

U.S. NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

UT Coverage Calculations- Is it time to formalize the process?

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NRC/RES/DE

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Background

- ISI of ASME Code Class 1, 2, and 3 components is to be performed in accordance with ASME Code, Section XI, and applicable addenda, as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i).
- 10 CFR 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.
- Licensees submit relief requests when they are unable to meet the Code requirements.



Background

- The relevant requirements of the ASME Code, Section XI require that essentially 100% of the weld be examined.
- ASME Code Case N-460, *Alternative Examination Coverage for Class 1 and Class 2 Welds*, as an alternative approved for use by the NRC in Regulatory Guide (RG) 1.147, Revision 16, *Inservice Inspection Code Case Acceptability* (RG 1.147), states that a reduction in examination coverage due to part geometry or interference for any Class 1 and 2 weld is acceptable provided that the reduction is less than 10%, i.e., greater than 90% examination coverage is obtained.



Background

- The NRC needs to clearly understand how coverage was achieved in order to satisfy the requirements of 10 CFR 50.55a(a)(3).
- Submittals vary widely
 - Methods to calculate coverage vary from vendor-to-vendor and licensee-to-licsee
 - Level of detail provided ranges from hand drawn figures to detailed tables
 - It is often unclear which portions, and how much of the ASME Code-required volumes have been examined
 - When multiple angles are required, it is often unclear as to whether the coverage claimed was completed with the required angles
 - UT data sheets often submitted, leaving it to the Staff to sort out the relevant info
 - The content in figures/captions often do not match with the associated text in the body of submittal
- Many RAIs deal with clarifying coverage!



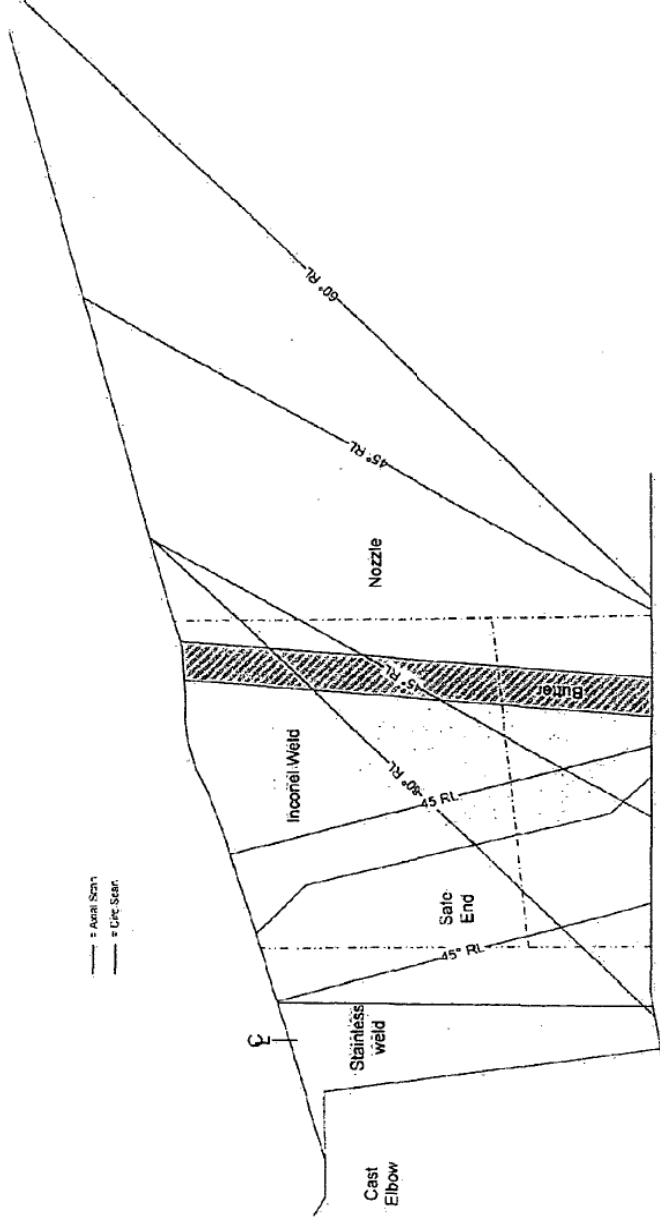
Example 1: R.E. Ginna ISI-02 (ML103620105, Dec. 2010)

- Figure in original submittal depicting coverage obtained

Item B5.70

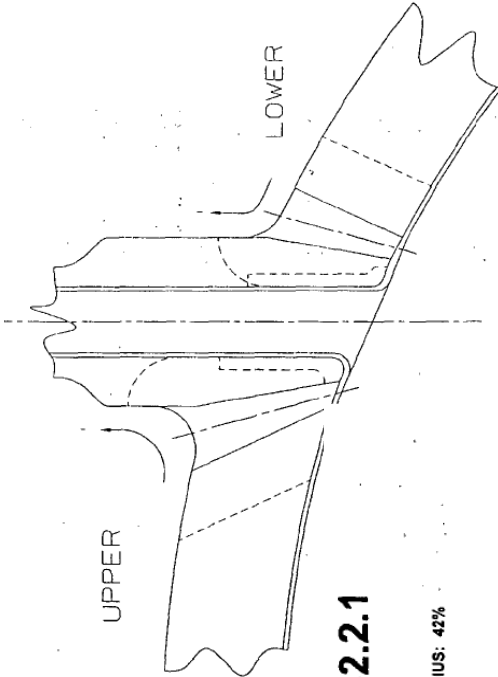
Component ID: NSE-3R (I006990)
(Inconel Weld = 690)

Wave Modality and Insonification Angle(s): 0°, 45° S, 45° L and 60° L (Axial and Circ Directions) were used where scanning was accessible.





Example 2: Crystal River (ML090820492, March 2009)



EXAMINATION COVERAGE FOR RELIEF NOZZLE: B2.2.1

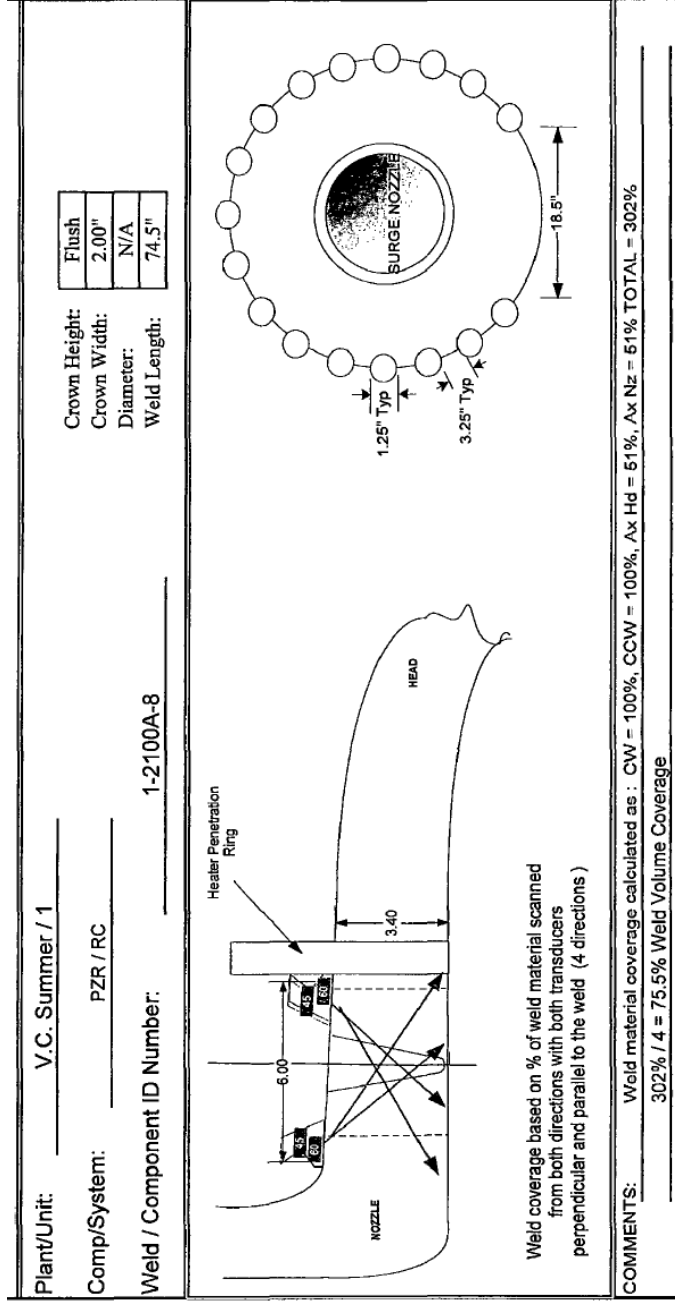
AGGREGATE COVERAGE OBTAINED: 50% AGGREGATE COVERAGE OBTAINED FOR INSIDE RADIUS: 42%

| | | | |
|---------------------|-----|------------------------|-----|
| Weld | 45% | Zone Coverage Obtained | 55% |
| Adjacent Base Metal | | Adjacent Base Metal | 55% |
| Inside Radius | | Inside Radius | 42% |

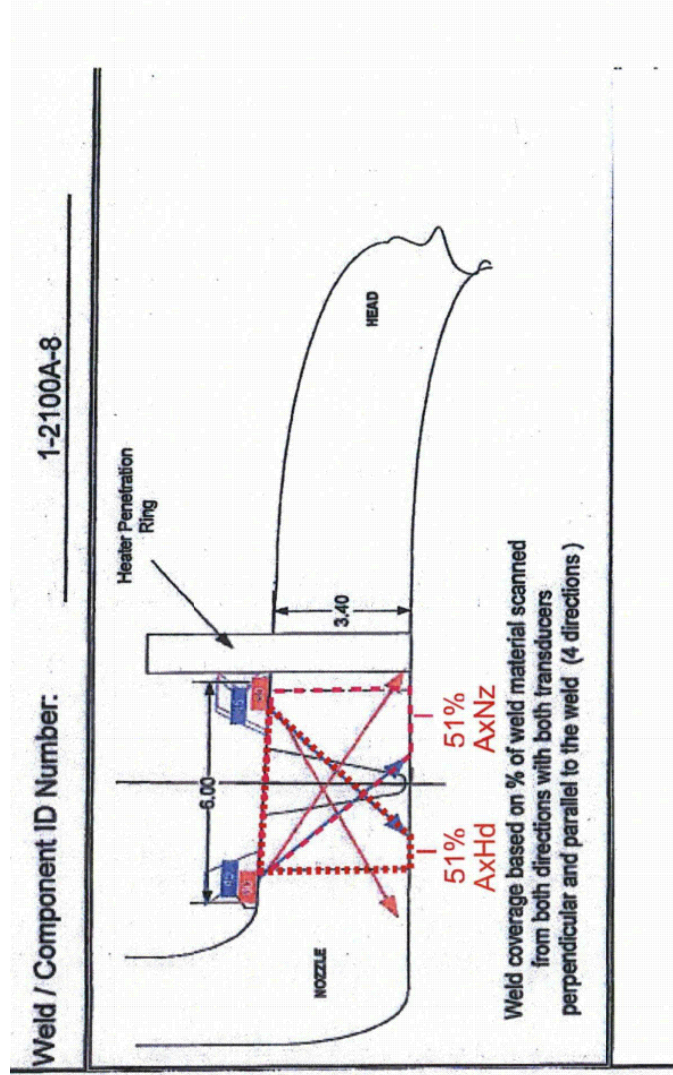
| UPPER SECTION EVALUATION | | | | | | | | | |
|--------------------------|----------------|-------------------------|---------------------------|-------------------------------|---------------------------|-----------------------------------|---------------------------|-------------------------|---------------------------|
| Area Measurement | | Volume Calculation | | Examination Volume Definition | | Examination Coverage Calculations | | Nozzle Bore Diameter | |
| Weld | 10.48 sq. in. | Weld | 156.9 cu. in. | Weld | 415.7 cu. in. | Weld | 2.9 sq. in. | Weld | 2.5 in. |
| Adjacent Base Metal | 21.77 sq. in. | Adjacent Base Metal | 11.2 cu. in. | Adjacent Base Metal | 11.2 cu. in. | Adjacent Base Metal | 2.9 sq. in. | Adjacent Base Metal | 2.5 in. |
| Inside Radius | 2.9 sq. in. | Inside Radius | 11.2 cu. in. | Inside Radius | 11.2 cu. in. | Inside Radius | 2.9 sq. in. | Inside Radius | 2.5 in. |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 0 | n/a | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1 | 0 | 0.0 | 180.0 | 0.0 | 156.9 | 0% | 0% | 0.0 | 156.9 |
| 2 | 45 | 1 | 4.3 | 180.0 | 63.8 | 156.9 | 41% | 1 | 4.3 |
| 3 | 45 | 2 | 0.0 | 180.0 | 0.0 | 156.9 | 0% | 2 | 0.0 |
| 4 | 45 | 3 | 0.5 | 180.0 | 7.6 | 156.9 | 5% | 3 | 0.5 |
| 5 | 45 | 4 | 0.5 | 180.0 | 7.6 | 156.9 | 5% | 4 | 0.5 |
| 6 | 60 | 1 | 7.2 | 180.0 | 107.8 | 156.9 | 69% | 1 | 7.2 |
| 7 | 60 | 2 | 0.0 | 180.0 | 0.0 | 156.9 | 0% | 2 | 0.0 |
| 8 | 60 | 3 | 4.4 | 180.0 | 65.3 | 156.9 | 42% | 3 | 4.4 |
| 9 | 60 | 4 | 4.4 | 180.0 | 65.3 | 156.9 | 42% | 4 | 4.4 |
| Totals: | | 977.4 | | 1477.9 | | 25% | | 977.4 | |
| Adjacent Base Metal | | | | | | | | | |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 0 | n/a | 7.7 | 180.0 | 114.0 | 415.7 | 28% | 28% | 7.7 | 180.0 |
| 1 | 0 | 14.6 | 180.0 | 216.0 | 415.7 | 52% | 52% | 14.6 | 180.0 |
| 2 | 45 | 3 | 7.7 | 180.0 | 114.0 | 415.7 | 28% | 3 | 7.7 |
| 3 | 45 | 4 | 7.7 | 180.0 | 114.0 | 415.7 | 28% | 4 | 7.7 |
| 4 | 45 | 18.2 | 180.0 | 283.0 | 415.7 | 61% | 61% | 18.2 | 180.0 |
| 5 | 60 | 18.2 | 180.0 | 283.0 | 415.7 | 61% | 61% | 18.2 | 180.0 |
| 6 | 60 | 3 | 16.9 | 180.0 | 252.7 | 415.7 | 61% | 3 | 16.9 |
| 7 | 60 | 4 | 16.9 | 180.0 | 252.7 | 415.7 | 61% | 4 | 16.9 |
| Totals: | | 1330.8 | | 2910.0 | | 46% | | 1330.8 | |
| Inside Radius | | | | | | | | | |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 45 | axial | 0.2 | 180.0 | 0.5 | 11.2 | 6% | 6% | 0.2 | 180.0 |
| 1 | 45 | 0.1 | 180.0 | 0.4 | 11.2 | 3% | 3% | 0.1 | 180.0 |
| 2 | 45 | 1.5 | 180.0 | 5.9 | 11.2 | 52% | 52% | 1.5 | 180.0 |
| 3 | 60 | 1.4 | 180.0 | 5.5 | 11.2 | 49% | 49% | 1.4 | 180.0 |
| 4 | 60 | | | | | | | | |
| Totals: | | 12.7 | | 44.9 | | 28% | | 12.7 | |

| LOWER SECTION EVALUATION | | | | | | | | | |
|--------------------------|----------------|-------------------------|---------------------------|-------------------------------|---------------------------|-----------------------------------|---------------------------|-------------------------|---------------------------|
| Area Measurement | | Volume Calculation | | Examination Volume Definition | | Examination Coverage Calculations | | Nozzle Bore Diameter | |
| Weld | 7.93 sq. in. | Weld | 118.7 cu. in. | Weld | 325.0 cu. in. | Weld | 2.5 sq. in. | Weld | 2.5 in. |
| Adjacent Base Metal | 21.71 sq. in. | Adjacent Base Metal | 100.1 cu. in. | Adjacent Base Metal | 100.1 cu. in. | Adjacent Base Metal | 2.5 sq. in. | Adjacent Base Metal | 2.5 in. |
| Inside Radius | 2.5 sq. in. | Inside Radius | 100.1 cu. in. | Inside Radius | 100.1 cu. in. | Inside Radius | 2.5 sq. in. | Inside Radius | 2.5 in. |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 0 | n/a | 5.5 | 180.0 | 81.7 | 118.7 | 69% | 69% | 5.5 | 180.0 |
| 1 | 0 | 7.1 | 180.0 | 105.7 | 118.7 | 89% | 89% | 7.1 | 180.0 |
| 2 | 45 | 2 | 0.0 | 180.0 | 0.0 | 118.7 | 0% | 2 | 0.0 |
| 3 | 45 | 3 | 6.7 | 180.0 | 100.1 | 118.7 | 84% | 3 | 6.7 |
| 4 | 45 | 4 | 6.7 | 180.0 | 100.1 | 118.7 | 84% | 4 | 6.7 |
| 5 | 45 | 4 | 6.7 | 180.0 | 100.1 | 118.7 | 84% | 5 | 6.7 |
| 6 | 60 | 1 | 7.3 | 180.0 | 109.3 | 118.7 | 92% | 1 | 7.3 |
| 7 | 60 | 2 | 0.0 | 180.0 | 0.0 | 118.7 | 0% | 2 | 0.0 |
| 8 | 60 | 3 | 7.2 | 180.0 | 107.6 | 118.7 | 91% | 3 | 7.2 |
| 9 | 60 | 4 | 7.2 | 180.0 | 107.6 | 118.7 | 91% | 4 | 7.2 |
| Totals: | | 712.3 | | 1069.4 | | 67% | | 712.3 | |
| Adjacent Base Metal | | | | | | | | | |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 0 | n/a | 11.3 | 180.0 | 169.2 | 325.0 | 52% | 52% | 11.3 | 180.0 |
| 1 | 0 | 16.0 | 180.0 | 239.6 | 325.0 | 74% | 74% | 16.0 | 180.0 |
| 2 | 45 | 3 | 11.3 | 180.0 | 169.2 | 325.0 | 52% | 3 | 11.3 |
| 3 | 45 | 3 | 11.3 | 180.0 | 169.2 | 325.0 | 52% | 4 | 11.3 |
| 4 | 45 | 18.2 | 180.0 | 298.6 | 325.0 | 78% | 78% | 18.2 | 180.0 |
| 5 | 60 | 18.2 | 180.0 | 298.6 | 325.0 | 78% | 78% | 18.2 | 180.0 |
| 6 | 60 | 3 | 15.0 | 180.0 | 224.1 | 325.0 | 69% | 3 | 15.0 |
| 7 | 60 | 4 | 15.0 | 180.0 | 224.1 | 325.0 | 69% | 4 | 15.0 |
| Totals: | | 1452.1 | | 2274.3 | | 64% | | 1452.1 | |
| Inside Radius | | | | | | | | | |
| Exam. Angle (deg.) | Beam Direction | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) | Area Examined (sq. in.) | Volume Examined (cu. in.) |
| 45 | axial | 1.6 | 180.0 | 8.4 | 9.7 | 65% | 65% | 1.6 | 180.0 |
| 1 | 45 | 0.6 | 180.0 | 2.2 | 9.7 | 23% | 23% | 0.6 | 180.0 |
| 2 | 45 | 2.1 | 180.0 | 8.1 | 9.7 | 84% | 84% | 2.1 | 180.0 |
| 3 | 60 | 1.2 | 180.0 | 4.7 | 9.7 | 49% | 49% | 1.2 | 180.0 |
| 4 | 60 | | | | | | | | |
| Totals: | | 21.4 | | 38.6 | | 55% | | 21.4 | |

Example 3: V.C. Summer (ML13129A178, May 2013)



Example 3: V.C. Summer (ML13289A183, October 2013)





What is NRC interested in learning/understanding?

- History of past attempts to formalize coverage calculations including difficulties encountered.
- What would need to be done and by whom to standardize the method(s) used for coverage calculations?