the top of the thread relief to a value less than the required coverage dimension "a" shown in Figure 2 of Code Case N-729-1.

As required by the NRC Order EA-03-009 (Reference 9), Exelon Generation Corporation, LLC (EGC) obtained examination coverage data on all 78 CRDM penetrations in each of the reactor vessel heads at both Braidwood Station and Byron Station. This information was used to support EGC's previous NRC Order Relaxation Requests (References 3 through 5) regarding examination coverage below the J-groove weld; the Relaxation Requests were approved by the NRC in References 6 through 8. However, the issuance of 10 CFR 50.55a(g)(6)(ii)(D), "Reactor vessel head inspections," on September 10, 2008 requires implementation of Code Case N-729-1 with NRC conditions by December 31, 2008. Once a licensee implemented the provisions of 10 CFR 50.55a(g)(6)(ii)(D), the Order and all previously approved relaxations were no longer applicable.

The distance from the top of the thread relief to the bottom of the fillet of the J-groove weld, identified as "a" in Figure 1 below, varies based on location of the penetration in the reactor vessel head. This distance is generally longer for penetrations at inboard locations and becomes progressively shorter for penetrations located farther away from the center of the reactor vessel head.

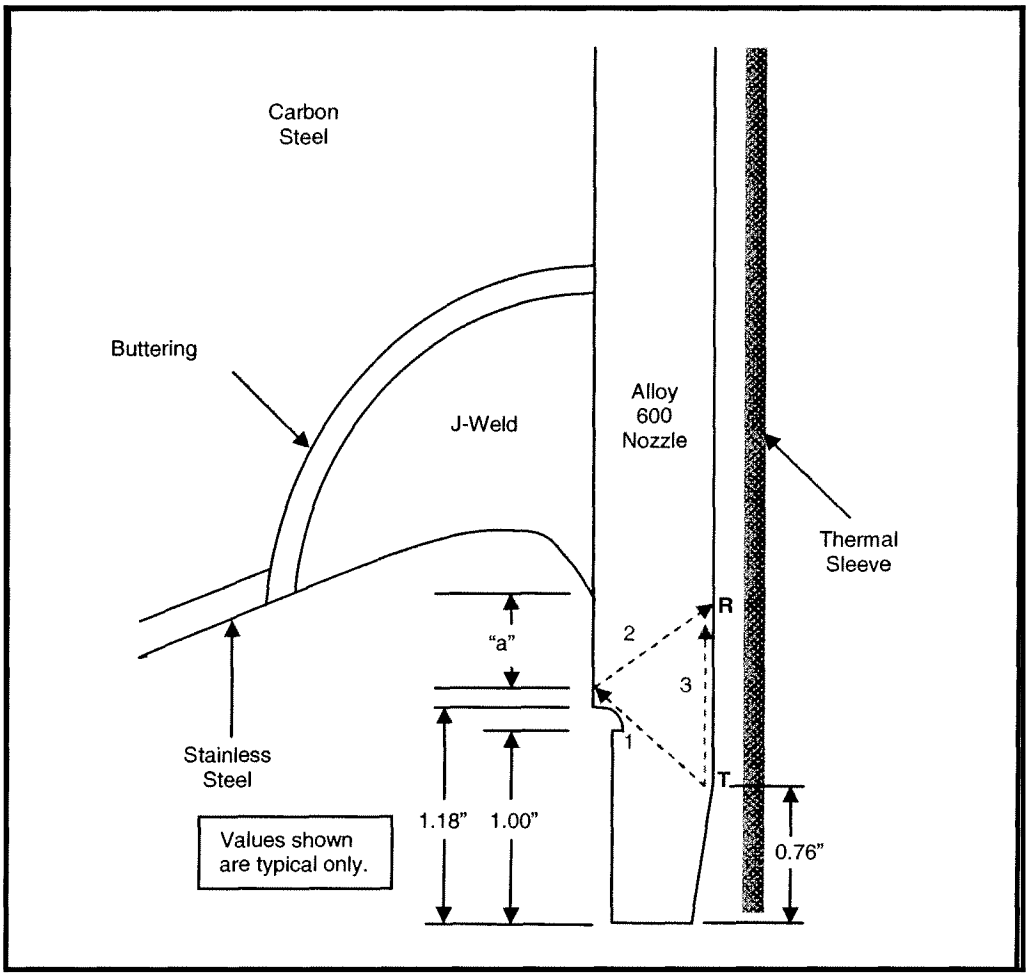

Figure 1: Illustration of volumetric examination coverage on Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, penetration geometry (including general dimensions) at 0 degrees.

Tables 1 through 4 list the extent of the inspection coverage that was previously obtained for the reactor vessel head penetrations at Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2 under the NRC Order EA-03-009 examinations. The attainable examination coverage in inches below the toe of the J-groove weld fillet on the limiting (i.e., downhill) side of each penetration corresponds to the proposed alternative coverage being requested. The examination coverage required by ASME Code Case N-729-1 Figure 2 is also shown in Tables 1 through 4.

Table 1: Braidwood Station, Unit 1, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

Pen. No.	θ (degrees)	N-729-1 Required Exam Coverage (inches)	Inspection Coverage Obtained/ Alternative Coverage Requested (inches)	Relief Requested
1	0.0	1.5	1.28	Yes
2	11.1	1.5	1.36	Yes
3	11.1	1.5	1.52	No
4	11.1	1.5	1.48	Yes
5	11.1	1.5	1.52	No
6	15.8	1.5	1.52	No
7	15.8	1.5	1.56	No
8	15.8	1.5	1.56	No
9	15.8	1.5	1.44	Yes
10	17.7	1.5	1.72	No
11	17.7	1.5	1.88	No
12	17.7	1.5	1.80	No
13	17.7	1.5	1.68	No
14	22.6	1.5	1.40	Yes
15	22.6	1.5	1.28	Yes
16	22.6	1.5	1.28	Yes
17	22.6	1.5	1.36	Yes
18	24.0	1.5	1.84	No
19	24.0	1.5	1.64	No
20	24.0	1.5	1.56	No
21	24.0	1.5	1.60	No
22	25.4	1.5	1.40	Yes
23	25.4	1.5	1.60	No
24	25.4	1.5	1.72	No
25	25.4	1.5	1.48	Yes
26	25.4	1.5	1.48	Yes
27	25.4	1.5	1.52	No
28	25.4	1.5	1.40	Yes
29	25.4	1.5	1.16	Yes
30	29.3	1.5	1.24	Yes
31	29.3	1.5	1.48	Yes
32	29.3	1.5	1.36	Yes
33	29.3	1.5	1.48	Yes
34	29.3	1.5	1.28	Yes
35	29.3	1.5	1.28	Yes
36	29.3	1.5	1.20	Yes
37	29.3	1.5	1.08	Yes
38	32.9	1.0	1.24	No
39	32.9	1.0	1.64	No
40	32.9	1.0	1.32	No
41	32.9	1.0	1.12	No
42	34.1	1.0	0.92	Yes
43	34.1	1.0	1.20	No
44	34.1	1.0	1.24	No
45	34.1	1.0	1.60	No
46	34.1	1.0	1.16	No
47	34.1	1.0	1.36	No
48	34.1	1.0	1.04	No
49	34.1	1.0	0.76	Yes
50	35.2	1.0	1.04	No
51	35.2	1.0	1.40	No
52	35.2	1.0	1.44	No
53	35.2	1.0	1.24	No
54	37.4	1.0	0.92	Yes
55	37.4	1.0	1.20	No
56	37.4	1.0	1.44	No
57	37.4	1.0	1.16	No
58	37.4	1.0	1.24	No
59	37.4	1.0	1.04	No
60	37.4	1.0	1.08	No
61	37.4	1.0	1.08	No
62	42.8	1.0	1.24	No
63	42.8	1.0	0.92	Yes
64	42.8	1.0	1.04	No
65	42.8	1.0	0.92	Yes
66	43.8	1.0	0.92	Yes
67	43.8	1.0	1.00	No
68	43.8	1.0	1.04	No
69	43.8	1.0	1.20	No
70	43.8	1.0	1.04	No
71	43.8	1.0	0.88	Yes
72	43.8	1.0	0.92	Yes
73	43.8	1.0	1.00	No
74	47.0	1.0	1.08	No
75	47.0	1.0	1.36	No
76	47.0	1.0	1.12	No
77	47.0	1.0	0.92	Yes
78	47.0	1.0	0.84	Yes

Table 2: Braidwood Station, Unit 2, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

Pen. No.	θ (degrees)	N-729-1 Required Exam Coverage (inches)	Inspection Coverage Obtained/ Alternative Coverage Requested (inches)	Relief Requested
1	0.0	1.5	1.40	Yes
2	11.1	1.5	1.69	No
3	11.1	1.5	1.52	No
4	11.1	1.5	1.44	Yes
5	11.1	1.5	1.48	Yes
6	15.8	1.5	1.73	No
7	15.8	1.5	1.72	No
8	15.8	1.5	1.44	Yes
9	15.8	1.5	1.92	No
10	17.7	1.5	2.28	No
11	17.7	1.5	2.20	No
12	17.7	1.5	2.24	No
13	17.7	1.5	2.32	No
14	22.6	1.5	1.68	No
15	22.6	1.5	2.00	No
16	22.6	1.5	2.16	No
17	22.6	1.5	1.64	No
18	24.0	1.5	2.36	No
19	24.0	1.5	2.36	No
20	24.0	1.5	2.08	No
21	24.0	1.5	2.44	No
22	25.4	1.5	2.40	No
23	25.4	1.5	2.20	No
24	25.4	1.5	2.60	No
25	25.4	1.5	2.36	No
26	25.4	1.5	2.36	No
27	25.4	1.5	2.16	No
28	25.4	1.5	2.36	No
29	25.4	1.5	2.36	No
30	29.3	1.5	1.72	No
31	29.3	1.5	1.60	No
32	29.3	1.5	1.28	Yes
33	29.3	1.5	1.52	No
34	29.3	1.5	1.32	Yes
35	29.3	1.5	1.28	Yes
36	29.3	1.5	1.84	No
37	29.3	1.5	1.52	No
38	32.9	1.0	1.12	No
39	32.9	1.0	1.48	No
40	32.9	1.0	0.96	Yes
41	32.9	1.0	1.36	No
42	34.1	1.0	1.24	No
43	34.1	1.0	1.36	No
44	34.1	1.0	1.08	No
45	34.1	1.0	1.20	No
46	34.1	1.0	0.88	Yes
47	34.1	1.0	1.24	No
48	34.1	1.0	1.20	No
49	34.1	1.0	1.36	No
50	35.2	1.0	1.08	No
51	35.2	1.0	1.32	No
52	35.2	1.0	1.00	No
53	35.2	1.0	1.12	No
54	37.4	1.0	1.16	No
55	37.4	1.0	1.04	No
56	37.4	1.0	1.16	No
57	37.4	1.0	1.16	No
58	37.4	1.0	1.04	No
59	37.4	1.0	1.16	No
60	37.4	1.0	1.28	No
61	37.4	1.0	1.20	No
62	42.8	1.0	1.48	No
63	42.8	1.0	1.24	No
64	42.8	1.0	1.52	No
65	42.8	1.0	1.16	No
66	43.8	1.0	0.92	Yes
67	43.8	1.0	0.68	Yes
68	43.8	1.0	0.92	Yes
69	43.8	1.0	1.04	No
70	43.8	1.0	0.64	Yes
71	43.8	1.0	0.56	Yes
72	43.8	1.0	1.08	No
73	43.8	1.0	0.84	Yes
74	47.0	1.0	0.80	Yes
75	47.0	1.0	1.36	No
76	47.0	1.0	0.92	Yes
77	47.0	1.0	0.96	Yes
78	47.0	1.0	0.68	Yes

Table 3: Byron Station, Unit 1, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

Pen. No.	θ (degrees)	N-729-1 Required Exam Coverage (inches)	Inspection Coverage Obtained/ Alternative Coverage Requested (inches)	Relief Requested
1	0.0	1.5	1.36	Yes
2	11.1	1.5	1.48	Yes
3	11.1	1.5	1.32	Yes
4	11.1	1.5	1.40	Yes
5	11.1	1.5	1.52	No
6	15.8	1.5	1.40	Yes
7	15.8	1.5	1.40	Yes
8	15.8	1.5	1.48	Yes
9	15.8	1.5	1.56	No
10	17.7	1.5	1.52	No
11	17.7	1.5	1.52	No
12	17.7	1.5	1.76	No
13	17.7	1.5	1.76	No
14	22.6	1.5	1.68	No
15	22.6	1.5	1.40	Yes
16	22.6	1.5	1.60	No
17	22.6	1.5	1.48	Yes
18	24.0	1.5	1.68	No
19	24.0	1.5	1.84	No
20	24.0	1.5	2.04	No
21	24.0	1.5	1.70	No
22	25.4	1.5	1.68	No
23	25.4	1.5	1.52	No
24	25.4	1.5	1.68	No
25	25.4	1.5	1.84	No
26	25.4	1.5	1.80	No
27	25.4	1.5	1.84	No
28	25.4	1.5	1.84	No
29	25.4	1.5	1.76	No
30	29.3	1.5	1.36	Yes
31	29.3	1.5	1.36	Yes
32	29.3	1.5	1.44	Yes
33	29.3	1.5	1.44	Yes
34	29.3	1.5	1.36	Yes
35	29.3	1.5	1.40	Yes
36	29.3	1.5	1.56	No
37	29.3	1.5	1.48	Yes
38	32.9	1.0	1.32	No
39	32.9	1.0	1.00	No
40	32.9	1.0	1.20	No
41	32.9	1.0	1.16	No
42	34.1	1.0	1.20	No
43	34.1	1.0	1.32	No
44	34.1	1.0	1.08	No
45	34.1	1.0	1.24	No
46	34.1	1.0	1.12	No
47	34.1	1.0	1.24	No
48	34.1	1.0	1.36	No
49	34.1	1.0	1.32	No
50	35.2	1.0	1.20	No
51	35.2	1.0	1.16	No
52	35.2	1.0	1.40	No
53	35.2	1.0	1.16	No
54	37.4	1.0	1.24	No
55	37.4	1.0	1.20	No
56	37.4	1.0	1.12	No
57	37.4	1.0	1.16	No
58	37.4	1.0	1.28	No
59	37.4	1.0	1.00	No
60	37.4	1.0	1.12	No
61	37.4	1.0	1.16	No
62	42.8	1.0	0.84	Yes
63	42.8	1.0	1.20	No
64	42.8	1.0	1.20	No
65	42.8	1.0	1.12	No
66	43.8	1.0	0.96	Yes
67	43.8	1.0	1.12	No
68	43.8	1.0	0.50	Yes
69	43.8	1.0	0.68	Yes
70	43.8	1.0	1.00	No
71	43.8	1.0	1.08	No
72	43.8	1.0	1.00	No
73	43.8	1.0	1.00	No
74	47.0	1.0	0.72	Yes
75	47.0	1.0	0.56	Yes
76	47.0	1.0	1.32	No
77	47.0	1.0	1.00	No
78	47.0	1.0	1.08	No

Table 4: Byron Station, Unit 2, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

Pen. No.	θ (degrees)	N-729-1 Required Exam Coverage (inches)	Inspection Coverage Obtained/ Alternative Coverage Requested (inches)	Relief Requested
1	0.0	1.5	1.16	Yes
2	11.1	1.5	1.40	Yes
3	11.1	1.5	1.28	Yes
4	11.1	1.5	1.28	Yes
5	11.1	1.5	1.20	Yes
6	15.8	1.5	1.16	Yes
7	15.8	1.5	1.12	Yes
8	15.8	1.5	1.16	Yes
9	15.8	1.5	1.20	Yes
10	17.7	1.5	2.00	No
11	17.7	1.5	1.96	No
12	17.7	1.5	1.92	No
13	17.7	1.5	2.00	No
14	22.6	1.5	1.16	Yes
15	22.6	1.5	1.16	Yes
16	22.6	1.5	1.44	Yes
17	22.6	1.5	1.24	Yes
18	24.0	1.5	1.88	No
19	24.0	1.5	1.76	No
20	24.0	1.5	1.90	No
21	24.0	1.5	1.92	No
22	25.4	1.5	2.04	No
23	25.4	1.5	2.00	No
24	25.4	1.5	1.56	No
25	25.4	1.5	1.56	No
26	25.4	1.5	2.00	No
27	25.4	1.5	1.96	No
28	25.4	1.5	1.80	No
29	25.4	1.5	1.72	No
30	29.3	1.5	1.12	Yes
31	29.3	1.5	1.20	Yes
32	29.3	1.5	1.08	Yes
33	29.3	1.5	0.92	Yes
34	29.3	1.5	0.88	Yes
35	29.3	1.5	1.28	Yes
36	29.3	1.5	1.16	Yes
37	29.3	1.5	1.48	Yes
38	32.9	1.0	1.16	No
39	32.9	1.0	0.80	Yes
40	32.9	1.0	1.04	No
41	32.9	1.0	1.20	No
42	34.1	1.0	0.88	Yes
43	34.1	1.0	1.08	No
44	34.1	1.0	0.84	Yes
45	34.1	1.0	0.80	Yes
46	34.1	1.0	1.00	No
47	34.1	1.0	1.12	No
48	34.1	1.0	1.16	No
49	34.1	1.0	1.12	No
50	35.2	1.0	1.00	No
51	35.2	1.0	0.96	Yes
52	35.2	1.0	0.88	Yes
53	35.2	1.0	0.88	Yes
54	37.4	1.0	1.20	No
55	37.4	1.0	0.92	Yes
56	37.4	1.0	0.64	Yes
57	37.4	1.0	1.08	No
58	37.4	1.0	0.84	Yes
59	37.4	1.0	1.60	No
60	37.4	1.0	1.20	No
61	37.4	1.0	1.00	No
62	42.8	1.0	1.20	No
63	42.8	1.0	0.76	Yes
64	42.8	1.0	1.40	No
65	42.8	1.0	1.52	No
66	43.8	1.0	1.28	No
67	43.8	1.0	1.00	No
68	43.8	1.0	0.84	Yes
69	43.8	1.0	0.80	Yes
70	43.8	1.0	1.08	No
71	43.8	1.0	0.96	Yes
72	43.8	1.0	1.00	No
73	43.8	1.0	1.24	No
74	47.0	1.0	1.12	No
75	47.0	1.0	1.04	No
76	47.0	1.0	1.24	No
77	47.0	1.0	1.12	No
78	47.0	1.0	1.08	No

Based on the measured values listed in Tables 1 through 4, deviation from the volumetric and surface examination coverage requirements of ASME Code Case N-729-1 of Item B4.20 is anticipated. Specifically, deviation from the required inspection coverage is sought for the reactor vessel head penetrations summarized in Table 5 below.

Table 5: Braidwood Station and Byron Station Reactor Vessel Head Penetrations Requiring Relief from Volumetric and Surface Examination Coverage Requirements

	Incidence Angle (θ) ≤ 30 degrees Required coverage (a) = 1.5"	Incidence Angle (θ) > 30 degrees Required coverage (a) = 1.0"
Braidwood Unit 1	1, 2, 4, 9, 14 through 17, 22, 25, 26, and 28 through 37	42, 49, 54, 63, 65, 66, 71, 72, 77, and 78
Braidwood Unit 2	1, 4, 5, 8, 32, 34, and 35	40, 46, 66, 67, 68, 70, 71, 73, 74, 76, 77, and 78
Byron Unit 1	1 through 4, 6, 7, 8, 15, 17, 30 through 35, and 37	62, 66, 68, 69, 74, and 75
Byron Unit 2	1 through 9, 14 through 17, and 30 through 37	39, 42, 44, 45, 51, 52, 53, 55, 56, 58, 63, 68, 69, and 71

5. PROPOSED ALTERNATIVE AND BASIS FOR USE

As an alternative to the volumetric and surface examination coverage requirements shown as dimension "a" in Figure 2 of ASME Code Case N-729-1, EGC proposes the use of attainable ultrasonic examination distances shown in Tables 1 through 4 of this request for those head penetrations listed in Table 5. The required examination coverage dimension for the other penetrations will be met or exceeded. In addition, EGC will examine the wetted surfaces on the vent line and vent line J-groove weld using the eddy current method as was done in the previous examinations performed under the NRC Order.

Appendix I of ASME Code Case N-729-1 provides the analysis procedure for the evaluation of an alternative examination area or volume to that specified in Figure 2 of the Code Case if impediments prevent the examination of the complete zone. Section I-1000 of ASME Code Case N-729-1 requires that for alternative examination zones that eliminate portions of the Figure 2 examination zone below the J-groove weld, the analyses shall be performed using at least the stress analysis method (Section I-2000) or the deterministic fraction mechanics analysis method (Section I-3000) to demonstrate that the applicable criteria are satisfied. In support of this relief request, the techniques of both Sections I-2000 and Method 1 of Section I-3200 were validated against Reference 2.

5.1 Stress Analysis in Accordance with ASME Code Case N-729-1 Section I-2000

Section I-2000 of ASME Code Case N-729-1 requires that plant-specific analysis demonstrate that the hoop and axial stresses remain below 20 ksi (tensile) over the

entire region outside the alternative examination zone but within the examination zone defined in Figure 2 of the Code Case. Analyses were performed for five different CRDM geometries, including the outermost row at 0 degrees angular position from the reactor vessel centerline, rows at 25.4 degrees, 42.8 degrees, 43.8 degrees and 47 degrees. The penetration nozzle numbers that are bounded by the analyzed penetration nozzle incidence angles are shown in Table 6.

Table 6: Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, Bounding Analyses

Figure No.	Analyzed Penetration Nozzle Incidence Angle (θ)	Penetration Nozzle Numbers Bounded by the Analyzed Nozzle
2	0°	1 – 21
3	25.4°	22 – 61
4	42.8°	62 – 65
5	43.8°	66 – 73
6	47°	74 – 78

The distance below the J-groove weld that needs to be examined, as determined by the point at which the CRDM penetration hoop stress distribution for the operating stress levels is less than 20,000 pounds per square inch (ksi) tension, was obtained from the graphs contained in Appendix A of Reference 2, Topical Report WCAP-16394-P, Revision 0, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Byron and Braidwood Units 1 and 2," dated February 2005. Reference 2 was previously submitted to the NRC as part of Reference 3.

The stress analysis methodology and conclusions are in Section 5 of Reference 2. The hoop stress distribution plots for the analyzed geometries are provided in Figures 2 through 6 of this submittal. Note that in all cases the hoop stresses during steady state operation dominate the axial stresses; Sections 5.3 through 5.5 of Reference 2 provide additional discussion.

The hoop stress distribution plots in Figures 2 through 6 indicate that the minimum achievable inspection coverage below the bottom of the J-groove weld ensures the stresses remain below 20 ksi (tensile) over the entire region outside the alternative examination zone but within the examination zone defined in Figure 2 as required by I-2000 of ASME Code Case N-729-1. Figures 2 through 6 were used to prepare the crack growth predictions shown in Figures 7 through 12 below and demonstrate that obtaining at least 0.55" below the J-groove weld is sufficient to allow for a minimum of six effective full power years (EFPY) or four 18-month cycles between examinations.

The inspection coverage obtained and the corresponding alternative coverage requested for each penetration nozzle, except Byron Station, Unit 1, penetration number 68, is greater than 0.55" as shown in Tables 1 through 4. The deterministic fracture mechanics analysis presented in Figure 12 below addresses Byron Station, Unit 1, penetration number 68, and illustrates the alternative coverage requested is sufficient.

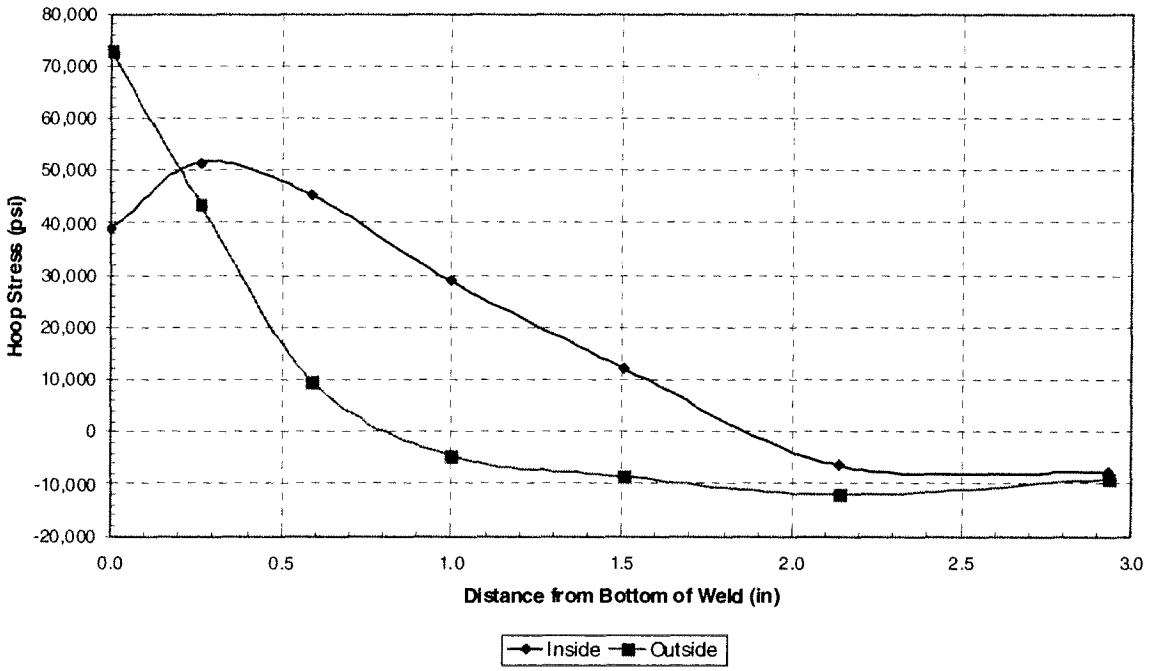

Figure 2: Hoop Stress Distribution Downhill and Uphill Side for 0° CRDM Penetration Nozzle (Figure A-1 from Reference 6)

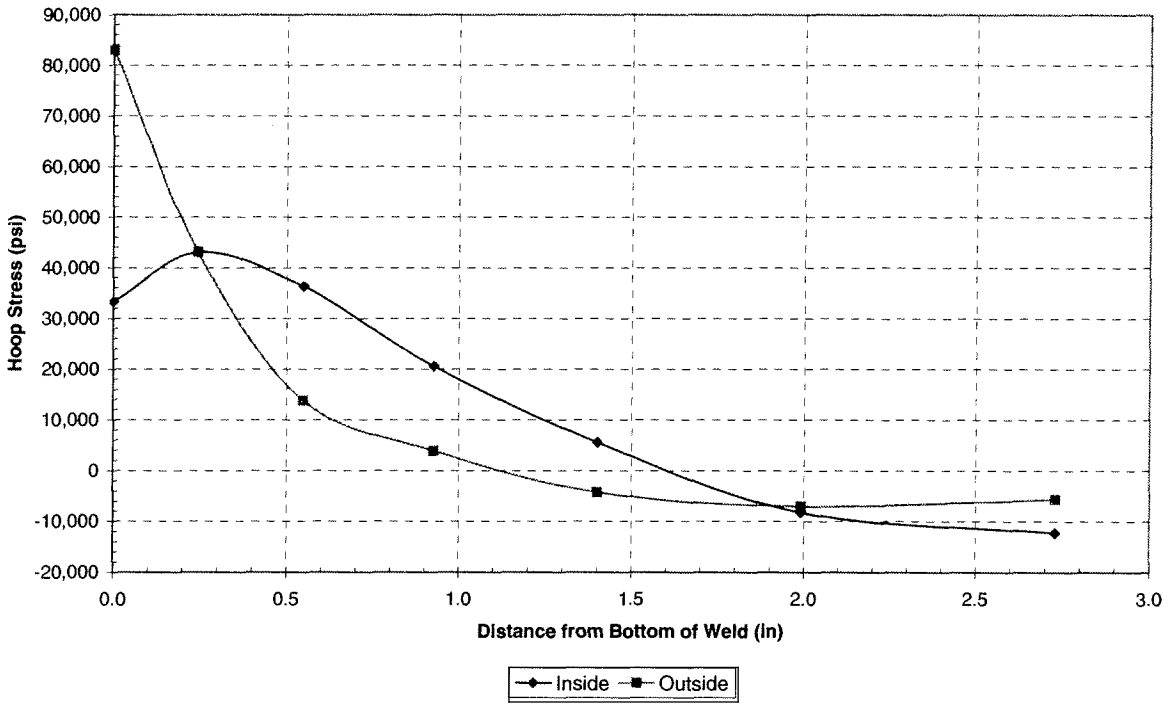

Figure 3: Hoop Stress Distribution Downhill Side for 25.4° CRDM Penetration Nozzle (Figure A-2 from Reference 6)

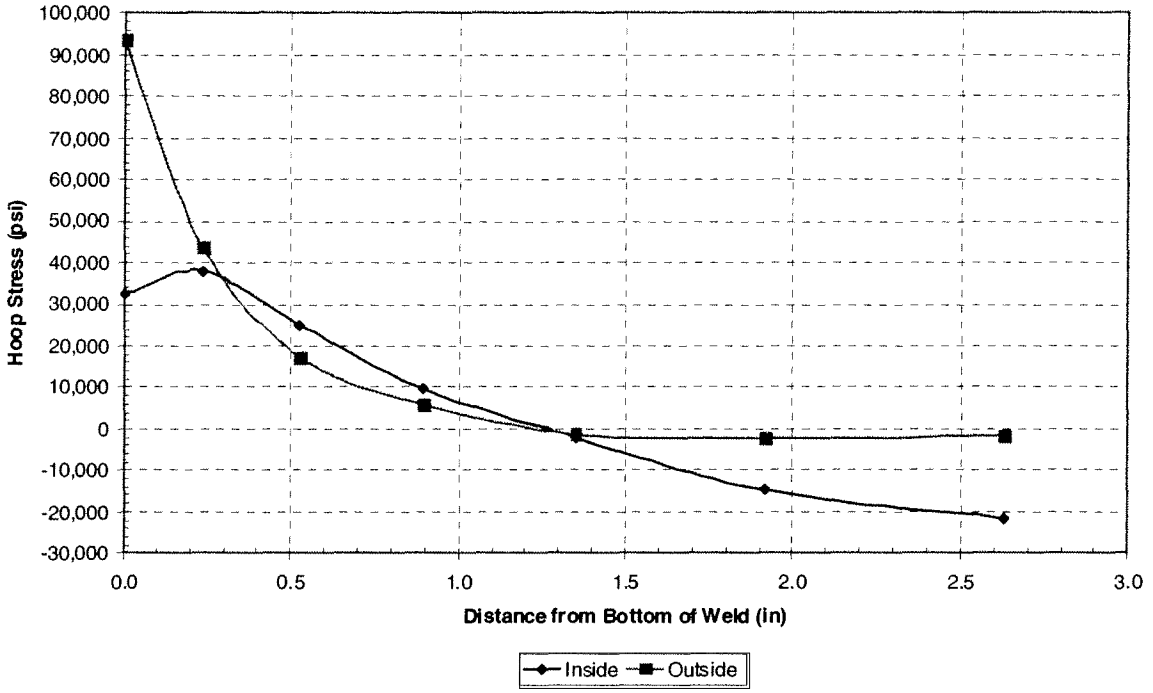

Figure 4: Hoop Stress Distribution Downhill Side for 42.8° CRDM Penetration Nozzle (Figure A-4 from Reference 6)

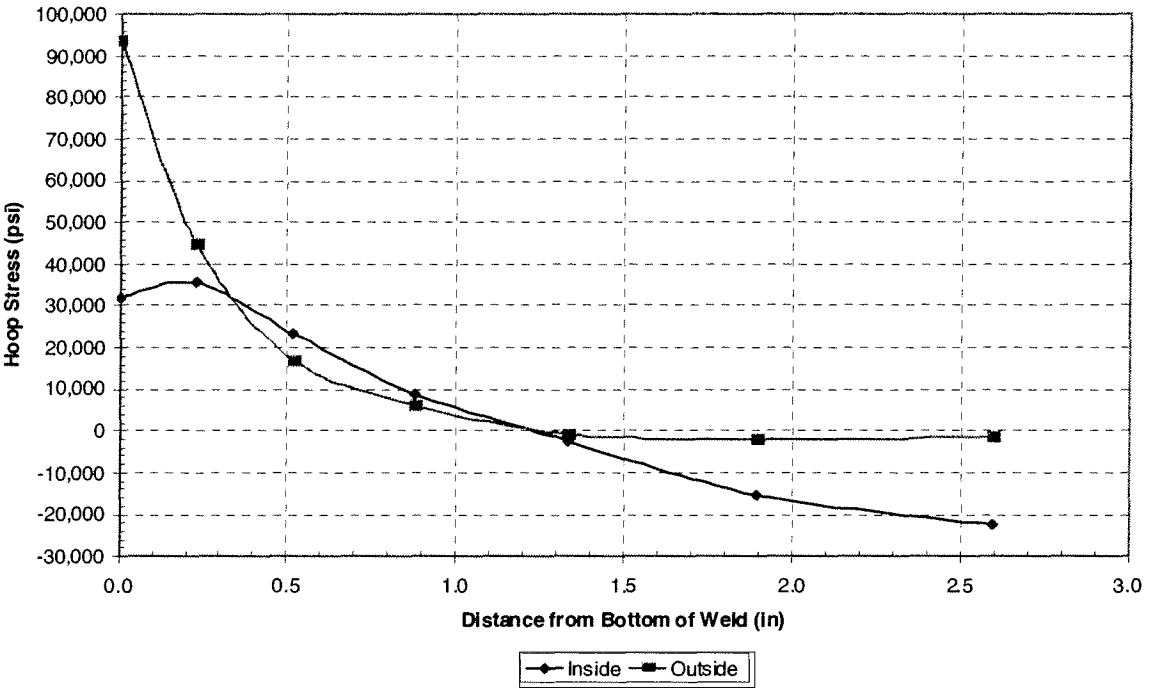

Figure 5: Hoop Stress Distribution Downhill Side for 43.8° CRDM Penetration Nozzle (Figure A-6 from Reference 6)

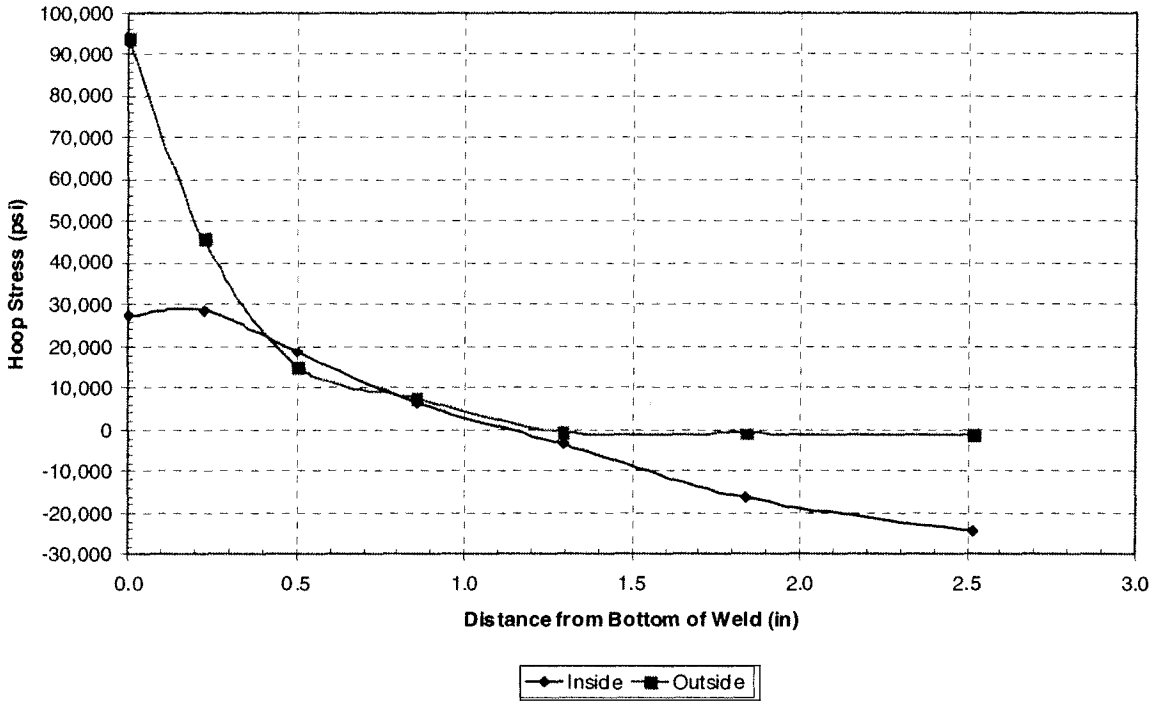

Figure 6: Hoop Stress Distribution Downhill Side for 47° CRDM Penetration Nozzle (Figure A-8 from Reference 6)

5.2 Deterministic Fracture Mechanics Analysis in Accordance with ASME Code Case N-729-1 Section I-3200, Method 1

In addition to the stress analysis detailed above, a fracture mechanics analysis was previously performed which meets the requirements of ASME Code Case N-729-1, Appendix I, Method 1 of Section I-3200 to demonstrate that a potential axial crack in the unexamined zone will not grow to the toe of the J-groove weld prior to the next scheduled examination.

The complete fracture mechanics analysis is provided in Section 6 of Reference 2 and was performed using input from the previously discussed stress analysis and bounding penetration geometries. The results of the analysis are shown as flaw tolerance charts which can be used to determine the minimum required inspection coverage to ensure that any flaws initiated below the weld in the region of the penetration nozzle not being inspected would not reach the bottom of the weld before the next inspection. The flaw tolerance charts are presented in Figures 7 through 11 and are further detailed in Reference 2. The flaw tolerance chart for Byron Station, Unit 1, penetration number 68 is presented in Figure 12 and is further discussed in Reference 10.

In accordance with Method I of I-3200, the crack growth calculations performed to produce the flaw tolerance charts assume the initial upper extremity of the through-wall flaw to be at or within the bottom edge of the alternative examination zone, and the lower extremity to be located on the penetration nozzle where either the inside or the outside surface hoop stress becomes compressive. The average of inside and outside surface hoop stress was applied along the entire length of the assumed through-wall crack, and the stress intensity factor was calculated using the standard expression for an axial through-wall crack in a cylinder. The crack growth rate determination used in Reference 2 meets the requirements of Appendix O of the 2004 Edition of the ASME Code, Section XI.

The resulting flaw tolerance charts in Figures 7 through 11 demonstrate that a postulated through-wall flaw at the bottom edge of the proposed alternative examination zone will not grow to the toe of the J-groove weld within an inspection interval of four refueling cycles. In all cases, the crack growth predictions show greater than six EFPY of operation required to grow the postulated flaw to the toe of weld. Additionally, the assumed initial upper extremity locations of axial through-wall flaws are conservative based on a review of the achievable inspection coverage zone in Tables 1 through 4 of this request, because the assumed upper crack extremities are located within the achievable inspection zone.

For Byron Station, Unit 2, only, per approved Relief Request I3R-16, Byron Station will complete the full volumetric and/or surface examination of all 78 nozzles, including the vent connection, every other outage and will complete a bare metal visual examination every outage. For CRDM penetration number 68, volumetric and surface examinations will be completed every outage. Reference 11 provides further details pertaining to Byron Station, Unit 2, CRDM penetration number 68.

Examination of portions of the nozzle significantly below the J-groove weld is not pertinent to the phenomena of concern, which include leakage through the J-groove weld and circumferential cracking in the nozzle above the J-groove weld. In all cases, the measured coverage is adequate to allow Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, to continue to operate prior to the hypothetical flaws reaching the J-groove weld. In accordance with 10 CFR 50.55a(g)(6)(ii)(D) requirements, the next examination required for the aforementioned units would be completed prior to flaw propagation into the J-groove welds. The flaw propagation studies are aligned with the examination interval in Byron Station, Unit 2, Relief Request I3R-16, which was previously approved by the NRC in Reference 11.

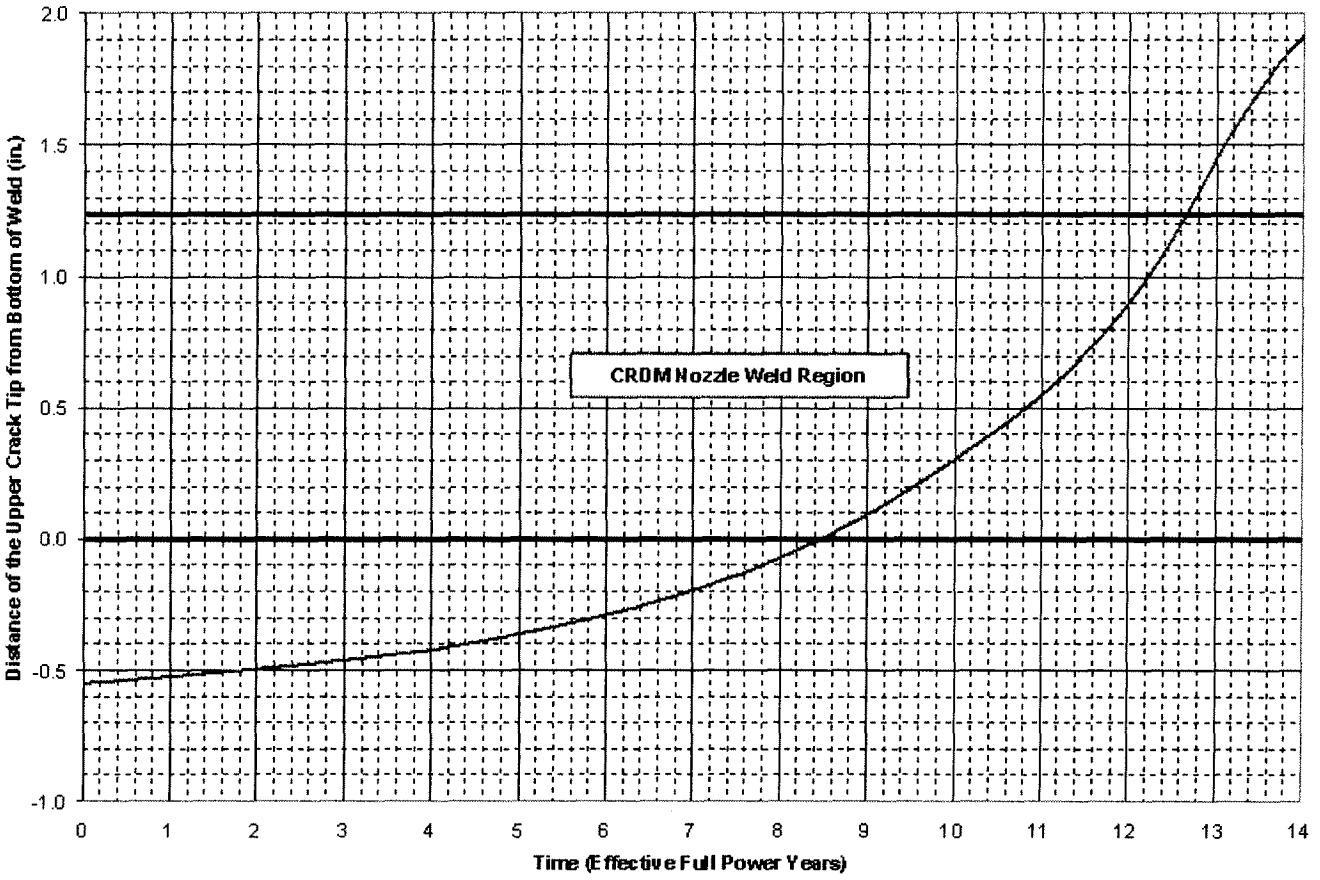

Figure 7: Crack growth prediction for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, for through-wall longitudinal flaws located in the center CRDM (0°) penetration (Figure 6-11 from Reference 2)

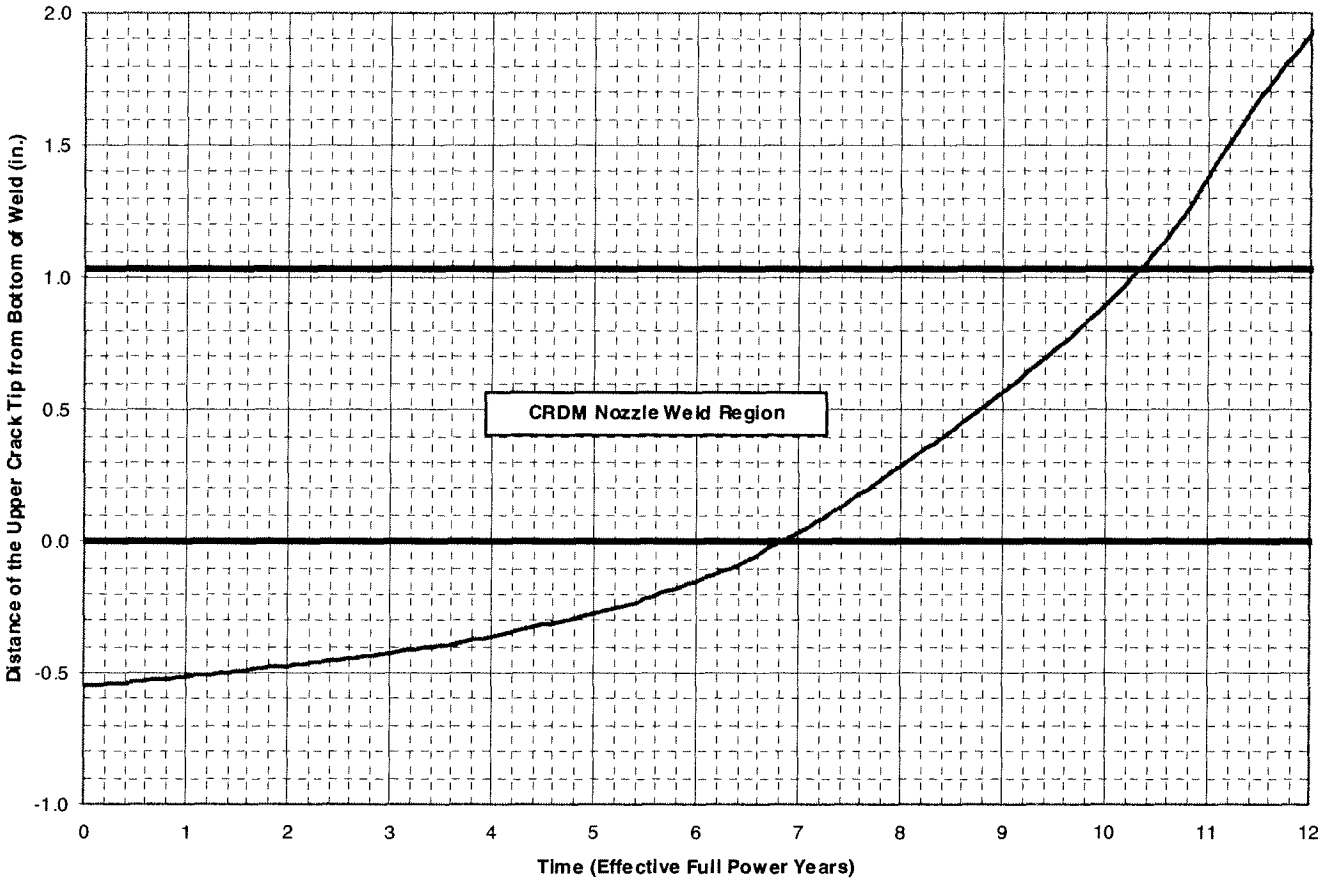

Figure 8: Crack growth prediction for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, for through-wall longitudinal flaws located in the CRDM (25.4°) penetration (Figure 6-12 from Reference 2)

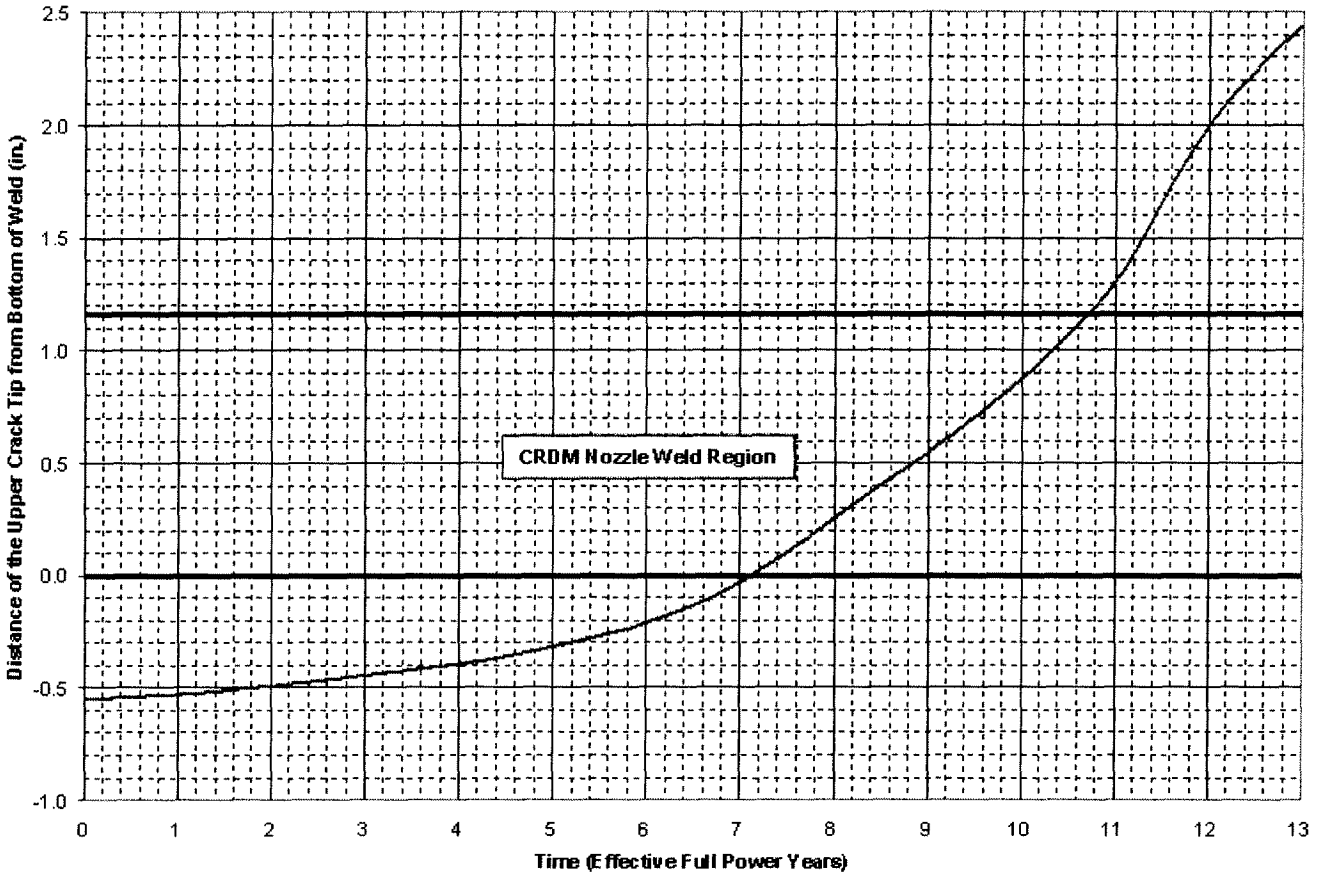

Figure 9: Crack growth prediction for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, for through-wall longitudinal flaws located in the CRDM (42.8°) penetration (Figure 6-13 from Reference 2)

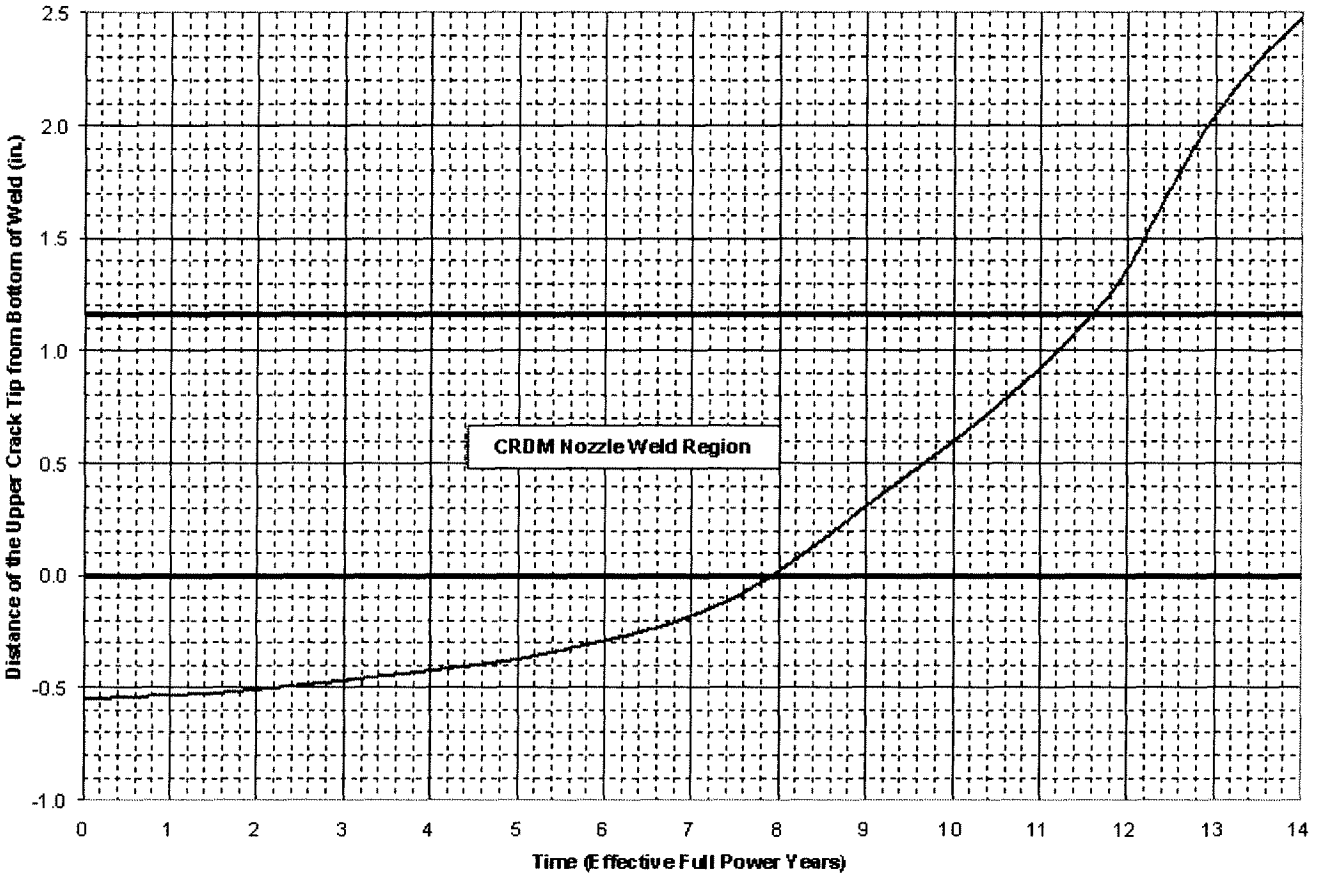

Figure 10: Crack growth prediction for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, for through-wall longitudinal flaws located in the CRDM (43.8°) penetration (Figure 6-14 from Reference 2)

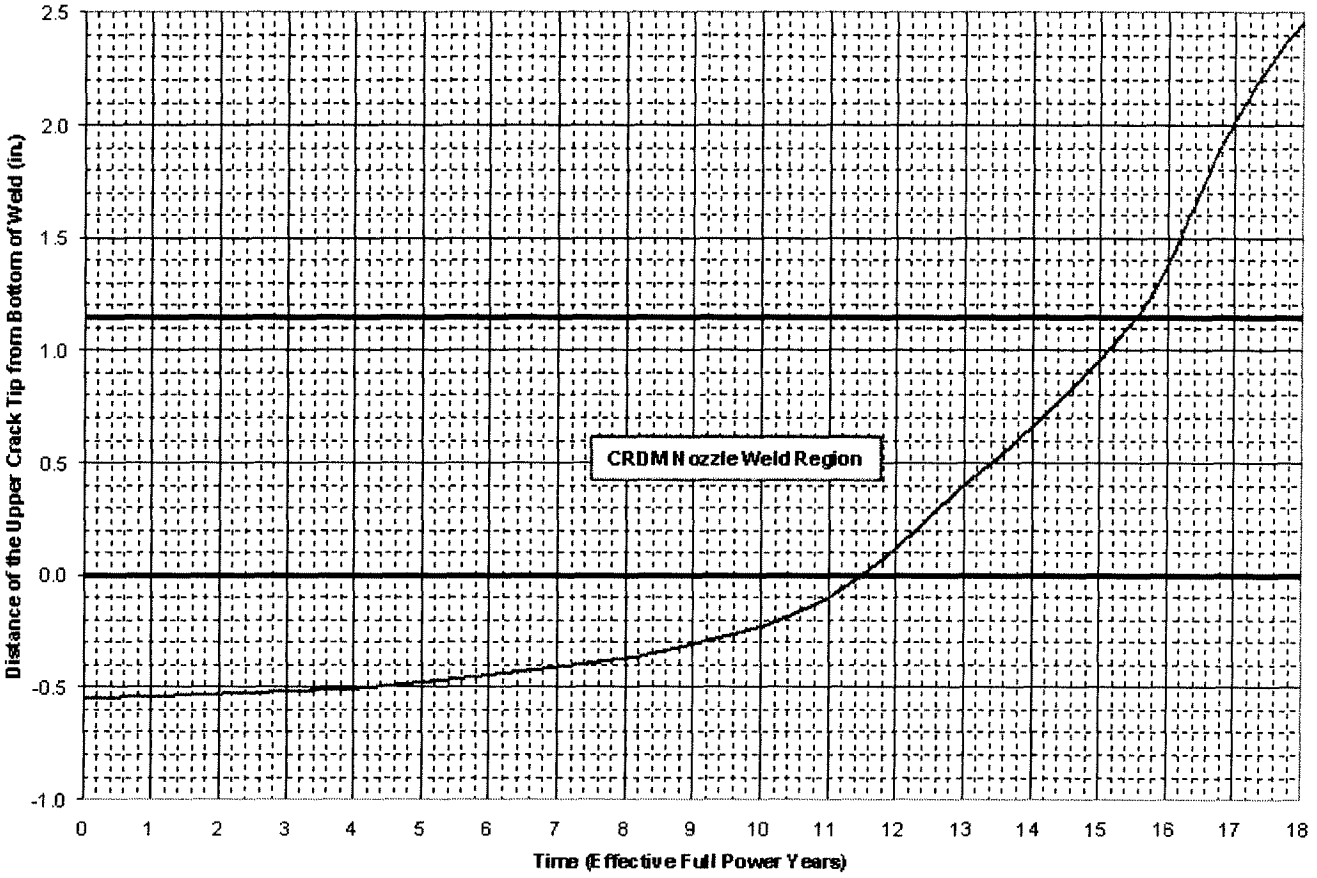

Figure 11: Crack growth prediction for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, for through-wall longitudinal flaws located in the CRDM (47.0°) penetration (Figure 6-15 from Reference 2)

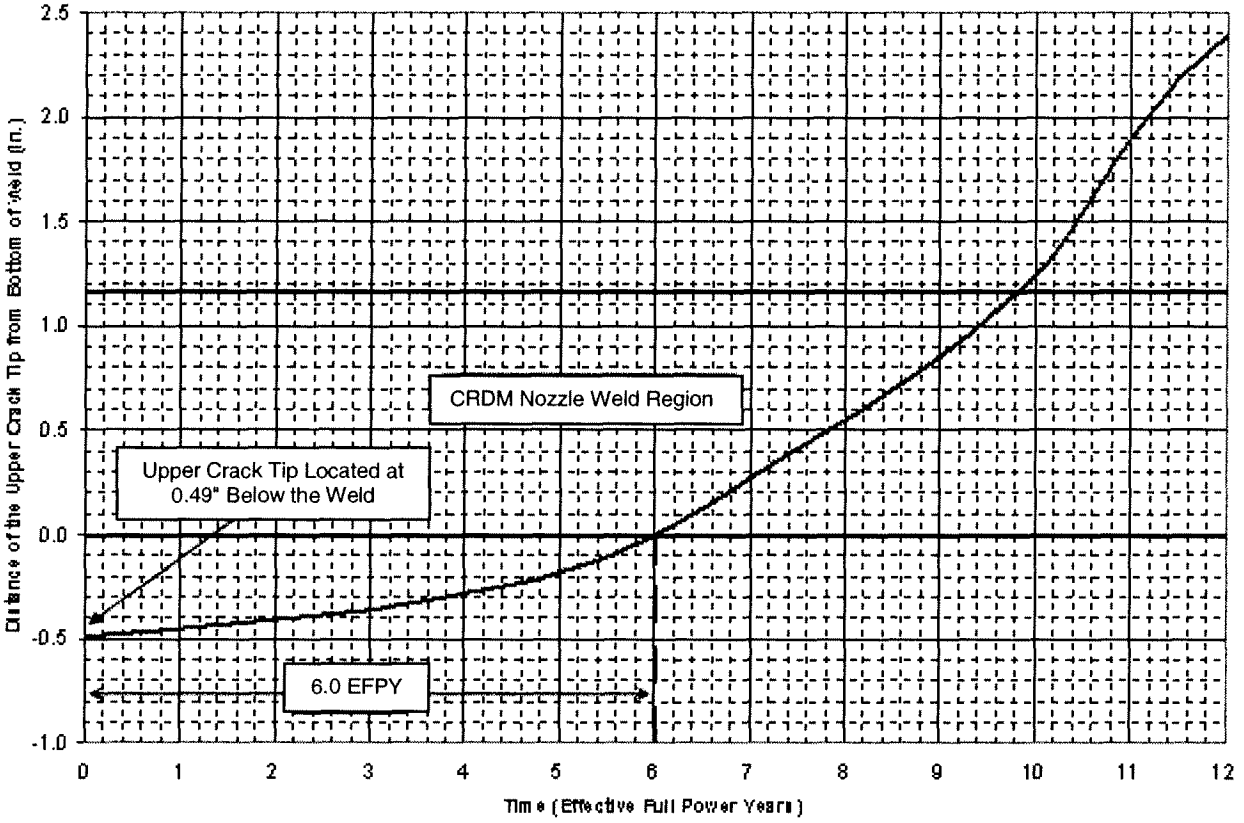

Figure 12: Crack growth prediction for Byron Station, Unit 1, for through-wall longitudinal flaws located in the CRDM penetration number 68 (Reference 10)

6. DURATION OF PROPOSED ALTERNATIVE:

The duration of the proposed alternative is for the remainder of the Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, third ten-year ISI interval. For Braidwood Station, the current interval end dates are July 28, 2018 for Unit 1 and October 16, 2018 for Unit 2. For Byron Station, the current interval end dates are July 15, 2016 for both Units 1 and 2.

7. PRECEDENT:

Precedence for relief from the requirements of examination coverage exists, since Beaver Valley, Unit 2, San Onofre, Unit 2, and Indian Point, Unit 2, have all been granted relief for the same issue.

Relaxations to the previously mandated requirements of NRC Order EA-03-009 were submitted and approved by the NRC for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2 (References 6, 7 and 8). The previously approved relaxation requests for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, applied to all of the 78 CRDM penetrations in the reactor vessel head under the requirements of the initial issuance of the Order and were based on Revision 0 of Reference 2.

The current request applies to the nozzles listed in Table 5 above due to the same geometric limitations encountered in satisfying the Order requirements.

8. REFERENCES:

1. ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1," dated March 28, 2006

2. WCAP-16394-P, Revision 0, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Byron and Braidwood Units 1 and 2," dated February 2005

3. Letter from J. A. Bauer (Exelon Generation Company, LLC) to U. S. NRC, "Relaxation Request for First Revised Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated March 31, 2006 (Braidwood Station, Unit 2, and Byron Station, Unit 1)

4. Letter from T. Coutu (Exelon Generation Company, LLC) to U. S. NRC, "Relaxation Request for First Revised Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated November 22, 2006 (Braidwood Station, Unit 1)

5. Letter from D. Hoots (Exelon Generation Company, LLC) to U. S. NRC, "Relaxation Request for First Revised Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated August 30, 2007 (Byron Station, Unit 2)

6. Letter from R. Gibbs (U. S. NRC) to C. Pardee (Exelon Generation Company, LLC), "Byron Station, Unit No. 2 – Relaxation of the First Revised Order EA-03-009 (TAC No. MD6638)," dated February 7, 2008

7. Letter from T. J. McGinty (U. S. NRC) to C. M. Crane (Exelon Generation Company, LLC), "Byron Station, Unit No. 1, and Braidwood Station, Unit No. 2 – Relaxation of the First Revised Order EA-03-009 (TAC Nos. MD1159 and MD1160)," dated September 11, 2006

8. Letter from T. J. McGinty (U. S. NRC) to C. M. Crane (Exelon Generation Company, LLC), "Braidwood Station, Unit 1 – Relaxation of the First Revised Order EA-03-009 (TAC No. MD3675)," dated September 26, 2007

9. NRC Order EA-03-009, "Issuance of First Revised Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 20 2004

10. Letter (No. CAE-06-34) from D. W. Alexander (Westinghouse Electric Company) to D. Bauers (Exelon Generation Company, LLC), "Exelon Nuclear Byron Unit 1 Inspection Coverage Evaluation for Byron Unit 1 (B1R13) CRDM Penetration No. 68 and No. 75," dated March 30, 2006.

11. Letter from S. J. Campbell (U. S. NRC) to C. G. Pardee (Exelon Generation Company, LLC), "Byron Station, Unit No. 2 – Relief Request I3R-16 for Reactor Pressure Vessel Head Penetration Examination Frequency (TAC No. ME1066)", dated January 28, 2010