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December 19, 2003
L-03-198

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

Subject: Beaver Valley Power Station, Unit No. 2
BV-2 Docket No. 50-412, License No. NPF-73
Supplement to Order (EA-03-009) Relaxation Request

References:

1) NRC Order EA-03-009, "Issuance of Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 11, 2003.

2) FirstEnergy Nuclear Operating Company (FENOC) response to NRC Order EA-03-009 for Beaver Valley Power Station (BVPS) Unit 1 and Unit 2, L-03-035 dated March 3, 2003.

3) BVPS Unit 2 Order Relaxation Request, L-03-088 dated July 29, 2003.

This letter transmits supplemental information to support a previous BVPS Unit 2 request (Reference 3) for a relaxation of requirements contained in NRC Order EA-03-009 (Reference 1) establishing interim inspection requirements for pressurized water reactor pressure vessel (RPV) heads. The Order requirements involve nondestructive examination (ultrasonic, eddy current, and dye penetrant testing) of the penetration nozzles below the J-groove weld that attaches the nozzle to the head. In Reference 2, FENOC consented to the Order for BVPS Unit 1 and Unit 2 with exceptions that were identified as potential items for relaxation.

The BVPS Unit 2 request (Reference 3) identified that limited portions of the bottom of the RPV head penetration nozzles can not be tested utilizing eddy current and ultrasonic methods due to the physical configuration of the nozzles and the limitations of the test equipment. Therefore, relaxation from the requirements specified in Section IV, paragraph C.(2)(b)(i) and C.(2)(b)(ii) of the Order was requested for BVPS Unit 2 regarding inspection to the bottom of the RPV head penetration nozzles.

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Secondly, FENOC requested that either of the techniques described in parts IV.C.(2)(b)(i) and IV.C.(2)(b)(ii) of the Order be used for any individual RPV head penetration, allowing for the use of a combination of techniques to complete a comprehensive inspection.

BVPS Unit 2 completed a refueling outage (2R10) in October 2003, at which time inspections to meet the requirements of the Order Part IV.C.(2)(a) and Part IV.C.(2)(b) for the RPV head penetrations were conducted. Note that since the Part IV.C.(2)(b) inspections were not required to be completed during 2R10 per the frequency specified in the Order, NRC approval of the relaxation was not necessary to support restart from 2R10.

Attachment 1 to this letter provides supplemental information, including field evaluation data obtained during 2R10, and applicable supporting analysis to demonstrate acceptability of the unexamined portions of the nozzles.

As demonstrated in the relaxation request submittal (Reference 3) and supported by the information in the attachment, the requested relaxation meets item IV.F.(2) of the Order, as compliance is unnecessary and would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety. Therefore, FENOC requests approval of the subject relaxation for the fulfillment of the requirements of NRC Order EA-03-009 Part IV.C.(2)(b). A response to this relaxation is requested by June 1, 2004 so that appropriate planning and resources may be allocated to the 2R11 RPV head inspection.

There are no new regulatory commitments identified in this document. If there are any questions regarding this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

Sincerely,

L. W. Pearce

L. William Pearce

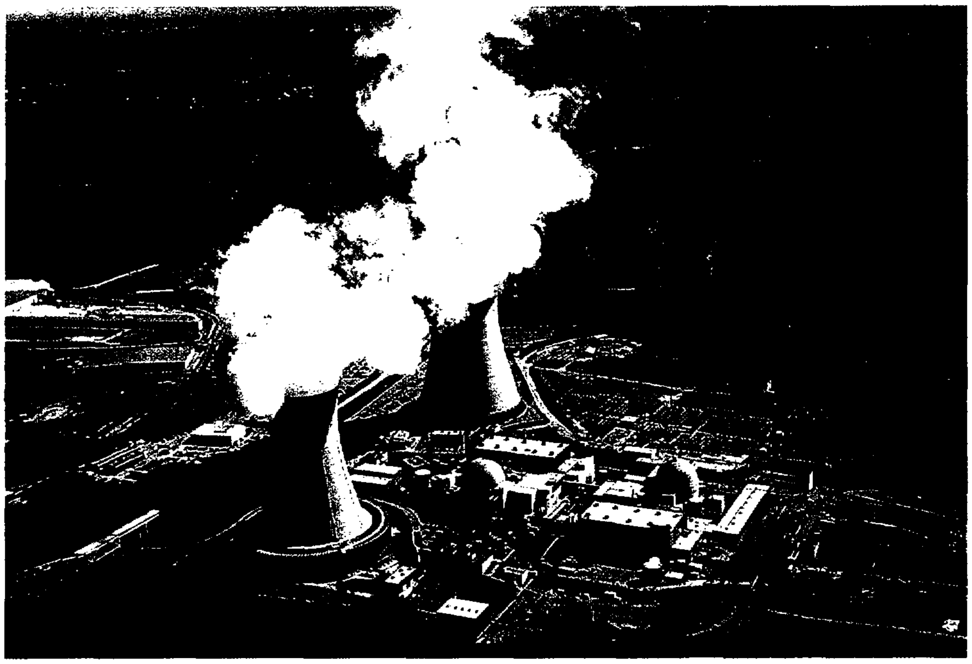
Attachments:
1) Supplemental Evaluation Report in support of BVPS Unit 2 Relaxation Request
2) WCAP-16144-NP, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Beaver Valley Unit 2"

c: Mr. T. G. Colburn, NRR Senior Project Manager
Mr. P. C. Cataldo, NRC Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Mr. S. J. Collins, Director, Office of Nuclear Reactor Regulation

Attachment 1

NRC Order EA-03-009
Beaver Valley Power Station Unit 2

FirstEnergy Nuclear Operating Company (FENOC)



Supplemental Evaluation Report

in Support of

Beaver Valley Power Station Unit 2

Relaxation Request to

NRC Order EA-03-009

December 2003

References

1. NRC Order EA-03-009, "Issuance of Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 11, 2003.
2. BVPS Unit 2 Order Relaxation Request, L-03-088 dated July 29, 2003.
3. BVPS Unit 2 60-Day Response to Order, dated December 9, 2003.

Background

On July 29, 2003, FENOC submitted a request for relaxation (Reference 2) from two of the requirements of NRC Order EA-03-009 (Reference 1) for Beaver Valley Power Station (BVPS) Unit 2. In this request, it was acknowledged that some information necessary to support the relaxation requests would not be available until after the non-destructive examination data had been obtained. Therefore, this supplemental report, which includes supplemental field evaluation data and applicable supporting analysis, is being submitted as the basis for determining that the non-destructive examinations performed during the 2R10 refueling outage provide an acceptable level of quality and safety to fulfill the requirements of part IV.C.(2)(b) of the Order.

Relaxation Item (a) requests relaxation from parts IV.C.(2)(b)(i) and IV.C.(2)(b)(ii) of the Order. Specifically, the relaxation is related to ultrasonic, eddy current, and dye penetrant testing of a limited bottom portion of the RPV penetration nozzles below the J-groove welds. These limited bottom portions of the nozzle are not part of the pressure boundary.

Relaxation Item (b) requests relaxation from part IV.C.(2)(b) of the Order, specifically, to allow for the requirements to be fulfilled using a combination of the techniques described in parts IV.C.(2)(b)(i) and IV.C.(2)(b)(ii) of the Order.

Clarification to Initial Relaxation Request (Reference 2)

Figure 1 of the original request depicted the design detail of the outermost penetrations of the BVPS Unit 2 Reactor Pressure Vessel (RPV) head. In the figure, the outermost penetrations are identified as numbers 62 through 69. These numbers were taken from generic Westinghouse 3-loop reactor vessel general assembly drawings. BVPS Unit 2 reactor vessel plant specific manufacturing drawings, however, label these outermost penetrations 58 through 65. This convention is used on all site reactor vessel drawings and was the convention used to perform and record the RPV head inspections. Therefore, Figure 1 of the original relaxation request should have identified the outermost penetrations as numbers 58 through 65.

Supplemental Information to Relaxation Request Item (a)

Non-Destructive Examination Results

The results of the non-destructive examinations performed during 2R10 were submitted as part of the BVPS Unit 2 60-day response (Reference 3) as required by Section IV, Paragraph E of the Order. As described in the response, non-destructive examinations were performed on all 65 Control Rod Drive Mechanism (CRDM) penetrations using the techniques described in part IV.C.(2)(b)(i) of the Order.

Time-of-flight diffraction ultrasonic data was obtained for each of the 65 CRDM penetrations in the BVPS Unit 2 RPV head from at least two inches above the J-groove weld to the uppermost elevation of the chamfer on the inside diameter (ID) surface (~0.75") and to slightly above the elevation of the thread relief on the outside diameter (OD) surface (~1.45"). The CRDM nozzle configuration is shown in Figure 1.

Straight beam ultrasonic data for the identification of leak paths in the interference fit area was obtained for each of the 65 CRDM penetrations from at least two inches above the J-groove weld to the top of the chamfer.

No Detectable Degradation (NDD) was reported in any of the 65 CRDM penetration tubes examined using time-of-flight diffraction ultrasonic testing. There were no indications of leak paths identified in the interference fit areas of any of the penetrations examined using straight beam ultrasonic testing. The final non-destructive examination report is included as Appendix A of the BVPS Unit 2 60-day response (Reference 3).

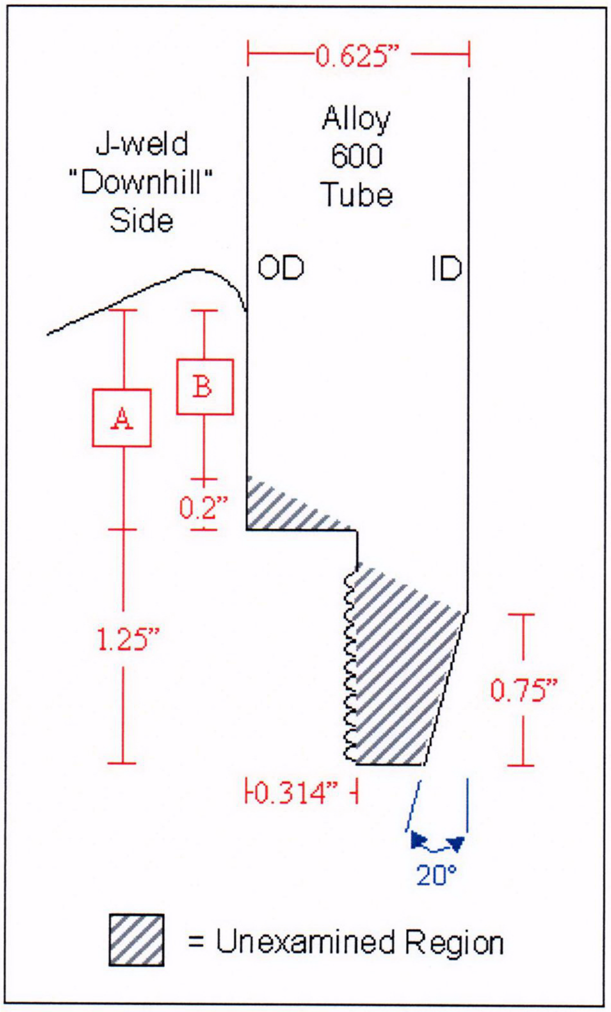


Figure 1: Inspection coverage obtained on the CRDM penetration "downhill" side. Dimensions "A" and "B" are specified for each penetration in Table 1.

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Non-Destructive Examination Coverage

As previously noted, the time-of-flight diffraction ultrasonic data was obtained for the 65 CRDM penetrations in the BVPS Unit 2 RPV head from at least two inches above the J-groove weld to the uppermost elevation of the chamfer on the ID surface (~0.75") and to slightly above the elevation of the thread relief on the OD surface (~1.45"). The inspection coverage is detailed in Figure 1.

The distance "A" on Figure 1, the distance from the bottom of the weld fillet to the top of the thread relief, was measured using data from the 0° transducer that is used for leak-path detection. The measured distance from the bottom of the weld fillet to the top of the thread relief was shown to be substantially less than the distance shown in the plant design drawings (see Table 1). This further limits the amount of exposed, straight tube below the weld that is able to be inspected using the current ultrasonic inspection techniques.

The distance "B" on Figure 1 represents the length of tube for which time-of-flight diffraction ultrasonic data was obtained. This dimension is 0.2 inches less than the measured dimension "A". This is due to the design of the probe and the mechanics of the inspection technique. The time-of-flight technique is a "pitch and catch" type of UT, whereby the signal is projected through the tube at an angle by one transducer, bounces off of the backside of the tube, and is received by a second transducer. The two transducers are mounted on the probe head 23.5 millimeters apart. As a result, data is obtained in a triangular pattern, with more data being obtained on the ID than the OD. The corner of the thread relief scatters the ultrasonic signal, and thus precludes data acquisition from 0.2" above the relief on the OD surface down to the inner corner of the thread relief, approximately mid-way through the tube thickness.

To evaluate the significance of the unexamined portions of the nozzles, the inspection coverage obtained on the OD of each penetration is shown in Table 1 (Dimension "B"). The OD coverage dimensions are used because, as shown in Figure 1, the minimum inspection coverage obtained is always on the "downhill" side of the OD. "Theoretical Dimension 'A'" represents the distance from the bottom of the weld fillet to the top of the thread relief as shown on plant design drawings. "Measured Dimension 'A'" is the actual distance from the bottom of the weld fillet to the top of the thread relief as measured using the 0° transducer. "Inspection Coverage Obtained 'B'" is the distance below the bottom of the weld fillet for which time-of-flight ultrasonic data was obtained and analyzed. All values in Table 1 are in inches and refer to the shortest distance on the "downhill" side.

The minimum coverage obtained below the weld for any of the 65 CRDM penetrations was 0.40" on Penetration 58 and 0.48" on Penetration 62. For all other penetrations, the minimum inspection coverage below the weld on the "downhill" side was 0.60" or greater. No detectable degradation was identified in any of the ultrasonic data obtained. The significance of the unexamined portions of the nozzles is discussed below.

Axial flaws in the unexamined portions of the nozzles in the non-pressure boundary tube material below the J-groove weld are of no structural significance. However, a postulated flaw could grow to extend above the weld, resulting in leakage or the initiation of a circumferential flaw. To determine the significance of a through-wall axial flaw in the unexamined portion of the nozzle base material, a flaw tolerance approach is used.

A flaw evaluation was performed postulating a through-wall axial flaw in the unexamined nozzle base material using WCAP-16144-P, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Beaver Valley Unit 2." The WCAP-16144-P flaw evaluations are performed for five different nozzle geometries, specific to BVPS Unit 2. The evaluations of these five geometries are used to bound all of the CRDM penetration geometries (13 total) in the BVPS

Unit 2 RPV head to provide the most conservative estimates. Due to the varying extent of examination coverage and the varying stress states described in this WCAP, it is prudent to evaluate the penetrations in these five groups based upon their similar nozzle geometry. This information is also included in the non-proprietary WCAP-16144-NP, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Beaver Valley Unit 2," which is enclosed with this submittal.

Table 1: 2R10 Ultrasonic OD Inspection Coverage – "Downhill" Side (Reference Figure 1)

Penetration #	Theoretical Dimension "A"	Measured Dimension "A"	Inspection Coverage Obtained "B"	Penetration #	Theoretical Dimension "A"	Measured Dimension "A"	Inspection Coverage Obtained "B"
1	1.99	1.64	1.44	34	2.03	1.12	0.92
2	2.04	1.88	1.68	35	2.03	1.60	1.40
3	2.04	1.52	1.32	36	2.03	1.28	1.08
4	2.04	1.72	1.52	37	2.03	1.08	0.88
5	2.04	1.44	1.24	38	2.03	1.04	0.84
6	2.03	1.46	1.26	39	2.03	1.36	1.16
7	2.03	1.40	1.20	40	2.03	1.44	1.24
8	2.03	1.32	1.12	41	2.03	1.12	0.92
9	2.03	1.60	1.40	42	2.11	1.12	0.92
10	2.02	1.60	1.40	43	2.11	1.16	0.96
11	2.02	1.28	1.08	44	2.11	1.36	1.16
12	2.02	1.60	1.40	45	2.11	1.08	0.88
13	2.02	1.56	1.36	46	2.01	1.00	0.80
14	2.04	1.52	1.32	47	2.01	1.28	1.08
15	2.04	1.40	1.20	48	2.01	1.08	0.88
16	2.04	1.64	1.44	49	2.01	1.08	0.88
17	2.04	1.46	1.26	50	2.01	1.36	1.16
18	1.99	1.32	1.12	51	2.01	1.40	1.20
19	1.99	1.36	1.16	52	2.01	1.32	1.12
20	1.99	1.20	1.00	53	2.01	1.28	1.08
21	1.99	1.52	1.32	54	2.12	1.16	0.96
22	2.00	1.28	1.08	55	2.12	1.00	0.80
23	2.00	1.40	1.20	56	2.12	0.92	0.72
24	2.00	1.48	1.28	57	2.12	1.12	0.92
25	2.00	1.40	1.20	58	1.81	0.60	0.40
26	2.07	1.24	1.04	59	1.81	0.96	0.76
27	2.07	1.44	1.24	60	1.81	0.88	0.68
28	2.07	1.32	1.12	61	1.81	0.88	0.68
29	2.07	1.08	0.88	62	1.81	0.68	0.48
30	2.07	1.20	1.00	63	1.81	0.88	0.68
31	2.07	1.60	1.40	64	1.81	1.08	0.88
32	2.07	1.44	1.24	65	1.81	0.80	0.60
33	2.07	1.32	1.12				

Figures 2 – 6 (included as Appendix A) show the crack growth predictions for a through-wall axial flaw in penetrations at angles of 0°, 25.4°, 38.7°, 40°, and 42.7°, respectively. Figures 4 – 6 are taken from WCAP-16144-NP (Figures 6-16, 6-18, and 6-20). Figures 2 and 3 were taken from Westinghouse Letter FENOC-03-216 Revision 1, Figures 1 and 2, and were developed using the same methodology described in the WCAP. The postulated crack tip was relocated in Figures 2 and 3 to locations more appropriate to the inspection coverage obtained on the inboard penetrations. A summary of the information contained in Figures 2 – 6 is shown in Table 2.

As indicated by Figures 6-12, 6-14, 6-16, 6-18, and 6-20 in WCAP-16144-NP, the crack propagation rates increase from the outward penetrations toward the center of the RPV head, resulting in less time (in EFPY) for the same postulated flaw to grow to reach the bottom of the weld. However, because far more examination coverage was achieved on the inboard penetrations due to the greater amount of exposed tube on the downhill side, the tip of the postulated crack is moved to a distance further below the weld while remaining well within the area of full inspection coverage. This allows the additional coverage obtained on the higher stress inboard penetrations to be quantified in terms of EFPY for the postulated flaw to reach the weld. Figures 2 and 3 of Appendix A demonstrate this rationale by assuming the tip of the postulated flaw is located a distance below the weld of 0.7 and 0.55 inches, respectively.

Table 2: Summary of Appendix A, Figures 2 - 6

Figure #	Penetration Set	Applicable Geometry	Postulated Through-Wall Crack Tip Distance Below Weld	EFPY for Crack Growth to Weld	Minimum Inspection Coverage Beyond Postulated Crack Tip
2	1-17	0°	0.7"	8.8	0.38"
3	18 – 45	25.4°	0.55"	6.1	0.29"
4	46 – 53	38.7°	0.5"	7.7	0.30"
5	54 – 57	40°	0.5"	8.7	0.22"
6	58 - 65	42.7°	0.4"	6.2	0.00"*

* Only Penetration #58 achieved no coverage below the postulated crack tip. For all other penetrations (59-65), examination coverage extended ≥ 0.08" below the postulated crack tip.

In all cases, an axial through-wall flaw below the region of ultrasonic inspection coverage would require a period of greater than 6 years of operation to grow to reach the bottom of the weld. This time period is significantly greater than the current under-head inspection frequency of every other refueling cycle (18 months for BVPS Unit 2) identified in Section IV.C.(2)(b) of the Order.

Additional conservatism is inherent in the preceding evaluation:

- The time required for the postulated flaw to grow from the bottom of the weld through the pressure boundary was not taken into account in the evaluation.
- Additional margin is provided in the inspection coverage achieved below the end of the postulated flaw in all cases, with the exception of Penetration #58 where inspection coverage was achieved to the tip of the postulated flaw. Exam coverage extends between 0.08 and 0.48 inches below the end of the flaw for penetrations 59 through 65. For penetrations 1 through 57 this distance is greater than 0.2 inches in all cases.
- A "through-wall" flaw in the unexamined region of the OD would be detected by the increased coverage on the ID. An undetected flaw in the unexamined portion of the OD just above the thread relief would be at most 0.314 inches through the 0.625 inches thick wall.
- The minimum inspection coverage applies to a limited arc of the OD of each penetration in the non-pressure boundary tube material below the weld.

The finite element stress analysis results of the CRDM penetrations show that the magnitude of the stresses in the unexamined portions of the nozzles is low. Figures 8 through 16 in Appendix B show the hoop stress for the uphill and downhill sides of the five nozzle angles used in the analysis. For clarity, the minimum inspection zone for the group of penetrations bounded by each curve is indicated on the plot. In all cases, the unexamined portion of each penetration lies in the low stress region of the nozzle. The ultrasonic inspection coverage dimensions for the "uphill" side of each CRDM penetration are shown in Appendix B, Table 3 and its corresponding Figure 7.

Evaluation of the 2R10 ultrasonic examination results and coverage of the BVPS Unit 2 CRDM penetrations confirms that there are no challenges to the structural integrity of the CRDM penetration nozzles that could be caused by axial flaws in the unexamined portions of the nozzles. After prudent conservative assumptions, the approach used in this analysis shows that any axial flaw in the unexamined, non-pressure boundary portion of the nozzles would require in excess of 6 EFPY to grow to reach the bottom of the weld.

In the fully examined pressure boundary and non-pressure boundary portions of the nozzles, no detectable degradation was identified in any of the ultrasonic examinations performed on the 65 CRDM penetrations during 2R10. In addition, no evidence of a leak-path into the interference fit zone was identified on any of the 65 CRDM penetrations.

Supplemental Information to Relaxation Request Item (b)

The non-destructive examinations performed during 2R10 were performed using a combination of the acceptable techniques described in Section IV.C.(2)(b) of the Order:

Section IV.C.(2)(b)(i): The nozzle base material of the 65 CRDM penetrations was examined using ultrasonic testing from two inches above the J-groove weld to the uppermost elevation of the chamfer on the ID surface (~0.75") and to slightly above the elevation of the thread relief on the OD surface (~1.45") (see Figure 1). In addition ultrasonic leak-path examinations were performed on all 65 CRDM penetrations to determine if leakage had occurred into the interference fit zone.

Section IV.C.(2)(b)(ii): The one RPV head vent line was examined using eddy current testing of the wetted surface of the J-groove weld and penetration nozzle base material to at least two inches above the J-groove weld.

All non-destructive examinations were completed using the techniques described in either part IV.C.(2)(b)(i) or IV.C.(2)(b)(ii) and therefore, meet the level of quality and safety required by the Order.

Conclusion

In providing the preceding supporting evaluation to the original relaxation submittal (Reference 2), FENOC requests approval of the subject relaxation for the fulfillment of the requirements of NRC Order EA-03-009 Part IV.C.(2)(b).

Appendix A

Crack Growth Predictions

for

BVPS Unit 2

CRDM Penetrations

Figure 2

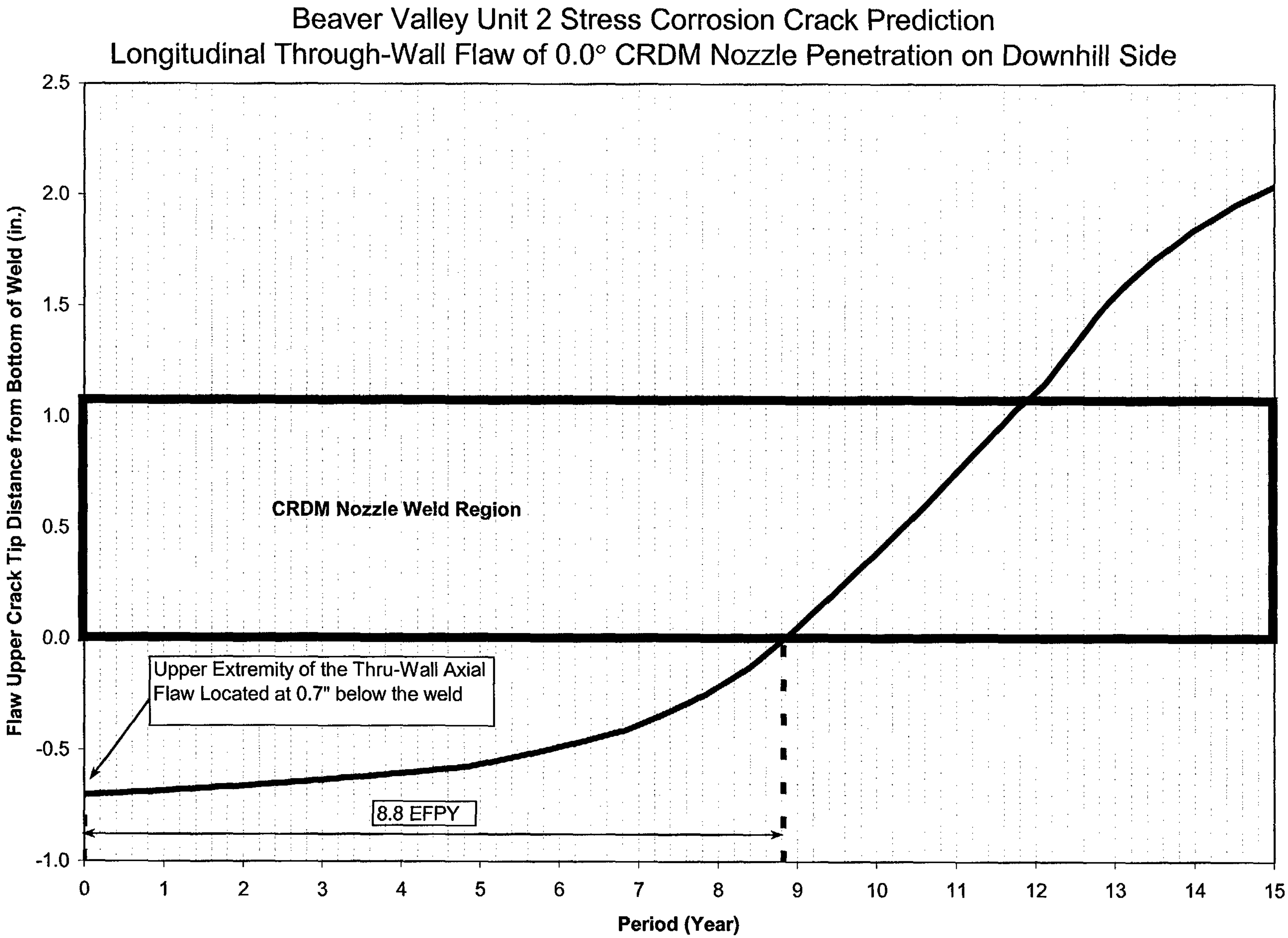

Beaver Valley Unit 2 Stress Corrosion Crack Prediction
Longitudinal Through-Wall Flaw of 0.0° CRDM Nozzle Penetration on Downhill Side
Flaw Upper Crack Tip Distance from Bottom of Weld (in.)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
CRDM Nozzle Weld Region
Upper Extremity of the Thru-Wall Axial Flaw Located at 0.7" below the weld
8.8 EFPY
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Period (Year)

Figure 3

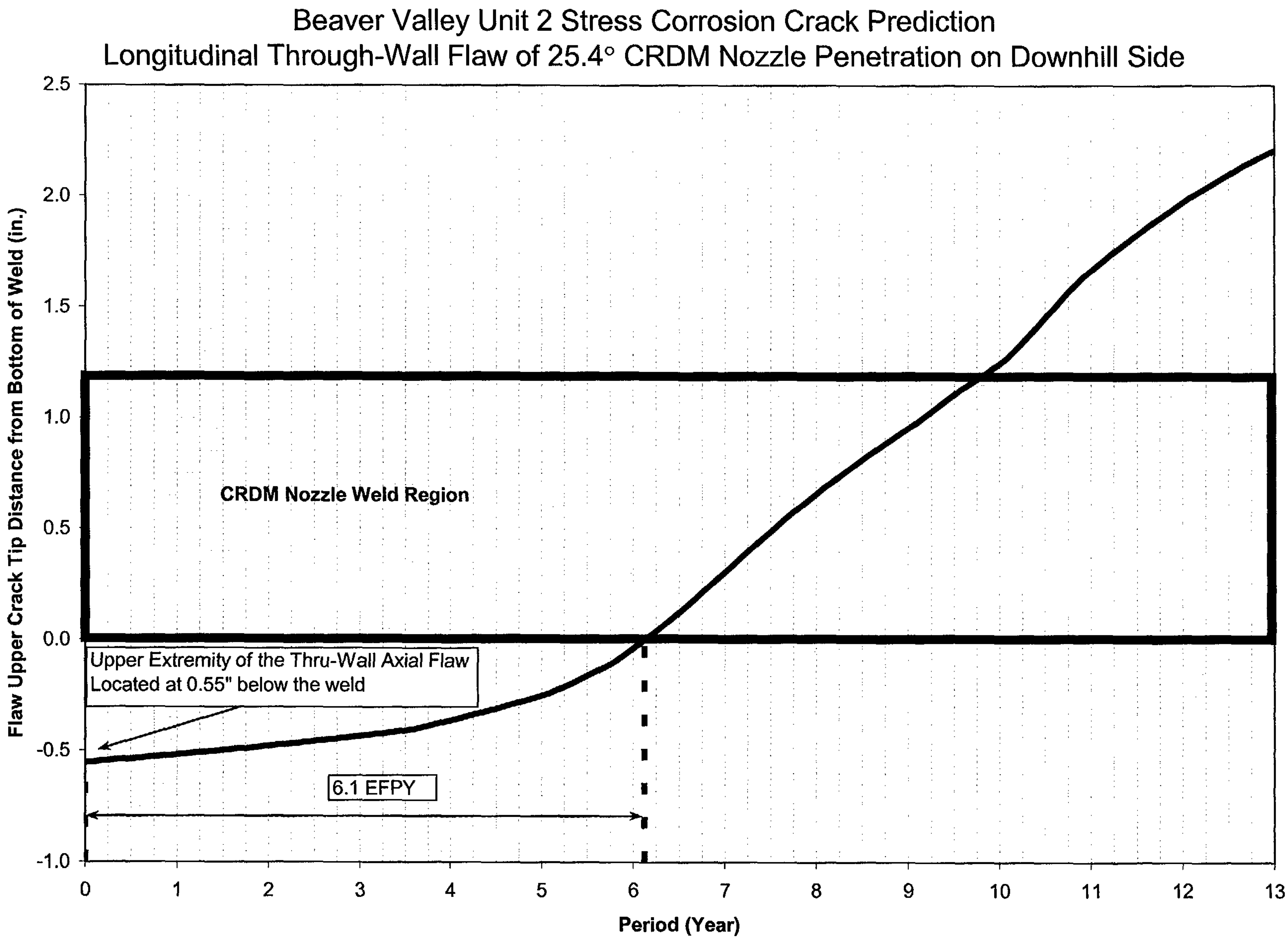

Beaver Valley Unit 2 Stress Corrosion Crack Prediction
Longitudinal Through-Wall Flaw of 25.4° CRDM Nozzle Penetration on Downhill Side
Flaw Upper Crack Tip Distance from Bottom of Weld (in.)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
CRDM Nozzle Weld Region
Upper Extremity of the Thru-Wall Axial Flaw
Located at 0.55" below the weld
6.1 EFPY
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Period (Year)

Figure 4

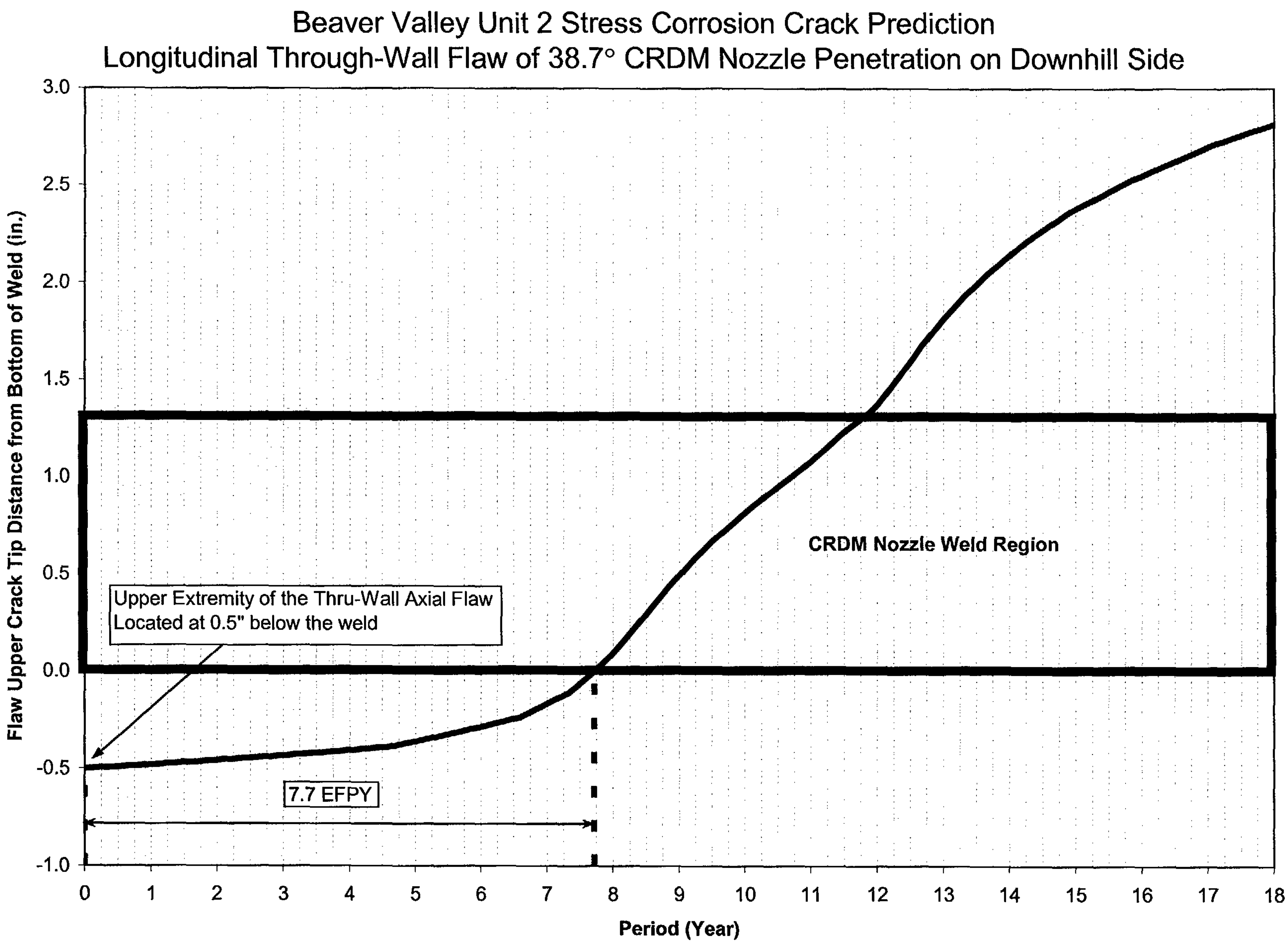
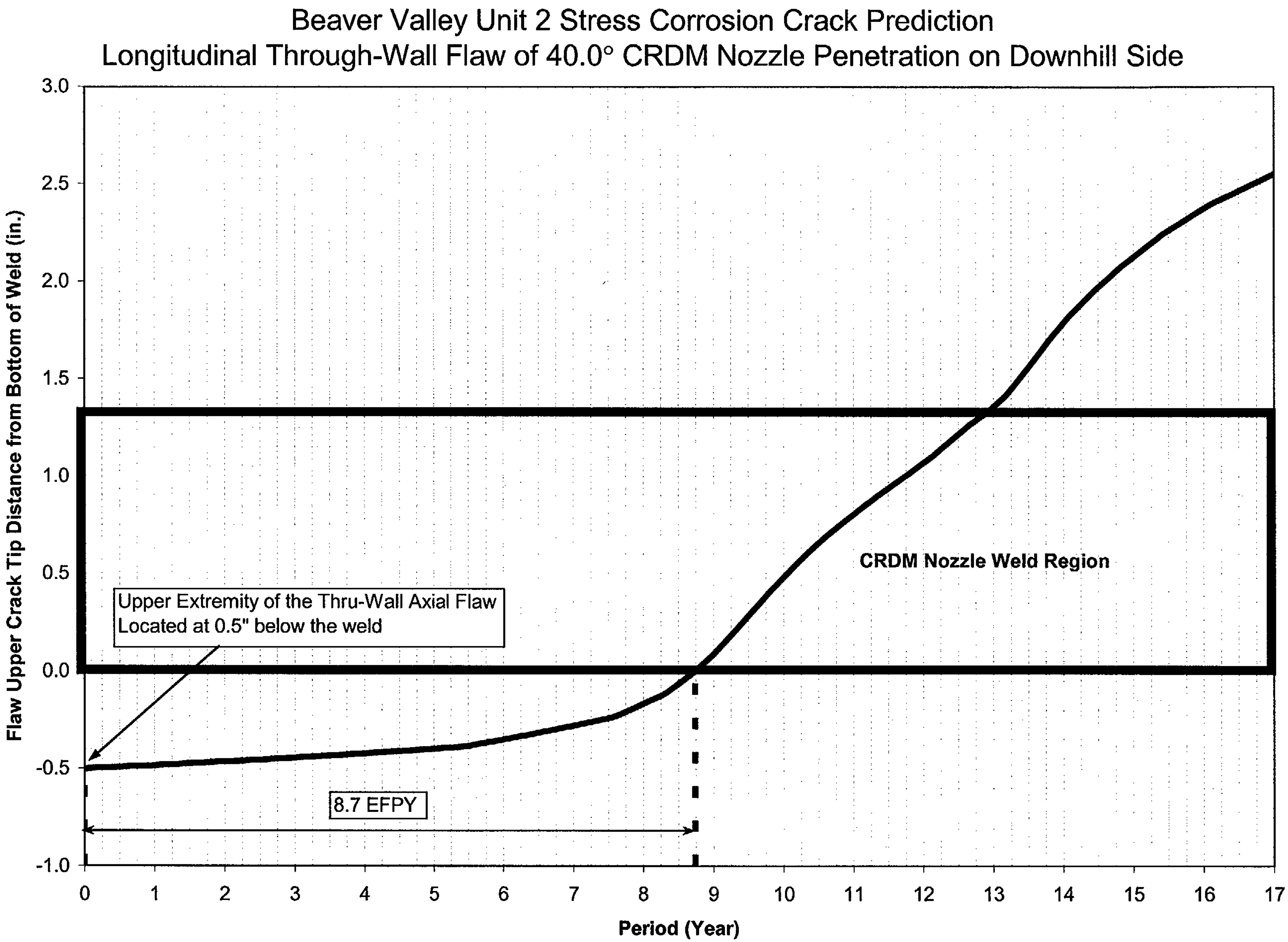
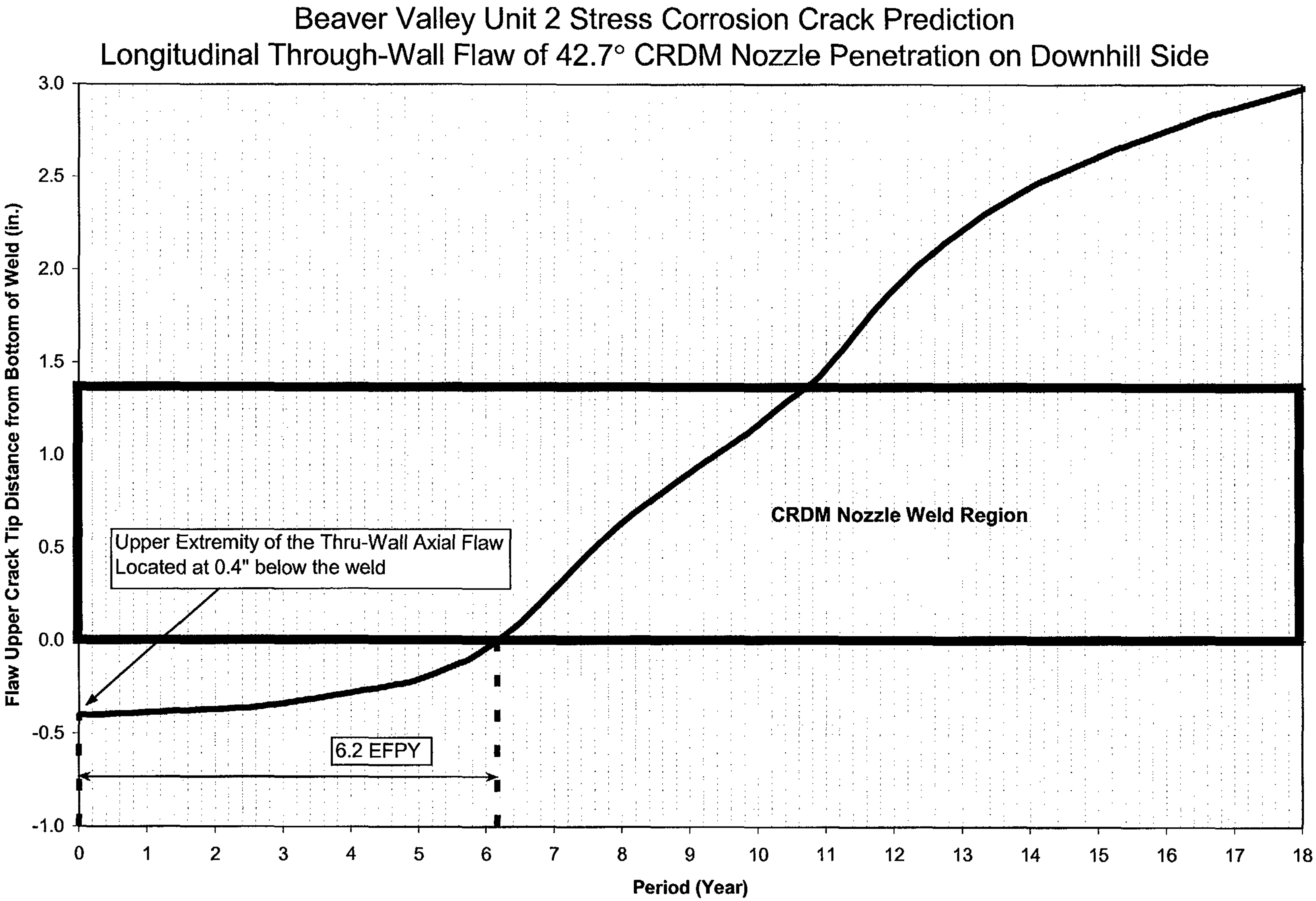

Beaver Valley Unit 2 Stress Corrosion Crack Prediction
Longitudinal Through-Wall Flaw of 38.7° CRDM Nozzle Penetration on Downhill Side
Flaw Upper Crack Tip Distance from Bottom of Weld (in.)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
CRDM Nozzle Weld Region
Upper Extremity of the Thru-Wall Axial Flaw Located at 0.5" below the weld
7.7 EFPY
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Period (Year)

Figure 5



Beaver Valley Unit 2 Stress Corrosion Crack Prediction
Longitudinal Through-Wall Flaw of 40.0° CRDM Nozzle Penetration on Downhill Side
Flaw Upper Crack Tip Distance from Bottom of Weld (in.)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
CRDM Nozzle Weld Region
Upper Extremity of the Thru-Wall Axial Flaw
Located at 0.5" below the weld
8.7 EFPY
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Period (Year)

Figure 6



Note that flaw upper crack tip of the longitudinal through-wall flaw for 42.7 degree penetration nozzle is postulated at 0.4" below the J-weld on the downhill side instead of 0.5" . This is because the stress intensity factor at 0.5" region is small (less than 9.0 Mpa*sqrt(M)).

Appendix B

"Uphill" Side Ultrasonic Inspection Coverage

and

Hoop Stress Distributions

for

BVPS Unit 2

CRDM Penetrations

Table 3: 2R10 Ultrasonic OD Inspection Coverage – "Uphill" Side (Reference Figure 7)

Penetration #	Theoretical Dimension "C"	Measured Dimension "C"	Inspection Coverage Obtained "D"		Penetration #	Theoretical Dimension "C"	Measured Dimension "C"	Inspection Coverage Obtained "D"
1	1.99	1.64	1.44		34	4.64	4.08	3.88
2	2.65	2.40	2.20		35	4.64	4.48	4.28
3	2.65	2.24	2.04		36	4.64	4.20	4.00
4	2.65	2.32	2.12		37	4.64	4.08	3.88
5	2.65	2.08	1.88		38	4.64	4.36	4.16
6	2.90	2.72	2.52		39	4.64	4.40	4.20
7	2.90	2.52	2.32		40	4.64	4.36	4.16
8	2.90	2.32	2.12		41	4.64	4.12	3.92
9	2.90	2.60	2.40		42	5.14	4.68	4.48
10	3.29	3.04	2.84		43	5.14	4.60	4.40
11	3.29	2.76	2.56		44	5.14	4.44	4.24
12	3.29	2.80	2.60		45	5.14	4.72	4.52
13	3.29	2.68	2.48		46	5.21	4.52	4.32
14	3.48	3.20	3.00		47	5.21	5.04	4.84
15	3.48	3.04	2.84		48	5.21	4.72	4.52
16	3.48	3.08	2.88		49	5.21	4.96	4.76
17	3.48	2.88	2.68		50	5.21	5.08	4.88
18	3.88	3.40	3.20		51	5.21	5.04	4.84
19	3.88	3.40	3.20		52	5.21	5.08	4.88
20	3.88	3.36	3.16		53	5.21	4.84	4.64
21	3.88	3.64	3.44		54	5.45	5.00	4.80
22	4.05	4.04	3.84		55	5.45	5.20	5.00
23	4.05	3.48	3.28		56	5.45	5.04	4.84
24	4.05	3.88	3.68		57	5.45	4.96	4.76
25	4.05	3.76	3.56		58	5.50	5.08	4.88
26	4.24	3.76	3.56		59	5.50	5.52	5.32
27	4.24	3.88	3.68		60	5.50	5.20	5.00
28	4.24	3.68	3.48		61	5.50	5.32	5.12
29	4.24	3.72	3.52		62	5.50	5.28	5.08
30	4.24	3.88	3.68		63	5.50	5.16	4.96
31	4.24	4.04	3.84		64	5.50	5.16	4.96
32	4.24	3.84	3.64		65	5.50	5.20	5.00
33	4.24	3.80	3.60					

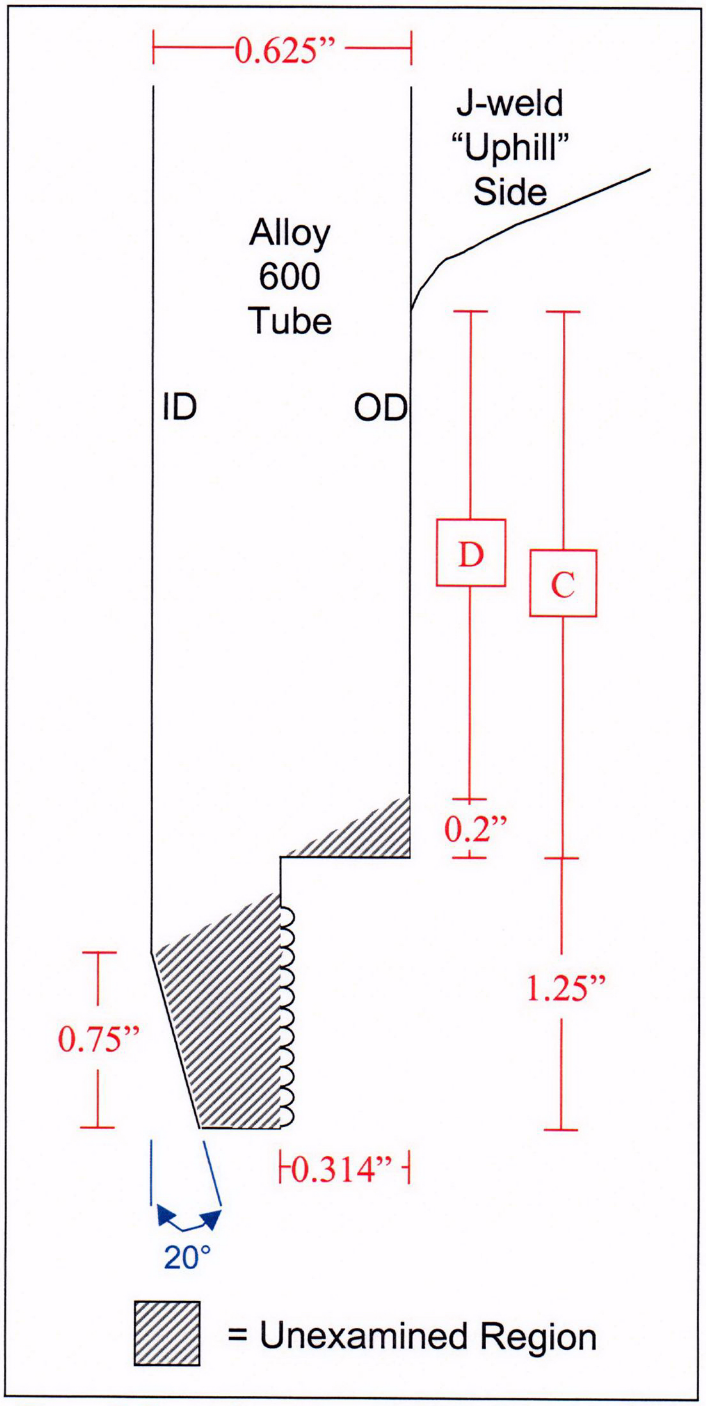
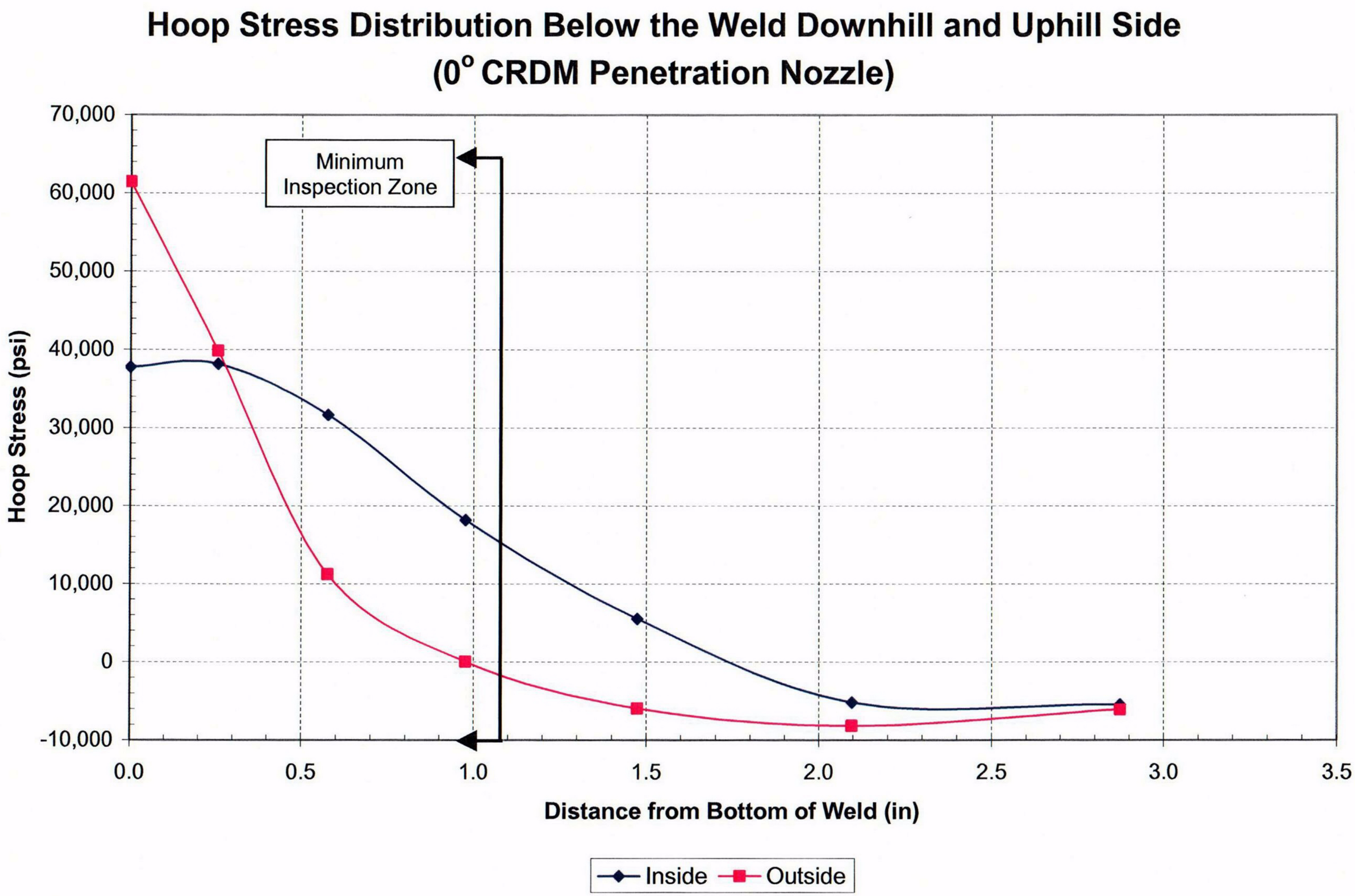


Figure 7: Inspection coverage obtained on the CRDM penetration "uphill" side. Dimensions "C" and "D" are specified for each penetration in Table 3.

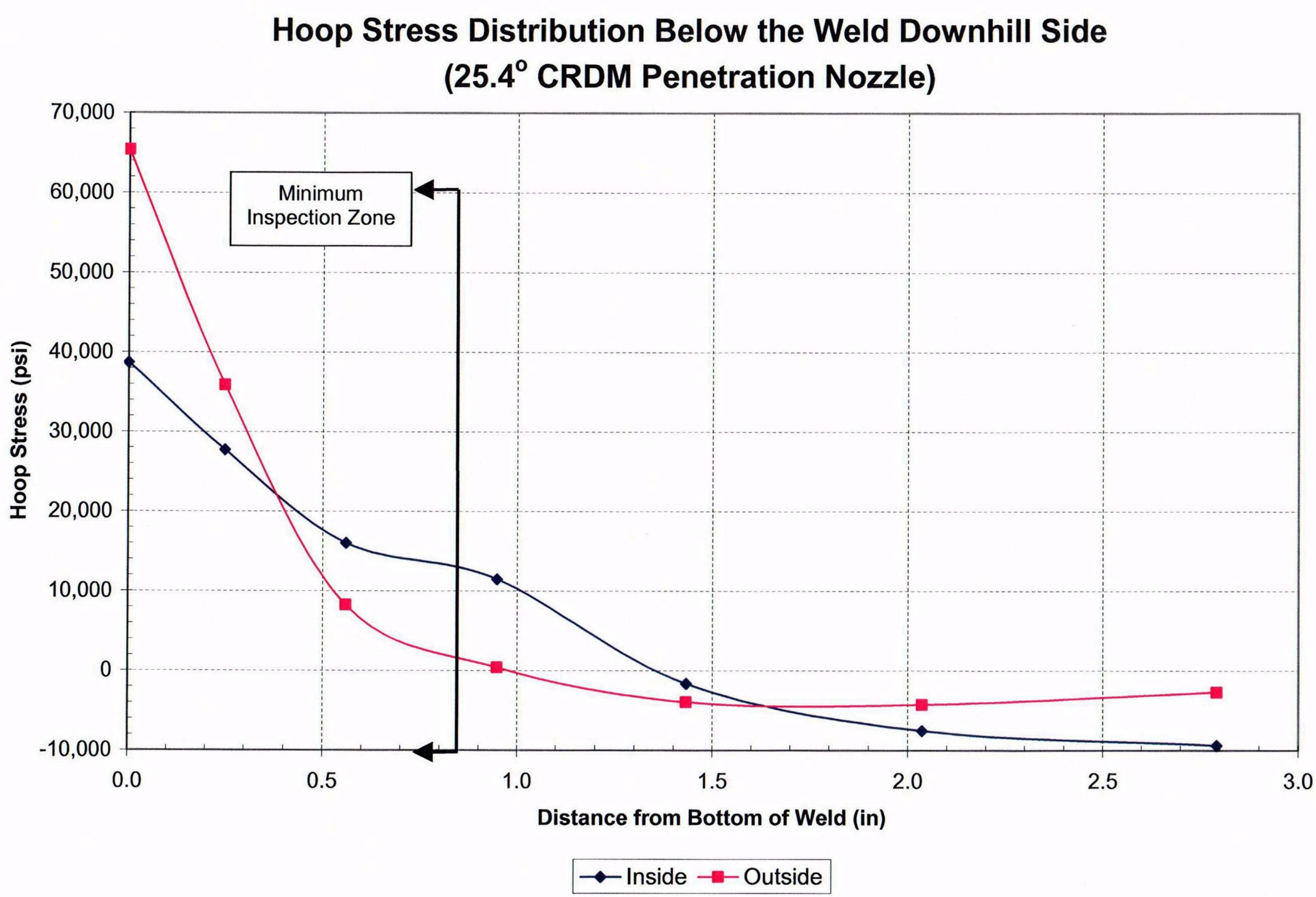
C-02

<u>**Figure 8**</u>



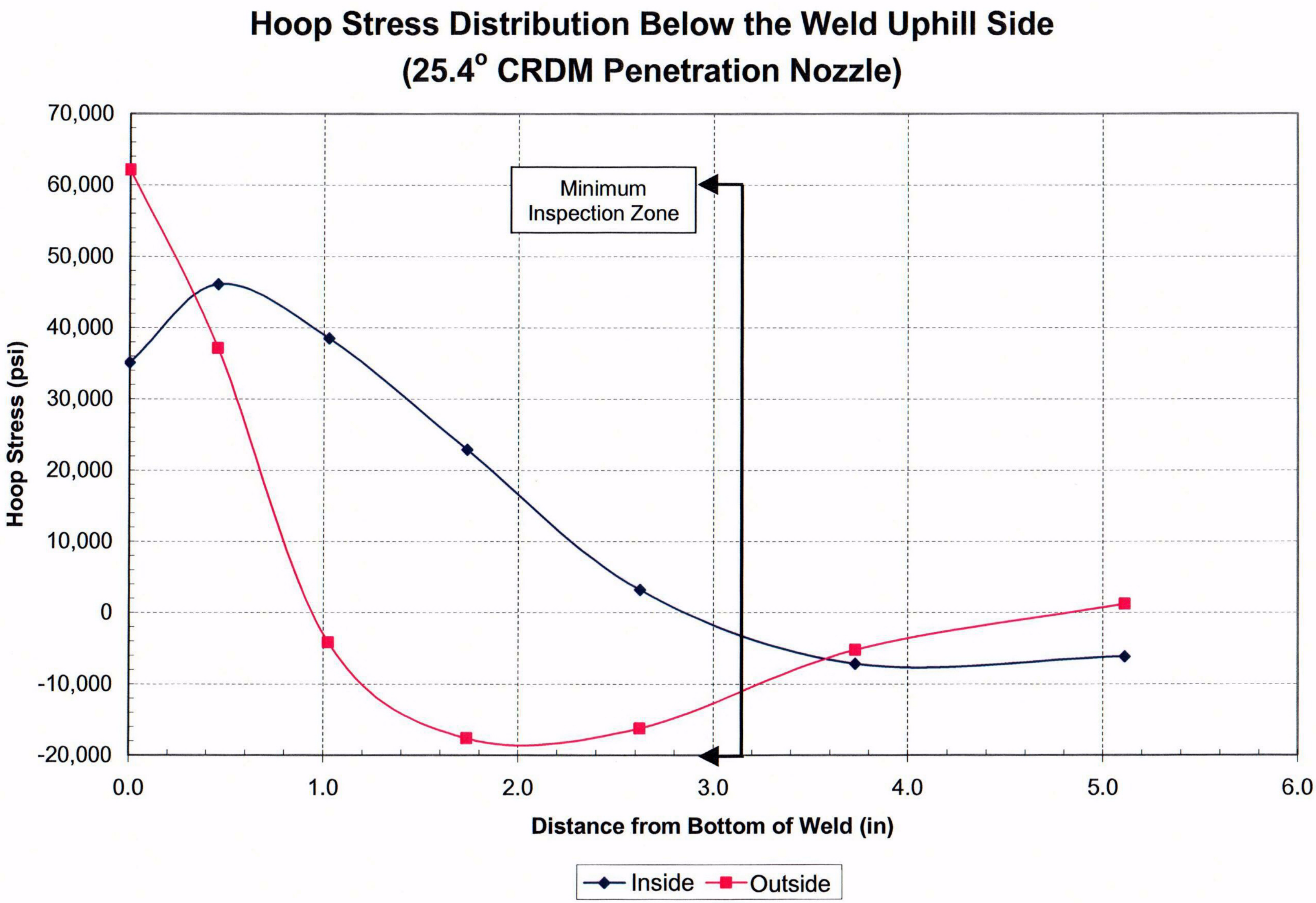
C-03

Figure 9


Hoop Stress Distribution Below the Weld Downhill Side
(25.4° CRDM Penetration Nozzle)
Minimum
Inspection Zone
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
Hoop Stress (psi)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Distance from Bottom of Weld (in)
Inside
Outside

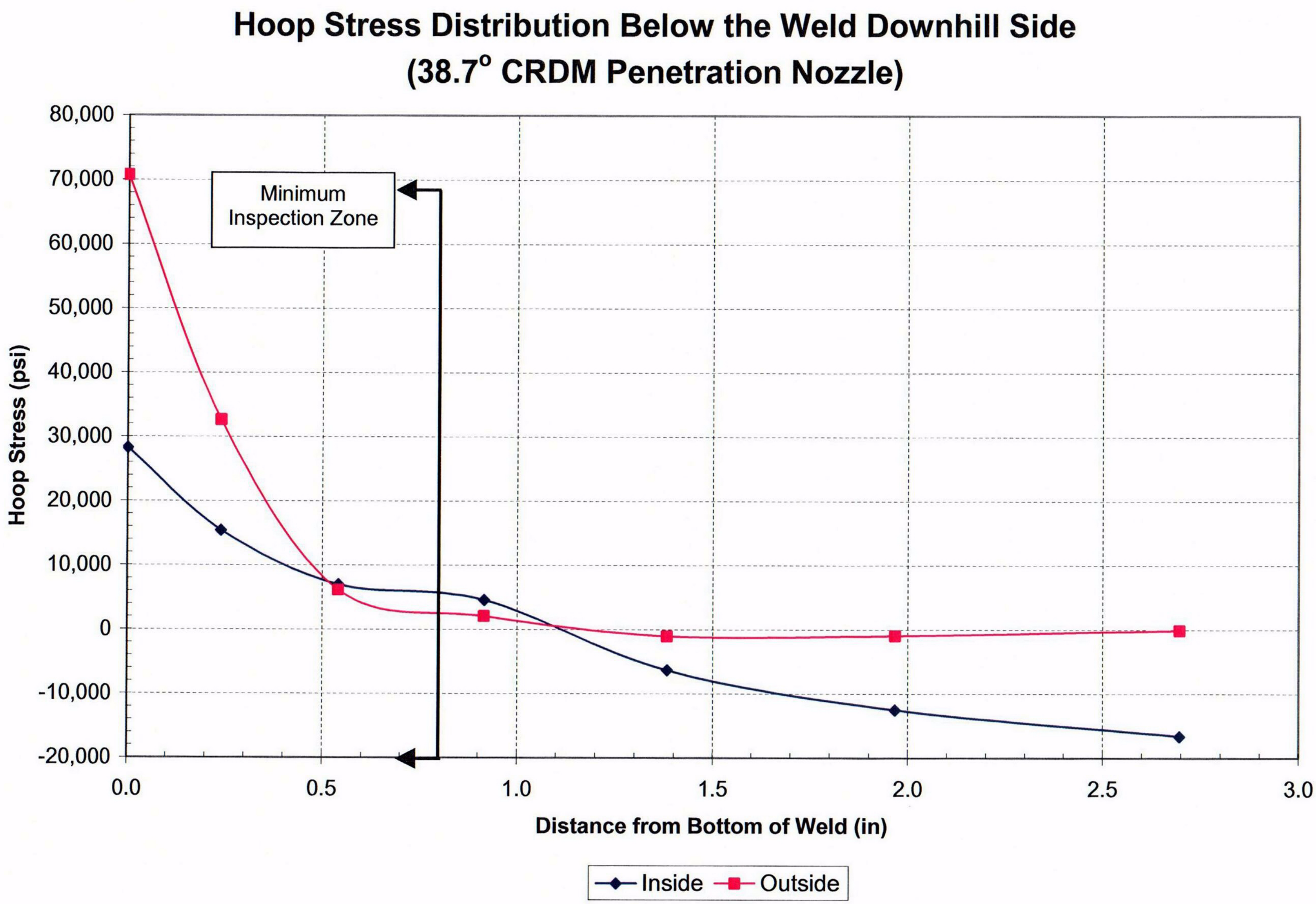
C-04

Figure 10



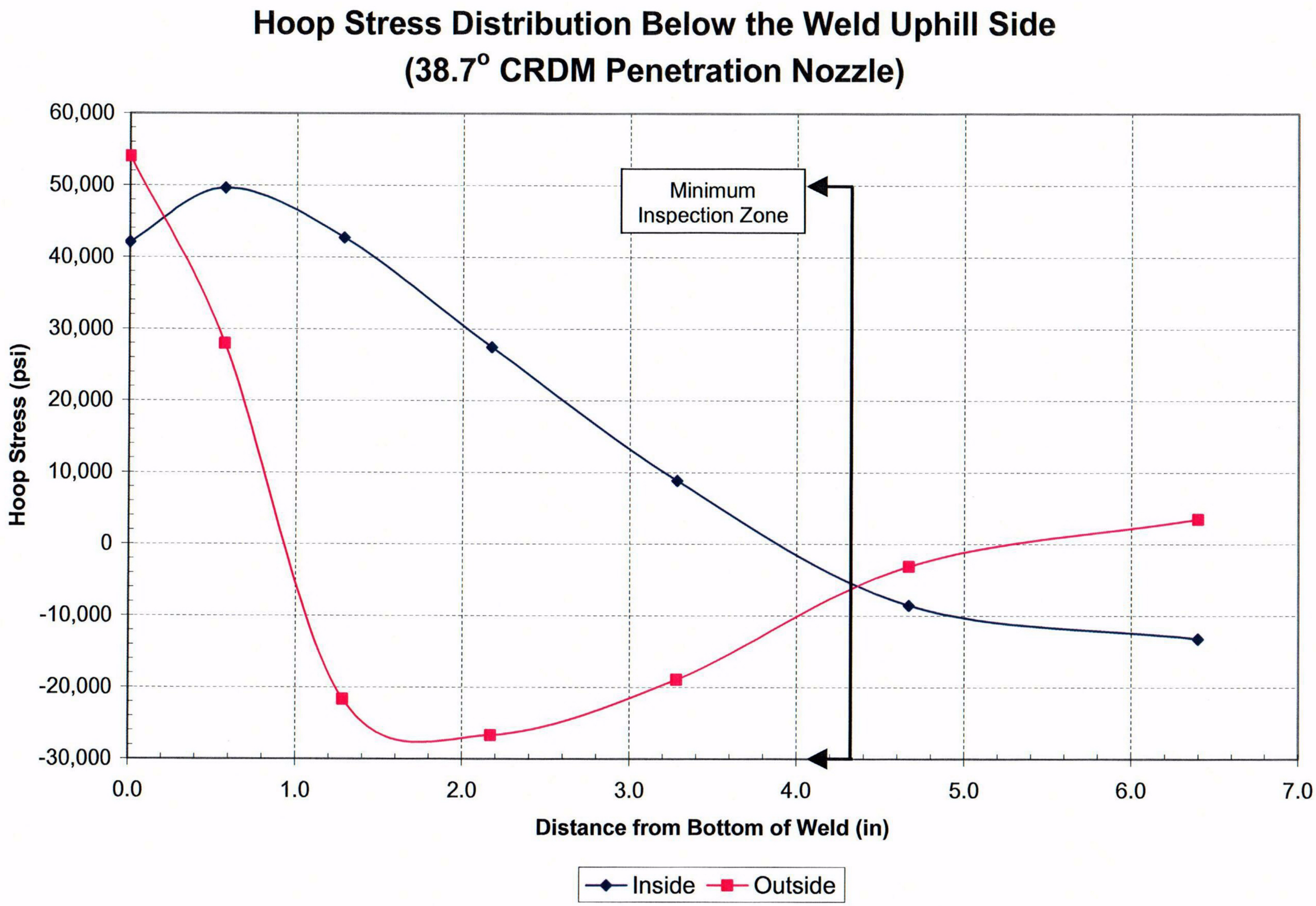
C-05

Figure 11



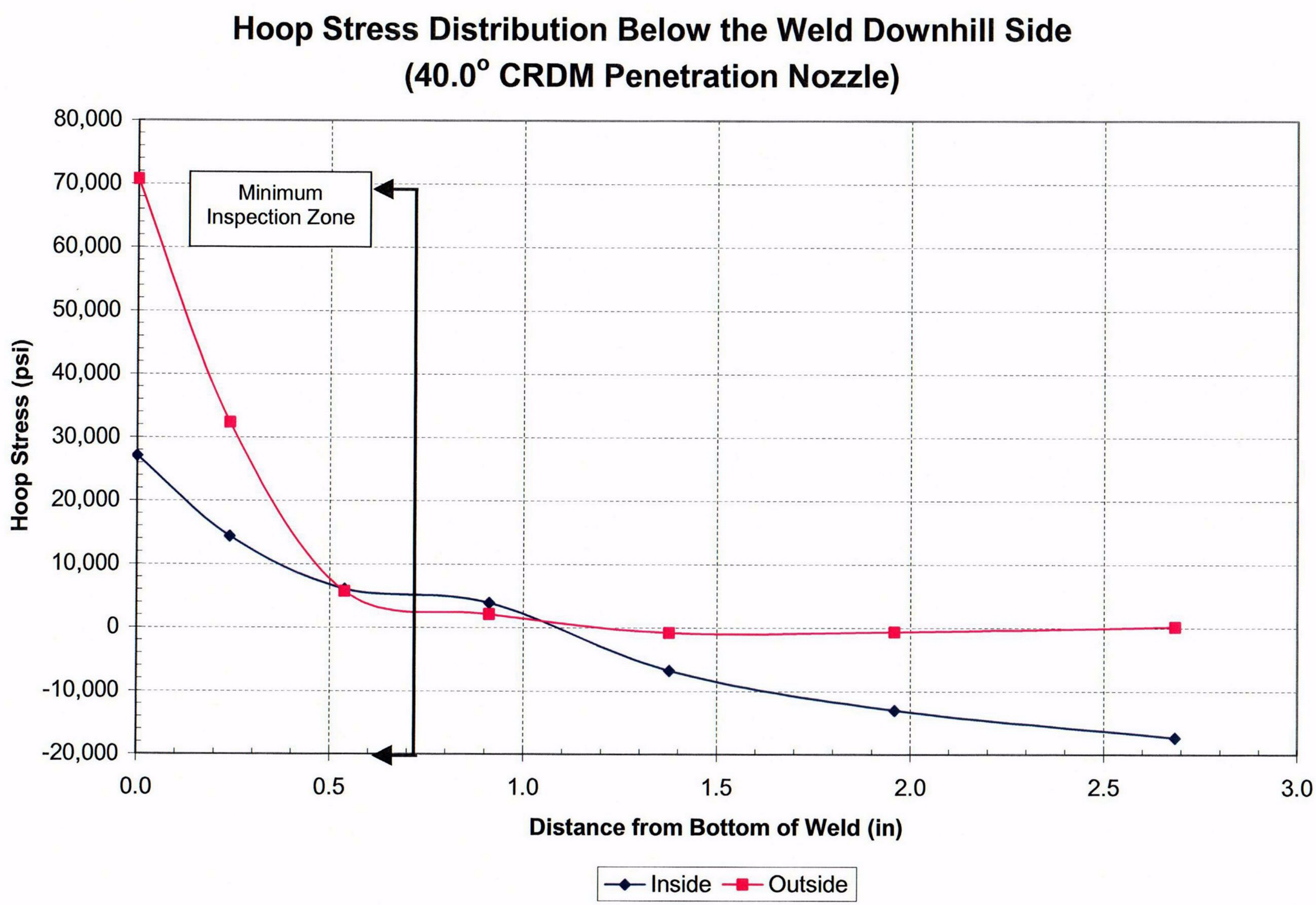
C-26

<u>**Figure 12**</u>



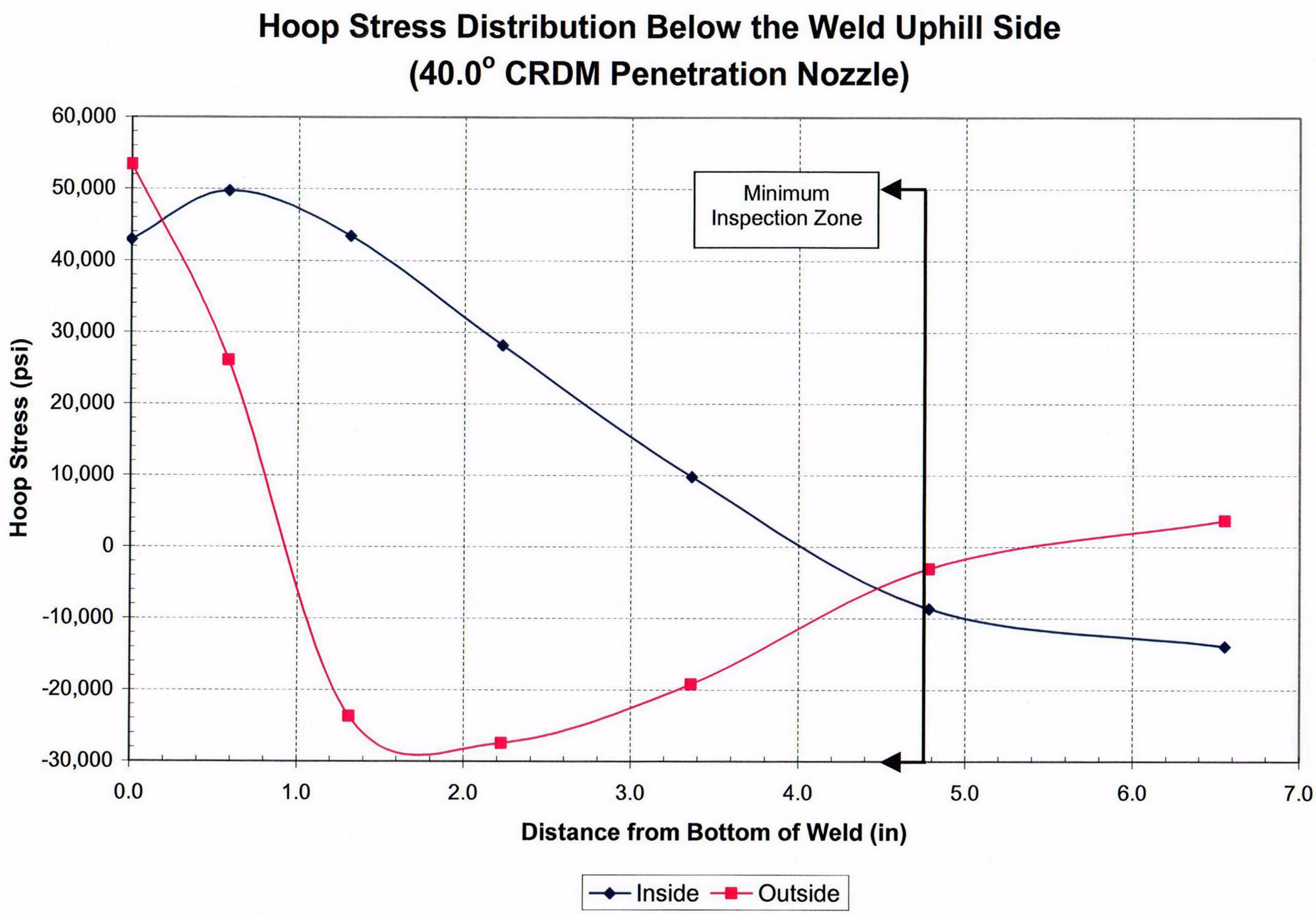
C-07

Figure 13



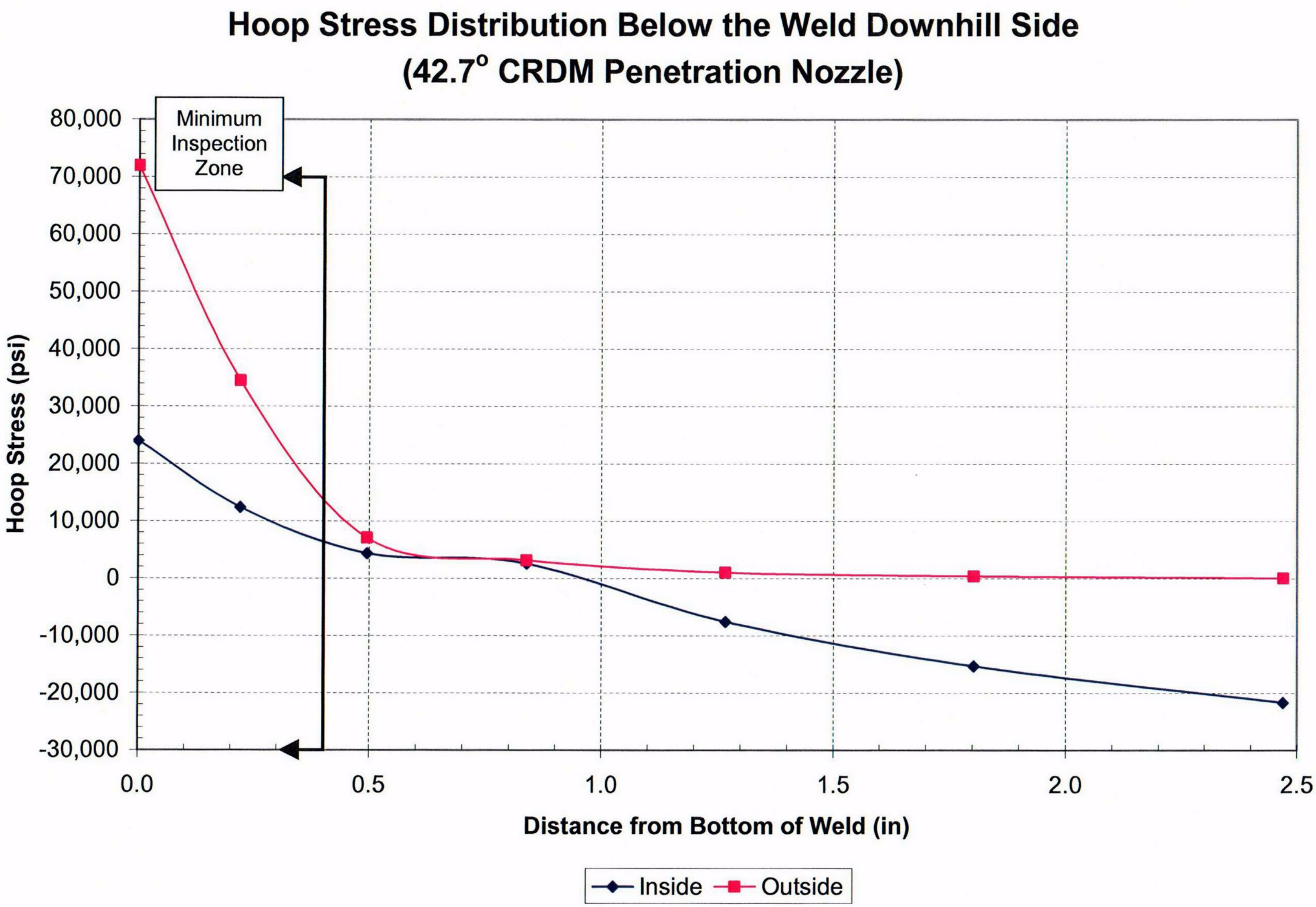
C-88

<u>**Figure 14**</u>



C-09

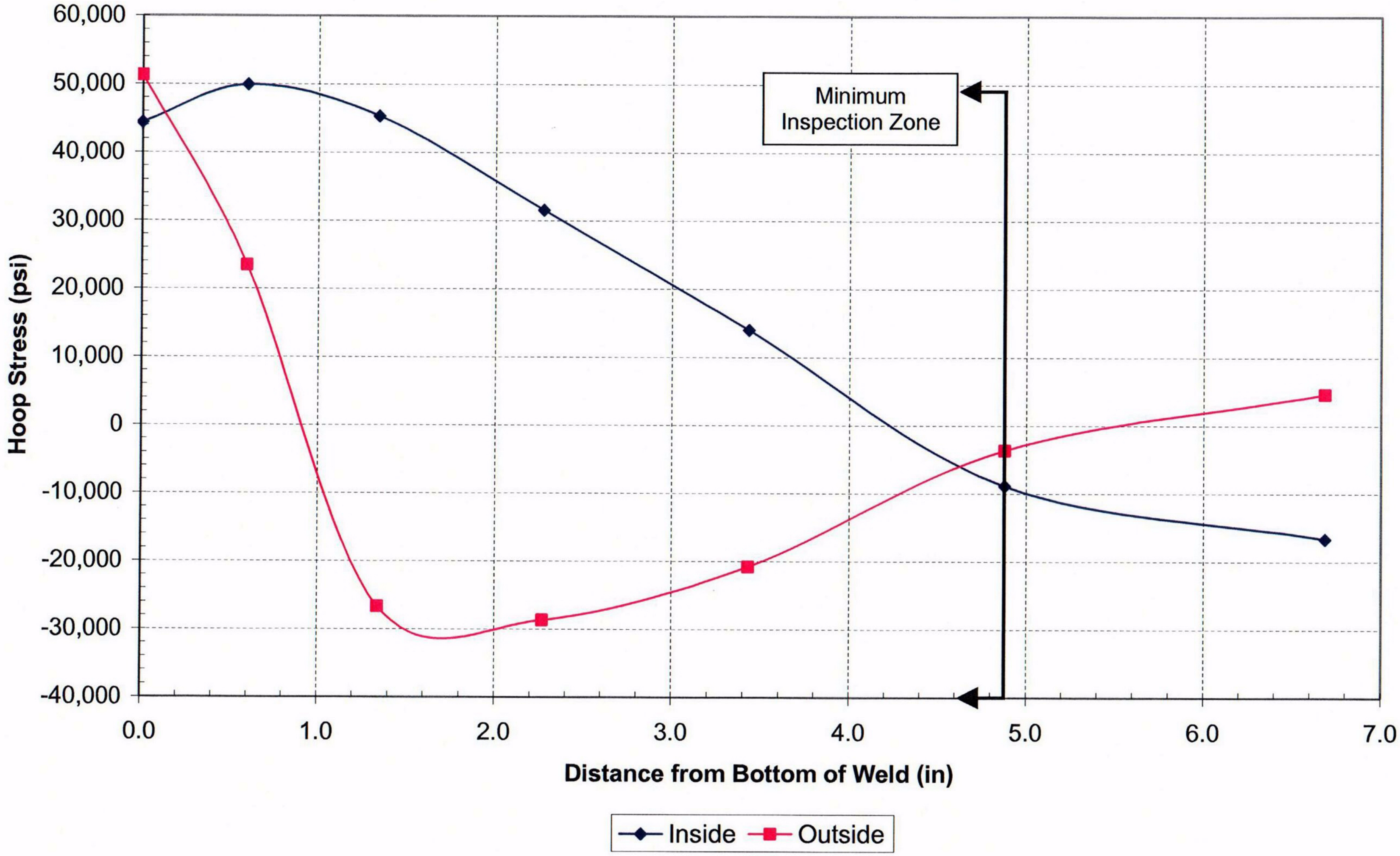
Figure 15



C-10

<u>**Figure 16**</u>

Hoop Stress Distribution Below the Weld Uphill Side (42.7° CRDM Penetration Nozzle)



C-11