Southern Nuclear Operating Company

ND-21-0070

Enclosure 6

Vogtle Electric Generating Plant (VEGP) Units 3 and 4

Revision to Proposed Alternative in Accordance with 10 CFR 50.55a(z)(2):

Alternative Requirements for ASME Section XI Examination Coverage of Weldolet Branch Connection Welds

(VEGP 3&4-PSI/ISI-ALT-15R1)

(This Enclosure consists of 10 pages, including this cover page)

Plant Site-Unit:	Vogtle Electric Generating Plant (VEGP) – Units 3 and 4
Interval-Interval Dates:	Applies to Preservice and Inservice Inspection (PSI and ISI) activities
Requested Date for Approval:	Approval is requested by April 29, 2021 to support completion of preservice inspection activities for Unit 3.
ASME Code Components Affected:	ASME Section III Class 1 applies to branch connection welds on the Reactor Coolant System (RCS) pressure boundary for Automatic Depressurization System (ADS) Stage 1 piping (refer to UFSAR Figure 5.1-5 Sheet 2 of 3). The subject welds are ASME Section XI, Table IWB-2500-1, Category B-J, and are listed below.

Item	Description	Limitation	Component
B9.31	Branch Connection Weld	Branch Connection Geometry	SV3-RCS-PLW-013-SW3
B9.31	Branch Connection Weld	Branch Connection Geometry	SV3-RCS-PLW-01C-SW3
B9.31	Branch Connection Weld	Branch Connection Geometry	SV4-RCS-PLW-013-SW3
B9.31	Branch Connection Weld	Branch Connection Geometry	SV4-RCS-PLW-01C-SW3

Applicable Code Edition and Addenda:	ASME B&PV Code, Section XI, 2007 Edition through the 2008 Addenda
Applicable Code Requirements:	IWA-2200 Examination Methods All nondestructive examinations of the required examination surface or volume shall be conducted to the maximum extent practical. When performing VT-1, surface, radiographic, or ultrasonic examination on a component with defined surface or volume, essentially 100% of the required

	surface or volume shall be examined. Essentially 100% coverage is achieved when the applicable examination coverage is greater than 90%; however, in no case shall the examination be terminated when greater than 90% coverage is achieved, if additional coverage of the required examination surface or volume is practical. Non-mandatory Appendix S provides guidance that may be used for evaluating examination coverage.
Reason for Request:	The examination volume required by IWA-2200(c) for weldolet branch connections identified in this alternative is not achievable due to the configurations of these weldolets used during construction of Vogtle 3&4. These weld configurations are widely used by the industry, and challenges for these configurations are typical and are frequently identified in relief requests for Inservice Inspection. 10 CFR 50.55a(g)(2)(ii) states that components classified as ASME Code Class 1, 2, and 3 must be designed and be provided with access to satisfy the preservice examination requirements set forth in ASME Section III and Section XI. The Vogtle Units 3 and 4 UFSAR (Section 5.2.4.2) states that components and welds requiring inservice inspection (and by default preservice inspection) are designed to allow for the application of the required inservice inspection methods (and preservice inspection methods). The goal of the 10 CFR 50.55a(g)(2)(ii) requirement is to ensure that the structural integrity of the system is maintained. This alternative demonstrates that the structural integrity of the system will be maintained, by a combination of the best available examinations, supplemented by a detailed structural integrity evaluation, which shows very large margins. Examination Category B-J for Pressure Retaining Welds in Piping as defined in Table IWB-2500-1 requires 100 percent surface and volumetric examinations for greater than or equal to Nominal Pipe Size (NPS) 4 branch connection welds (B9.31), while those with NPS less than 4 require surface examinations only. The applicable branch connection welds are NPS 4, Pipe-to-14x4 inch weldolets, and are located on the RCS Automatic Depressurization System lines. Examinations of these welds are tied to the completion of preservice inspection activities required for completion of ITAAC for the RCS. Volumetric Examination by use of Ultrasonic testing (UT) of essentially 100 percent is not possible for the required coverage area due to the configuration of the weldolets and the design of the joints used to comply with ASME Section III for the identified weld locations, and would result in hardship without a compensating increase in the level of quality and safety.

Proposed Alternative and Basis for Use:	**Proposed Alternative:** As an alternative to ASME Section XI, subarticle IWA-2200(c) requirement for essentially 100 percent of volumetric examination coverage for the listed weldolet branch connection welds listed above, SNC proposes to perform volumetric examinations as follows: • Volumetric examinations, in accordance with ASME Code and Appendix VIII, will be conducted to the maximum extent practical. Based on industry experience, examination coverage of the ASME defined examination volume is expected to be greater than 40 percent. Details of coverages obtained for Unit 3 are included in following Figures. Acceptance will be based on the indications identified in the coverage area, in accordance with IWB-3000, or postulated in areas where examination coverage could not be obtained to adequately size embedded flaws. To date, no recordable indications have been identified. • Best effort examination techniques will be applied to the maximum extent practical for the examination volume listed above and extending through the full thickness of the material. ASME Section XI additionally requires surface examination for these welds. Examination area coverage of essentially 100% is expected to be obtained. **Basis for Use:** This proposed alternative provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a based on precedent of prior approval for other operating facilities, compliance with the applicable code requirements, best effort volumetric examinations including additional examination volume, future code examinations, and the results of the representative flaw tolerance evaluation as detailed in this section. The proposed alternative has precedent within the industry, as demonstrated by an NRC Safety Evaluation Report issued to Brunswick Steam Electric Plant Unit 2 (ADAMS Accession ML11175A173). That precedent relies on the volumetric examination to the extent practical, complimented by a surface examination. Typical coverage on these configurations range from 40% to 80%, depending on the sizes of the weldolet fabrication tapers. Section XI single-side Performance Demonstration Initiative UT-2 (PDI UT-2) examinations were performed on the subject weldolet branch connections located in Unit 3. A 45-degree shear wave transducer was used on the 4-inch weldolet side of the welds, as no meaningful ultrasonic examination can be performed from the 14-inch pipe due to the inability of the sound to reach the weld. Due to the geometric nature of weldolets, the coverage was less than the 90 percent required by ASME Section XI. An additional qualified

30-degree transducer was used to attempt additional coverage. A total average axial coverage of 63.7 percent was achieved, as shown in Figure 1 below. A total aggregate circumferential coverage of 55.4 percent was achieved, as shown in Figures 3 and 4. Similar coverages are expected to be achieved for the subject weldolet branch connections in Unit 4.

Additionally, a supplemental best effort examination was conducted to the maximum extent practical for the code required examination volume and extended through the full thickness of these weld locations. A 63-degree transducer was used, which achieved the expected coverage detailed in Figure 2 below. The results of this best effort examination are preliminary, but conclusions to date indicate no recordable indications.

The best effort examination substantially reduces the volume of uninspected weld region and provides reasonable assurance that no substantial defects are present in the weld material.

Figures 1-4 depict the axial and circumferential coverages that were obtained on the subject weldolets, as well as the coverages that could be attained by using best effort techniques.

Figure 1: Typical PDI UT-2 Axial Scan Coverage and the Total Average Axial Coverage Achieved for Unit 3 Weld Locations SV3-RCS-PLW-01C-SW3 and SV3-RCS-PLW-013-SW3

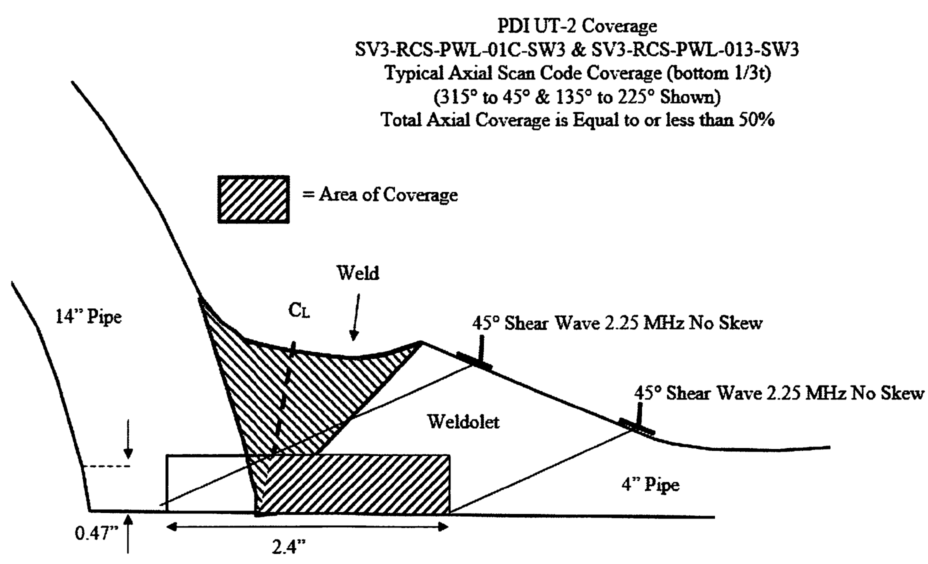


Figure 2: Best Effort / Augmented Coverage Achieved by Adding a 60-degree Refracted Longitudinal Examination in Addition to the 45-degree Shear Wave

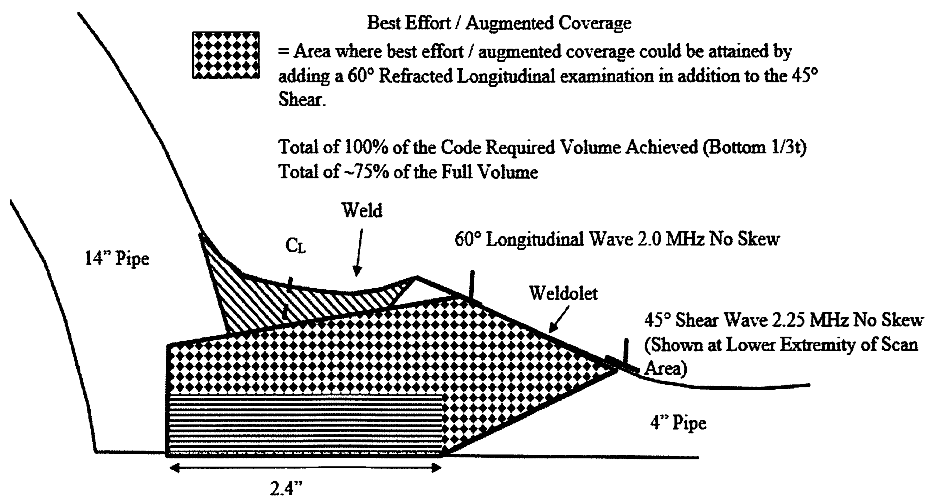


Figure 3: Typical PDI UT-2 Circumferential Scan Coverage (315 to 45 degrees and 135 to 225 degrees), and the Total Circumferential Coverage Achieved for Unit 3 Weld Locations SV3-RCS-PLW-01C-SW3 and SV3-RCS-PLW-013-SW3

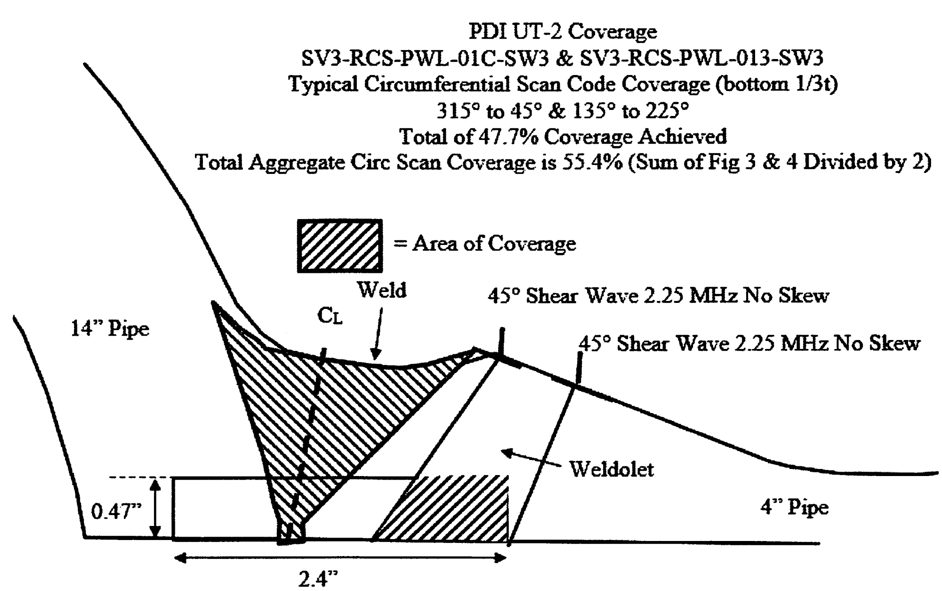


Figure 4: Typical PDI UT-2 Circumferential Scan Coverage (45 to 135 degrees and 225 to 315 degrees), and the Total Circumferential Coverage Achieved for Unit 3 Weld Locations SV3-RCS-PLW-01C-SW3 and SV3-RCS-PLW-013-SW3

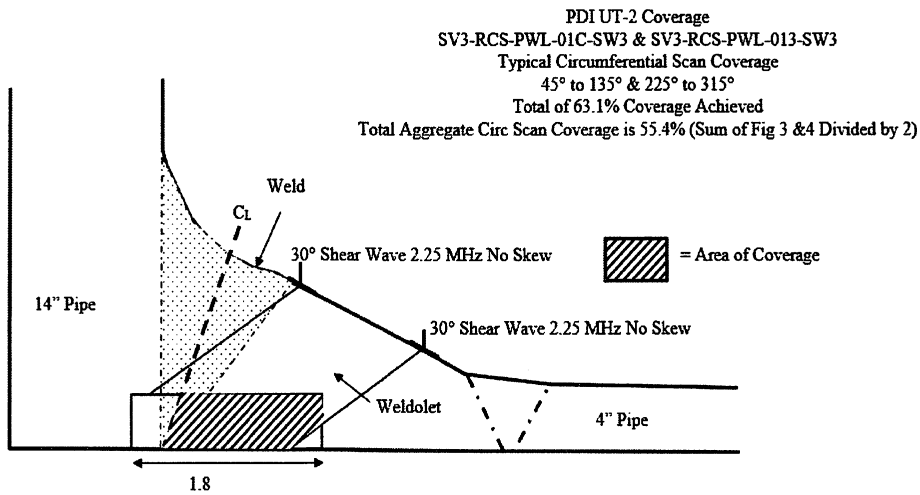
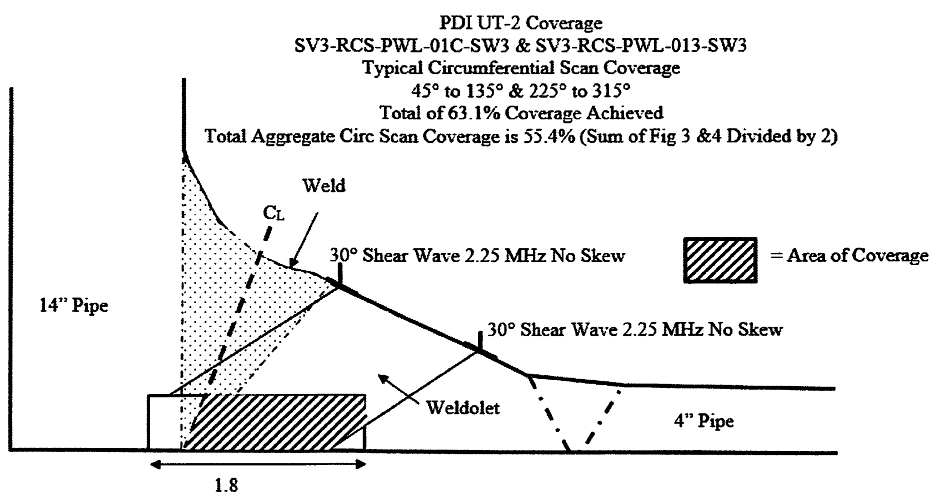


Figure 5: Typical PDI UT-2 Circumferential Scan Coverage Through Entire Volume



For the majority of the ASME required examination volume, a large portion of the through-wall dimension was inspected with no recordable indications, providing assurance that no substantial defects are present. This conclusion

	supports the flaw evaluation and high flaw tolerance of the material as presented later in this section. Section III and Section XI surface examinations were performed on the subject weldolets, using liquid penetrant examination methods. Coverage of 100% was achieved on both weldolet welds for Unit 3. The examination results were acceptable and show no outer diameter (OD) surface connected flaws. Weldolets are standard fittings for piping branch connections used in both nuclear and non-nuclear power plants as well as in piping applications in other industries. These fittings minimize the size of the opening in the main piping run. In the AP1000 application of interest for this alternative request, the hole in the main piping run is only four (4) inches in diameter. In addition, weldolet fittings add the ASME Code-required reinforcement. This results in greater weld thickness and minimizes stress concentrations at the branch connection. A flaw tolerance evaluation was conducted to justify the reduced examination coverage for the weldolet locations, by demonstrating that a large postulated inside surface axial or circumferential flaw at the weldolet to pipe weld regions encompassing the missed examination regions will not grow to the maximum end-of-evaluation flaw size for the 60-year design life of the plant. The engineering analysis performed in the flaw tolerance evaluation was heavily based on the technical work supporting code alternative request VEGP 3&4-PSI/ISI-ALT-06 (ADAMs Accession ML19087A143). The weldolet to pipe weld locations were evaluated based on the guidelines in paragraph IWB-3640 and Appendix C of the 2007 Edition with 2008 Addenda ASME Section XI code. The maximum allowable end-of-evaluation period flaw size was calculated at the stainless steel weldolet locations for a postulated inside surface axial and circumferential flaw using the guidance of ASME Section XI Appendix C-5000. Geometry, pipe loadings, design transients, and ASME reference material properties specific to the AP1000 design were considered when calculating the maximum allowable end-of-evaluation period flaws and fatigue crack growth analysis. Loadings under normal, upset, test, emergency and faulted conditions were considered with the applicable safety factors for the corresponding service conditions required in ASME Code Section XI. The primary crack growth mechanism considered for postulated flaws is Fatigue Crack Growth (FCG) in PWR water environments. Crack growth due to Primary Water Stress Corrosion Crack (PWSCC) growth does not need to be investigated due to the low susceptibility to stress corrosion cracking of the materials of construction. The weld and base materials used are stainless steel. The evaluation demonstrated a very large flaw tolerance in the region of interest; specifically, the evaluation showed very low fatigue loadings in the region. The calculated fatigue crack growth was less than one percent of the

thickness over sixty years of service. An axial and circumferential flaw depth of 33 percent of the thickness was postulated to represent the full ASME required examination thickness. The fatigue crack growth for this postulated flaw over sixty years, demonstrated that the final flaw depth would be 34 percent of the wall thickness, which is negligible growth, and well below the maximum allowable end-of-evaluation flaw size of nearly two-thirds of the wall thickness. This demonstrates significant flaw tolerance and structural stability for this location, even if any indications were present in the missed coverage regions.

The allowable end-of-evaluation period flaw depth was determined to be 71 percent of the wall thickness, for a postulated axial inside surface flaw, and 75 percent of the thickness for a postulated circumferential surface flaw. Axial and circumferential flaws with a depth of 1/3 of the wall thickness were postulated within the area of ASME required coverage. These hypothetical flaws will not grow to the maximum allowable end-of-evaluation flaw size during the 60-year design life of the plant.

Therefore, there is acceptable structural integrity margin for the weldolet to pipe location, as demonstrated in the table below.

Table 1: Weldolet Structural Integrity Margin

Postulated Flaw Configuration	Maximum Potential Inspection Zone Flaw Size (1/3 of wall thickness) (a/t)	60-year FCG Final Flaw Size (a_p/t)	Maximum Allowable End of Evaluation Flaw Size (a_f/t)
Axial Surface Flaw	0.33	0.34	0.71
Circumferential Surface Flaw	0.33	0.34	0.75

Note: a_p = final potential flaw depth, a_f = ASME Code Maximum Allowable flaw depth, t = thickness, a = initial flaw depth encompassing the missing inspection zone

The cumulative fatigue usage factor at the weldolet is very small (see Enclosure 2). Furthermore, the impact of the design transient stresses is negligible at this region and the resulting fatigue crack growth is only 1 percent of the thickness over the sixty-year design life of the plant. Therefore, a much larger postulated initial flaw size could be considered at this region. For example, this region may even accommodate a postulated initial flaw depth of 65 percent of the wall thickness. The analysis shows that

	even this large postulated flaw depth would not reach the maximum end-of-evaluation flaw size in sixty years, due to the low stresses and fatigue usage at this location. The combination of ultrasonic examinations and a flaw tolerance evaluation showing a high tolerance for fatigue growth demonstrate that even for postulated flaws equal to the full 1/3 thickness for examinations required by the ASME Code, the structural integrity of the material will be maintained. In addition, best effort examinations increase the through-wall detection outside of the ASME required volume and are likely to detect and demonstrate that no substantial flaws are present, which could grow to an unacceptable size over the service life of the plant. The above discussion demonstrates that this proposed alternative provides assurance of structural integrity, an acceptable level of safety and quality, and that compliance with ASME Section XI for performing 100% volumetric examinations results in hardship without a compensating increase in the level of quality and safety; therefore, this proposed alternative should be granted pursuant to 10 CFR 50.55a(z)(2).
Duration of Proposed Alternative:	During applicability of the PSI program until transition to the ISI program for each unit.
References:	ASME Section XI Boiler & Pressure Vessel Code, 2007 Edition through 2008 Addenda – Rules for Inservice Inspection of Nuclear Power Plant Components Brunswick Steam Generating Plant, Unit 2 – Relief Request NRC Approval Letter and Safety Evaluation (ADAMS Accession ML11175A173) Vogtle Electric Generating Plant – Alternative Request under Title 10 of the Code of Federal Regulations, Section 50.55a(z)(1): Preservice and Inservice Inspection Requirements for Specific Valve-to-Pipe Welds – VEGP 3&4-PSI/ISI-ALT-06 (ADAMS Accession ML19087A143)
Status:	Awaiting NRC authorization