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File No.: G25
10 CFR 50.55a

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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Rockville, MD 20852-2738

South Texas Project
Units 1 and 2
Docket No. STN 50-498, STN 50-499
Proposed Alternative to ASME Section XI Requirements for
Application of a Weld Overlay (RR-ENG-2-43)

In accordance with the provisions of 10 CFR 50.55a(a)(3)(i), the South Texas Project requests NRC approval of an alternative approach to the requirements of ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components." Approval will allow application of full structural weld overlays in pressurizer nozzle safe end welds which diverge from the requirements of the ASME Section XI code. The affected code requirements are:

- ASME Section XI, Code Case 504-2
- ASME Section XI, Code Case 638-1
- ASME Section XI, Appendix VIII, Supplement 11
- ASME Section XI, Nonmandatory Appendix Q
- ASME Section XI, Code Case N-416-2

The proposed alternative approach will provide an acceptable level of quality and safety.

The proposed structural weld overlay is intended as a preventive measure against flaw development or means of repair for flaws similar to those that have occurred at other nuclear power facilities. The overlay will be applied during the South Texas Project Unit 1 Fall 2006 and Unit 2 Spring 2007 refueling outages. The discussion in Attachment 1 provides the basis and justification for the proposed alternative. To support preparation for the upcoming outages, the NRC is requested to approve this proposed alternative by July 31, 2006.

Similar requests have been made for use of overlays to repair flaws in nozzle safe end welds. Examples are:

- Three Mile Island (TAC No. MC1201) (approved by the NRC on July 21, 2004)
- Millstone (TAC No. MC8609) (approved by the NRC on January 20, 2006)
- Donald C. Cook (TAC No. MC6704) (approved by the NRC on December 21, 2005)

~~A045~~
A047

STI: 31999766

There are no commitments included in the attached request.

If there are any questions, please contact either Mr. P. L. Walker at (361) 972-8392 or me at (361) 972-7030.

M. J. Berg
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PLW

Attachment: Proposed Alternative to ASME Section XI Requirements for Application of a Weld Overlay (RR-ENG-2-43) cc:

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SOUTH TEXAS PROJECT

PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIREMENTS FOR APPLICATION OF A WELD OVERLAY

(RELIEF REQUEST RR-ENG-2-43)

1.0 ASME Code Components Affected

System: Reactor Coolant System

Identifiers: Unit 1

16"RC1412NSS (Pressurizer Surge Line Nozzle Safe End Welds)

6"RC1003BB1 (Pressurizer Spray Line Nozzle Safe End Welds)

6"RC1004NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1009NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1012NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC1015NSS (Pressurizer Relief Line Nozzle Safe End Welds)

Unit 2

16"RC2412NSS (Pressurizer Surge Line Nozzle Safe End Welds)

6"RC2003BB1 (Pressurizer Spray Line Nozzle Safe End Welds)

6"RC2004NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC2009NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC2012NSS (Pressurizer Safety Line Nozzle Safe End Welds)

6"RC2015NSS (Pressurizer Relief Line Nozzle Safe End Welds)

Function: There are six low alloy steel nozzles for each pressurizer. Each has an Alloy 82/182 weld connecting the low alloy steel nozzle to an austenitic stainless steel (SS) safe end, and an SS weld connecting the safe end to SS piping. The nozzle configuration is shown in Figure 1. One nozzle located on the bottom of the pressurizer connects the surge line from the Loop 4 hot leg to the pressurizer. One nozzle at the top of the pressurizer receives flow from the Loop 1 and Loop 4 cold legs for pressurizer spray. Four nozzles at the top of the pressurizer provide a relief path to the pressurizer relief tank for overpressure protection. The pressurizer configuration is shown in Figure 2.

Code Class: Class 1

2.0 Applicable Code Edition and Addenda

The South Texas Project Inservice Inspection program for the second ten-year interval complies with the requirements of ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition and the 1995 Edition with 1996 Addenda for application of Section XI, IWA-2300, Appendix I, Appendix VII, and Appendix VIII.

Design and fabrication are in accordance with ASME Section III, 1974 Edition.

3.0 Applicable Code Requirements

ASME Section XI, Article 4000, specifies requirements for repair and replacement of pressure-retaining components. Certain requirements of IWA-4000 can be accomplished using the methodology of Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," and the methodology of Code Case N-638-1, "Similar and Dissimilar Metal Welding using Ambient Temperature Machine GTAW (Gas Tungsten Arc Welding) Temper Bead Technique, Section XI, Division I."

ASME Code Case N-504-2 allows use of a weld overlay (WOL) to enhance pipe integrity. This Code Case has been endorsed in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.147, Revision 14, for generic use with the condition that the provisions of Section XI, Nonmandatory Appendix Q, "Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments," must also be met.

ASME Code Case N-638-1 provides for welding dissimilar metals. This Code Case has been endorsed in NRC Regulatory Guide 1.147, Revision 14, for generic use with the condition that ultrasonic examination (UT) shall be demonstrated for the repaired volume using representative samples which contain construction-type flaws. The acceptance criteria of NB-5330 of Section III edition and addenda approved in 10 CFR 50.55a apply to all flaws identified within the repaired volume.

ASME Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," provides requirements for UT procedures, equipment, and personnel for UT of the completed WOL.

ASME Code Case N-416-2 allows use of a system leakage test, in conjunction with specified non-destructive examination (NDE), in lieu of a system hydrostatic test. N-416-2 has been approved by the NRC for use at the South Texas Project (reference 9.5).

4.0 Reason for Request

Given the location and thickness of the welded zones and the availability of Code Case N-504-2, removal of flaws prior to applying the overlay material would be a difficult task with no net benefit to the station. In addition, examination by UT of the safe end welds prior to the weld overlay is unnecessary because, if flaws are present, they will be mitigated by the WOL.

A WOL is to be applied over each pressurizer nozzle safe end weld using machine GTAW. ASME Code Case N-638-1 allows application without the use of elevated temperature pre-heat and without post-weld heat treatment following completion of GTAW. Both elevated temperature pre-heat and post-weld heat treatment require that the components be drained prior to pre-heat or post-weld heat treatment, which may be impractical for operational and radiological reasons.

Appendix VIII provides UT performance qualification requirements for a completed structural WOL application. In lieu of these ASME Code UT requirements, alternative techniques are proposed for UT examination of the full structural WOL. The specified requirements in Appendix VIII need clarification in part, and in some cases are not compatible with the implementation by the Performance Demonstration Initiative (PDI).

5.0 Proposed Alternatives

The South Texas Project proposes a full structural WOL for the nozzle safe end welds using Alloy 52 weld metal. References to Alloy 52 weld metal in the relief request are intended to apply to use of Alloy 52, 52M, or 152 weld metal. The WOL will extend around the full circumference of the existing nozzle safe end Alloy 82/182 welds, overlapping the neighboring sections of low alloy steel nozzle and stainless steel piping. A typical WOL configuration to be applied is shown in Figure 1.

5.1 Code Case N-504-2 and Section XI Nonmandatory Appendix Q

ASME Section XI Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping," provides for reducing defects in austenitic stainless steel piping to an acceptable size by deposition of weld reinforcement material on the outside surface of the pipe. The WOL will be designed in accordance with NRC-approved Code Case N-504-2, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping," with some exceptions. The provisions of Section XI Nonmandatory Appendix Q, "Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments," are imposed by NRC Regulatory Guide 1.147, Revision 14, as a condition for acceptance of Code Case N-504-2.

The weld reinforcement material is to be Alloy 52 or equivalent applied as a WOL to the existing austenitic stainless steel safe ends, the low alloy steel nozzles, stainless steel piping, and the Alloy 82/182 and austenitic stainless steel weld material joining them. The WOL will be designed as a full structural overlay consistent with the requirements of Code Case N-504-2 and Appendix Q. The WOL design assumes there is no contribution to structural integrity from the original section of pipe. The structural WOL will completely cover the existing Alloy 82/182 weld metal and extend onto the ferritic and austenitic stainless steel (SS) material at each end. The specific thickness and length of the WOL to be applied will be designed according to the guidance provided in the code case.

The methodology of Code Case N-504-2 and provisions of Appendix Q will be followed with modifications described in Table 1. Applicable requirements not listed will be met as described in Code Case N-504-2 and Appendix Q.

5.2 Code Case N-638-1

Application of the WOL requires welding on the low alloy steel nozzle material with Alloy 52. Temper bead welding will be used for this purpose using the guidance of Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique." Code Case N-638-1 describes the process for welding similar and dissimilar metals using ambient temperature machine gas tungsten arc weld (GTAW) temper bead method. GTAW will be performed in accordance with Code Case N-638-1, with some exceptions. Code Case N-638-1 was conditionally approved for generic use in NRC Regulatory Guide 1.147, Revision 14, and was developed for welding similar and dissimilar metals using ambient temperature machine GTAW temper bead technique.

Code Case N-638-1 specifies a limit of 100 square inches for a temper bead weld. This applies to the surge line nozzles (16-inch diameter), safety and relief line nozzles (6-inch diameter), and spray line nozzles (6-inch diameter). The intent of the code case is clarified to limit the area of an individual weld over the ferritic material. The weld surface areas over ferritic material are expected to be approximately 144 square inches, 52 square inches, and 26 square inches, respectively. Electric Power Research Institute Technical Report 1003616 (reference 9.4) provides justification for a maximum area of 500 square inches. The surge line nozzle weld area can be assumed to not exceed 200 square inches.

The methodology of Code Case N-638-1 will be followed for any welding on ferritic material where the Construction Code requires post-weld heat treatment with the modifications proposed in Table 2. Applicable requirements not listed will be met as described in Code Case N-638-1.

5.3 ASME Section XI, Appendix VIII, Supplement 11

UT of the completed structural WOL will be accomplished in accordance with ASME Section XI, Appendix VIII, Supplement 11 modified to comply with the Performance Demonstration Initiative (PDI), as described in Table 3. PDI has developed a program for qualifying equipment, procedures, and personnel for WOL examinations in accordance with the UT criteria of Appendix VIII, Supplement 11. Applicable requirements not listed will be met as described in Appendix VIII Supplement 11.

5.4 ASME Section XI, Code Case N416-2

Application of Code Case N-416-2 for a system leakage test in lieu of a system hydrostatic test requires performance of NDE in accordance with the methods and acceptance criteria of the applicable Subsection of the 1992 Edition of ASME Section III. The NDE requirements of Nonmandatory Appendix Q will be followed for the required NDE in lieu of ASME Section III.

6.0 Basis for Use

6.1 ASME Section XI Code Case N-504-2 and Section XI Nonmandatory Appendix Q

Table 1 addresses the specific changes and the bases justifying the proposed modifications.

6.2 ASME Code Case N-638-1

Table 2 addresses the specific changes and the bases justifying the proposed modifications.

Some of the reasons for the 100-square-inch limit are distortion of weld and base metal, cracking in weld and base metal, and large residual stresses. Since the nozzle-to-safe-end welds and the weld overlays are fabricated from austenitic materials with inherent toughness, no cracking in the overlays is expected to occur due to the shrinkage associated with the weld overlay. Many temper bead weld overlays have been applied in the nuclear industry to these nozzle-to-safe end locations. There has not been any reported cracking due to the weld overlay application. The stiffness and high toughness inherent in the nozzle material are expected to protect against cracking and limit any distortion that might occur in the nozzle. Axial shrinkage will be measured and evaluated for impact on the nozzle and safe end materials and on the piping system in accordance with ASME CC N-504-2. Also, any cracking would be detected by the final NDE of the weld overlay.

6.3 ASME Section XI, Appendix VIII, Supplement 11

Table 3 addresses the specific changes and the bases justifying the proposed modifications.

6.4 ASME Section XI Code Case N-416-2

ASME Section III Subsection NB Article 5000 for Examination does not address the structural weld overlay type configuration and appropriate NDE cannot be determined adequately. In the absence of clearly defined NDE requirements, application of

Nonmandatory Appendix Q addresses specific NDE with appropriate references to ASME Sections III and XI for acceptance criteria.

6.5 Leak-Before-Break

WCAP-10489, "Technical Bases for Eliminating Pressurizer Surge Line Ruptures as the Structural Design Basis for the South Texas Project," provides technical justification for eliminating pressurizer surge line breaks based on fracture mechanics analysis. Assessment using fracture mechanics demonstrated that small flaws or leakage cracks will remain stable and will be detected either by in-service inspection or by leakage monitoring systems long before such flaws can grow to a critical size (leak-before-break [LBB]).

In accordance with 10 CFR 50.12(a), the South Texas Project applied for an exemption from the requirements of 10 CFR 50, Appendix A, General Design Criterion 4 (GDC 4) for the treatment of pressurizer surge line pipe breaks. The exemption request was approved by the NRC in Supplement 7 to the South Texas Project Safety Evaluation Report (NUREG-0781).

MRP-140, "Materials Reliability Program: Leak-Before-Break Evaluation for PWR Alloy 82/182 Welds," addresses this issue. The LBB evaluation, conservatively including consideration of Pressurized Water Stress Corrosion Cracking (PWSCC) morphology, indicates that the margins in NUREG-1061, Volume 3 and draft Standard Review Plan 3.6.3 can be met for the relatively larger lines even after considering leak rate reduction resulting from PWSCC crack morphology. Assessment of leak detection capabilities concludes that action would be taken long before the Technical Specification leakage limit of 1 gpm. This is consistent with the leakage detection capability of 1 gpm used in the LBB submittals. Even with inclusion of PWSCC, there is ample time (more than one year) before leakage would increase to a point at which corrective action is necessary.

In the context of this submittal, only the pressurizer surge lines are included in LBB. The pressurizer spray, safety, and relief lines are not included under LBB. Effect of the overlay on pressurizer surge line LBB criteria is assessed during the overlay design process pursuant to 10 CFR 50.59.

6.6 NRC Bulletin 2004-01

Pursuant to NRC Bulletin 2004-01, “Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors,” (reference 9.1), the South Texas Project has inspected the steam space nozzles during recent refueling outages.

In addition to the ASME Section XI-required examinations, Bare Metal Visual (BMV) inspections were performed on all steam space nozzles during the Unit 2 refueling outage in March 2004. There was no evidence indicating any pressure boundary leakage from the pressurizer nozzle safe ends, nor was there any evidence of corrosion or wastage (reference 9.2).

As noted in a supplemental response to NRC Bulletin 2004-01, dated June 9, 2005 (reference 9.3), BMV inspections were performed on all steam space nozzles during the Unit 1 refueling outage that began in March 2005 (1RE12). A complete BMV examination was performed at each of the pressurizer nozzle safe ends. There was no evidence indicating pressure boundary leakage from these nozzle safe ends, nor was there evidence of corrosion or wastage.

6.7 Pressure Testing

The NRC previously approved Code Case N-416-2, "Alternative Pressure Test Requirement for Welded Repairs, Fabrication Welds for Replacement Parts and Piping Subassemblies, or Installation of Replacement Items by Welding, Class 1, 2, and 3," for use at the South Texas Project. The code case allows use of a system leakage test, in conjunction with specified NDE, in lieu of a system hydrostatic test to detect leakage from welded repairs, fabrication welds for replacement parts and piping subassemblies, or welds for installation of replacement items. For a system leakage test to be used, Code Case N-416-2 requires:

- Performance of NDE in accordance with the methods of Non-Mandatory Appendix Q and acceptance criteria of the applicable Subsection of the 1992 Edition of Section III (as described in Section 5.4).
- Performance of a visual examination (VT-2) prior to or immediately upon return to service in conjunction with a system leakage test, using the 1992 Edition of Section XI, in accordance with IWA-5000, at nominal operating pressure and temperature.
- Documentation of use of this Case on an NIS-2 Form.

6.8 Welder Qualification and Welding Procedures

All welders, welding operators, and welding procedures will be qualified in accordance with ASME Code Section IX, any special requirements from Section XI, and applicable code cases. If necessary, a manual shielded metal arc procedure will be qualified to facilitate localized repairs and to provide a seal weld prior to depositing the overlay over the existing F43 weld deposit material. This procedure uses shielded metal arc weld electrodes consistent with the requirements of ASME Section XI.

7.0 <u>Duration of Proposed Alternative</u>

This proposed alternative is for application as needed during the remainder of the current inspection interval which ends September 24, 2010 for Unit 1 and October 8, 2010 for Unit 2. The duration of the proposed alternative is the remaining service life of the affected components.

8.0 <u>Implementation</u>

The structural WOL will be installed during the South Texas Project Unit 1 Fall 2006 and Unit 2 Spring 2007 refueling outages as a preventive measure against flaw development or means of repair for any flaws that may be present in the dissimilar metal welds. NRC approval is requested by July 31, 2006, to support scheduling for completion of activities during the outage.

9.0 <u>References</u>

9.1 NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors," dated May 28, 2004

9.2 Correspondence from T. J. Jordan to Document Control Desk, "Response to NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors," dated July 27, 2004 (NOC-AE-04001762)

9.3 Correspondence from T. J. Jordan to Document Control Desk, "Response to NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors," dated June 9, 2005 (NOC-AE-05001890)

9.4 Electric Power Research Institute Technical Report 1003616, "Additional Evaluations to Extend Repair Limits for Pressure Vessels and Nozzles," March 2004

9.5 Correspondence from Robert A. Gramm, Nuclear Regulatory Commission, to William T. Cottle, "Request for Approval to Use American Society of Mechanical Engineers (ASME) Code, Section XI, Code Case N-416-2, Relief Request RR-ENG-2-20 (TAC Nos. MB0382 and MB0383), dated February 16, 2001

TABLE 1

DESIGN/MATERIAL/NONDESTRUCTIVE EXAMINATION
Modifications to ASME Code Case N-504-2 and ASME Section XI Appendix Q

Code Case N-504-2 and ASME Section XI Appendix Q	Modification/Basis
Current Requirements It is the opinion of the Committee that, in lieu of the requirements of IWA-4120 in Editions and Addenda up to and including the 1989 Edition with the 1990 Addenda, in IWA-4170(b) in the 1989 Edition with the 1991 Addenda up to and including the 1995 Edition, and in IWA-4410 in the 1995 Edition with the 1995 Addenda and later Editions and Addenda, defect in austenitic stainless steel piping may be reduced to a flaw of acceptable size in accordance with IWB-3640 from the 1983 Edition with the Winter 1985 Addenda, or later Editions and Addenda, by deposition of weld reinforcement (weld overlay) on the outside surface of the pipe, provided the following requirements are met. *[Essentially the same scope of Appendix Q]:*	Code Case N-504-2 will be used for weld overlay (WOL) repairs or mitigation to the ferritic (P3) and nickel alloy (F43/P43) base material as well as the austenitic stainless steel (P8) base material. **Basis:** Code Case N-504-2 is accepted for use along with Nonmandatory Appendix Q in NRC Regulatory Guide 1.147 Rev. 14. For the WOL, the base material will be ferritic material (P3) with existing nickel alloy weld metal (F43) to which an austenitic stainless steel (P8) safe end is welded. Industry operational experience has shown that PWSCC in Alloy 82/182 will blunt at the interfaces with stainless steel base metal, ferritic base metal, and Alloy 52 weld metal. Application of a 360° full structural WOL will mitigate any potential PWSCC crack and maintain weld integrity. The WOL will induce compressive stress in the weld, thus potentially impeding initiation or growth of any reasonably shallow cracks. The WOL will be sized to meet all structural requirements independent of the existing weld.
Weld Metal (b) Reinforcement weld metal shall be low carbon (0.035% max.) austenitic stainless steel applied 360° around the circumference of the pipe, and shall be deposited in accordance with a qualified welding procedure specification identified in the Repair Program. *[Essentially the same as Q-2000(a)]*	In lieu of austenitic stainless steel filler material, the reinforcement weld metal will be a nickel alloy. **Basis:** Alloy 52, 52M and 152 may be used as weld metal. The requirements of ASME Section III, NB-2400 will be applied to all filler material. These filler materials were selected for their improved resistance to PWSCC. Alloys 52, 52M and 152 all contain about 30% chromium which imparts excellent corrosion resistance. The existing Alloy 82/182 weld and the Alloy 52 WOL are austenitic

	and have ductile properties and toughness similar to austenitic stainless steel piping welds at pressurized water reactor operating temperatures. These filler materials are suitable for welding over the ferritic nozzle, Alloy 82/182 weld, and the austenitic stainless steel piping or safe ends.
Delta Ferrite Content (e) The weld reinforcement shall consist of a minimum of two weld layers having as-deposited delta ferrite content of at least 7.5 FN. The first layer of weld metal with delta ferrite content of least 7.5 FN shall constitute the first layer of the weld reinforcement design thickness. Alternatively, first layers of at least 5 FN may be acceptable based on evaluation. *[Same as Q-2000(d)]*	 Delta ferrite (FN) measurements will not be performed for WOL made of Alloy 52 weld metal. **Basis:** Alloy 52 welds are 100% austenitic and contain no delta ferrite due to the high nickel content (approximately 60% nickel).
Pressure Testing (h) The completed repair shall be pressure tested in accordance with IWA-5000. If the flaw penetrated the original pressure boundary prior to welding, or if any evidence of a flaw penetrating the pressure boundary is observed during the welding operation, a system hydrostatic test shall be performed in accordance with IWA-5000. If the system pressure boundary has not been penetrated, a system leakage, inservice, or functional test shall be performed in accordance with IWA-5000.	 If a flaw or evidence of a flaw is observed, in lieu of hydrostatic testing, a system leakage test and an ultrasonic examination (UT) of the weld overlay will be performed consistent with ASME Code Case N-416-2, as modified by Nonmandatory Appendix Q. **Basis:** Application of Code Case N-416-2 for a system leakage test in lieu of a system hydrostatic test requires performance of NDE in accordance with the methods and acceptance criteria of the applicable Subsection of the 1992 Edition of ASME Section III. ASME Section III Subsection NB Article 5000 for Examination does not address the structural weld overlay type configuration and appropriate NDE cannot be determined adequately. The NDE requirements of Nonmandatory Appendix Q will be followed for the required NDE in lieu of ASME Section III.

TABLE 2
AMBIENT TEMPER BEAD WELDING
Modifications to Code Case N-638-1

Code Case N-638-1	Modification/Basis
Weld Area 1.0(a) The maximum area of an individual weld based on the finished surface shall be 100 sq. in., and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.	The maximum area of an individual weld based on the finished surface ***over the ferritic material*** shall not exceed 200 square inches, and the depth of the WOL shall not be greater than one-half of the ferritic base metal thickness **Basis:** The maximum finished area of the WOL for the surge line nozzle will exceed 100 sq-in over the ferritic material. EPRI Technical Report 1003616 justifies extending the size of the temper bead repairs up to a finished area of 500 sq-in over the ferritic material. The area of the finished overlays will be substantially less than this.
Examination 4.0(b) The final weld surface and the band around the area defined in para. 1.0(d)* shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I. Refer to the 1989 Edition with the 1989 Addenda and later Editions and Addenda. *1.0(d) Prior to welding the area to be welded and a band around the area of at least 11⁄2 times the component thickness or 5 in., whichever is less shall be at least 50°F.	The UT coverage area will be defined using Code Case N-504-2 and Appendix Q instead of that defined by Code Case N-638-1. The band around the welded area will only receive a surface examination, not a UT examination. Examinations will be performed after the completed weld has been at ambient temperature for at least 48 hours. **Basis:** The ultrasonic examination requirements of N-638-1 are developed for repair activities involving excavation and repair, wherein the repair weld and adjacent base material(s) typically require volumetric examination. These requirements for volumetric examination are not considered suitable for pressurizer nozzle surfaces adjacent to the structural weld overlay, since the existing nozzle configuration is not conducive to effective ultrasonic examination. For structural weld overlays, Code Case N-504-2 has been developed specifically for installation of structural weld overlays, and contains NDE requirements consistent with structural weld overlay configurations. For this application, any major base material cracking is expected to take place in the heat affected zone directly below the WOL or in the underlying weld deposit and not in the band of

	material outside the WOL. UT of the final weld surface should identify such cracks if they are present. This Code Case applies to any type of welding where a temper bead technique is employed and is not specifically written for WOL applications. For structural weld overlays, Code Case N-504-2 specifically applies to structural weld overlays, and includes NDE requirements consistent with structural WOL configurations.

TABLE 3

ALTERNATIVES TO APPENDIX VIII, SUPPLEMENT 11

ASME Section XI Appendix VIII Supplement 11 – Qualification Requirements for Full Structural Weld Overlaid Wrought Austenitic Piping Welds	Modification/Basis
1.0 SPECIMEN REQUIREMENTS	
1.1(b) The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 inches or larger, the specimen set must include at least one specimen 24 inches or larger but need not include the maximum diameter. The specimen set ***must include at least one specimen with overlay thickness within -0.1 inches to +0.25 inches of the maximum nominal overlay thickness for which the procedure is applicable.***	1.1(b) The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 inches or larger, the specimen set must include at least one specimen 24 inches or larger but need not include the maximum diameter. The specimen set ***shall include specimens with overlays not thicker than 0.1 inch more than the minimum thickness, nor thinner than 0.25 inch of the maximum nominal overlay thickness for which the examination procedure is applicable.*** **Basis:** The proposed alternative provides clarification regarding application of the tolerance. The tolerance is unchanged for a single specimen set. It clarifies the tolerance for multiple specimen sets by providing tolerances for both minimum and maximum thicknesses. The proposed wording maintains the intent of the overlay thickness tolerance.
1.1(d) Flaw Conditions (1) Base metal flaws. All flaws must be ***cracks*** in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. ***Flaws may extend 100% through the base metal and into the overlay material; in this case, intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the cracking.*** Specimens containing IGSCC	(1) Base metal flaws. All flaws must be in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. **Intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the base metal flaws.** Specimens containing IGSCC shall be used when available. **At least 70 percent of the flaws in the detection and sizing tests shall be cracks**

[intergranular stress corrosion cracking] shall be used when available.	**and the remainder shall be alternative flaws. Alternative flaw mechanisms, if used, shall provide crack-like reflective characteristics and shall be limited by the following:** **(a) The use of alternative flaws shall be limited to when the implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws.** **(b) Flaws shall be semi-elliptical with a tip width less than or equal to 0.002 inch.** **Basis:** This paragraph requires that all base metal flaws be cracks. Implanting a crack requires excavation of the base material on at least one side of the flaw. While this may be satisfactory for ferritic materials, austenitic materials do not provide a realistic flaw response. To resolve this issue, the PDI developed a process for fabricating flaws that exhibit crack-like reflective characteristics. Use of alternative flaws is limited to when implantation of cracks precludes obtaining an effective ultrasonic response. Fabricated flaws are semi-elliptical with a tip width less than or equal to 0.002 inch. At least 70% of the flaws in the detection and sizing test are cracks and the rest are alternative flaws.
1.1(e) Detection Specimens (1) At least 20% but less than 40% of the flaws shall be oriented within +20 deg. of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. **The rules of IWA-3300 shall be used to determine whether closely spaced flaws should be treated as single or multiple flaws.**	(1) At least 20% but less than 40% of the **base metal** flaws shall be oriented within +20 degrees of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. **Basis:** The requirement for axially oriented overlay fabrication flaws was excluded from the PDI Program as an improbable scenario. Weld overlays are typically applied using automated GTAW techniques with the filler metal applied in a circumferential direction. Because fabrication-induced discontinuities would also be expected to have major dimensions oriented in the circumferential direction, axial overlay fabrication flaws are unrealistic. Used in place of IWA-3300, PDI treats each flaw as

	an individual flaw and not as part of a system of closely spaced flaws. PDI controls the flaws used in a test specification set to be free of interfering reflections from adjacent flaws. Spacing the test specimen flaws more closely results in a more challenging performance demonstration.
1.1(e) Detection Specimens (2) Specimens shall be divided into base and overlay grading units. Each specimen shall contain one or both types of grading units.	(2) Specimens shall be divided into base **metal** and overlay **fabrication** grading units. Each specimen shall contain one or both types of grading units. **Flaws shall not interfere with ultrasonic detection or characterization of other flaws.** **Basis:** Inclusion of "metal" and "fabrication" provides clarification. Flaw identification is improved by ensuring flaws are not masked by other flaws.
1.1(e) Detection Specimens (2)(a)(1) A base grading unit shall include at least 3 inches of the length of the overlaid weld. The base grading unit includes the outer 25 percent of the overlaid weld **and base metal on both sides.** The base grading unit shall **not include the inner 75 percent of the overlaid weld and base metal overlay material, or base metal-to-overlay interface.**	(2)(a)(1) A base **metal** grading unit includes **the overlay material** and the outer 25% of the original overlaid weld. The base **metal** grading unit shall **extend circumferentially for at least 1 inch and shall start at the weld centerline and be wide enough in the axial direction to encompass one half of the original weld crown and a minimum of 0.50 inch of the adjacent base material.** **Basis:** The PDI program intentionally excludes the phrase "and base metal on both sides," because some of the qualification samples include flaws on both sides of the weld. Several instances of the terms "cracks" and "cracking" were changed to the term "flaws" because of the use of alternative flaw mechanisms. The proposed change permits the PDI program to continue using test specimens from the existing weld overlay program which have flaws on both sides of the welds. These test specimens have been used successfully for testing the proficiency of personnel for over 16 years. The weld overlay qualification is designed to be a near-side [relative to the weld] examination, and it is improbable that a candidate would detect a flaw on the opposite side of the weld due to the sound attenuation and redirection caused by the weld microstructure. However, the presence of flaws on both sides of

	the original weld (outside the PDI grading unit) may actually provide a more challenging examination, as candidates must determine the relevancy of these flaws, if detected.
1.1(e) Detection Specimens (2)(a)(2) When base metal cracking penetrates into the overlay material, the base grading unit shall include the overlay metal within 1 inch of the crack location. This portion of the overlay material shall not be used as part of any overlay grading unit.	(2)(a)(2) When base metal **flaws** penetrate into the overlay material, the base **metal** grading unit shall not be used as part of any overlay **fabrication** grading unit. **Basis:** Substituted terms provide clarification. The PDI program adjusts for this conservative change.
1.1(e) Detection Specimens (2)(a)(3) When a base grading unit is designed to be unflawed, at least 1 inch of unflawed overlaid weld and base metal shall exist on either side of the base grading unit. The segment of weld length used in one base grading unit shall not be used in another base grading unit. Base grading units need not be uniformly spaced around the specimen.	(2)(a)(3) Sufficient unflawed overlaid weld and base metal shall exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws. **Basis:** The revised wording addresses the same concerns as the ASME Code.
1.1(e) Detection Specimens (2)(b)(1) An overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 square inches. The overlay grading unit shall be rectangular, with minimum dimensions of 2 inches	(2)(b)(1) An overlay **fabrication** grading unit shall include the overlay material and the base metal-to-overlay interface **for a length of at least 1 inch.** The PDI program reduces the base metal-to-overlay interface to at least 1 inch (in lieu of a minimum of 2 inches) and eliminates the minimum rectangular dimension. **Basis:** This criterion is necessary to allow use of existing examination specimens that were fabricated in order to meet NRC Generic Letter 88-01. This criterion may be more challenging than the ASME Code because of the variability associated with the shape of the grading unit.
1.1(e) Detection Specimens (2)(b)(2) An overlay grading unit designed to be unflawed shall be surrounded by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch around its entire perimeter. The specific area used in one	(2)(b)(2) Overlay **fabrication** grading units designed to be unflawed shall be **separated** by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch **at both ends. Sufficient unflawed overlaid weld and**

overlay grading unit shall not be used in another overlay grading unit. Overlay grading units need not be spaced uniformly about the specimen.	**base metal shall exist on both sides of the overlay fabrication grading unit to preclude interfering reflections from adjacent flaws.** The specific area used in one overlay fabrication grading unit shall not be used in another overlay fabrication grading unit. Overlay fabrication grading units need not be spaced uniformly about the specimen. **Basis:** Relaxation in the required area on the sides of the specimens, while still ensuring no interfering reflections, may provide a more challenging demonstration than required by the ASME Code because of the possibility for a parallel flaw on the opposite side of the weld.
1.1(e) Detection Specimens (2)(b)(3) Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base grading units, ten unflawed base grading units, five flawed overlay grading units, and ten unflawed overlay grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units.	 (2)(b)(3) Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base **metal** grading units, ten unflawed base **metal** grading units, five flawed overlay **fabrication** grading units, and ten unflawed overlay **fabrication** grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units. **For initial procedure qualification, detection sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.** **Basis:** The revised wording addresses the same concerns as the ASME Code. The additional wording for personnel qualification sets enhances the ASME Code requirements.
1.1(f) Sizing Specimen (1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be **cracks** open to the inside surface.	 (1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be open to the inside surface. **Sizing sets shall contain a distribution of flaw dimensions to assess sizing capabilities. For initial procedure qualification, sizing sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.**

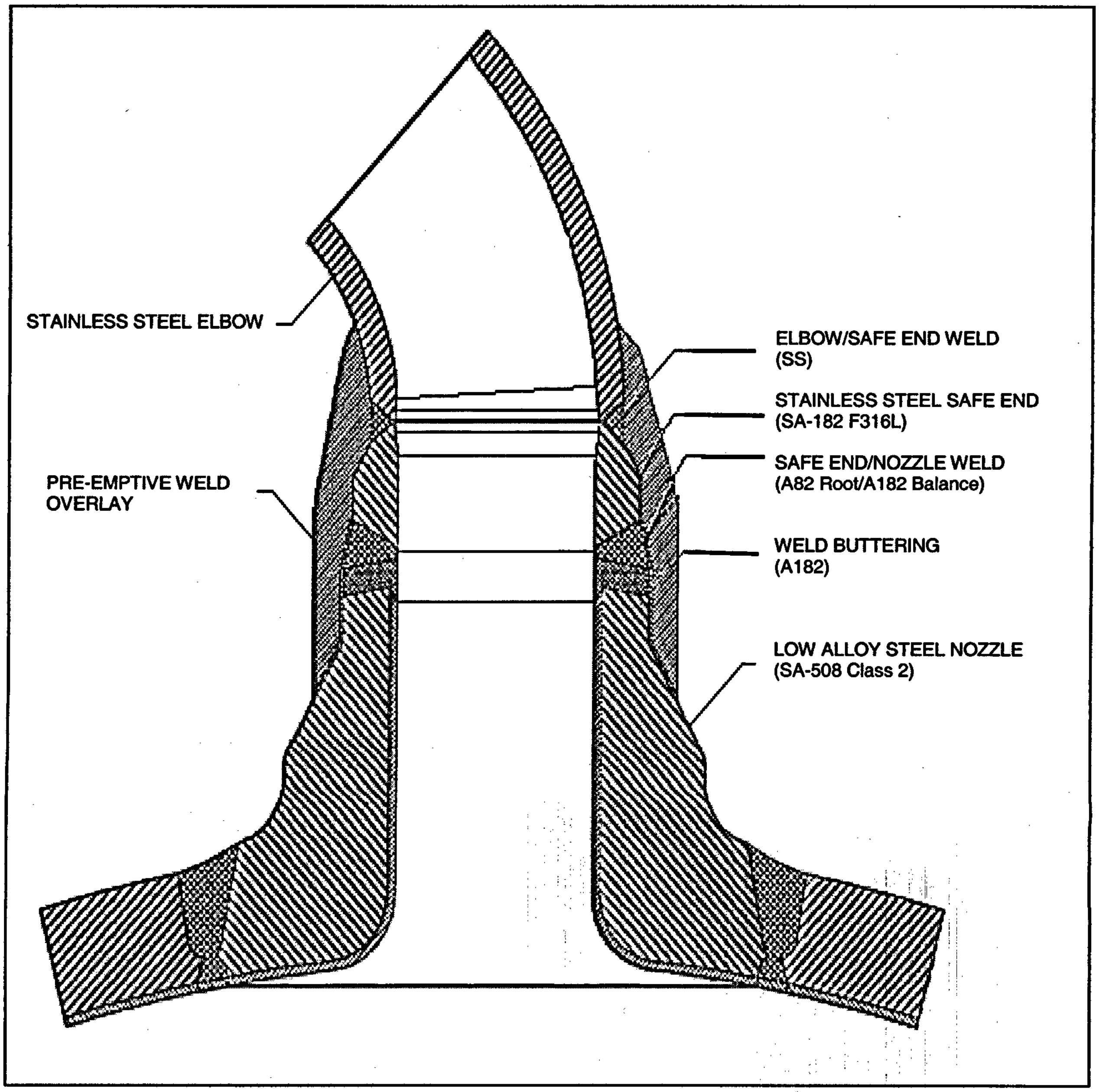
	Basis: The revised wording addresses the same concerns as the ASME Code. The additional wording for personnel qualification sets enhances the ASME Code requirements.
1.1(f) Sizing Specimen (3) Base metal **cracking** used for length sizing demonstrations shall be oriented circumferentially.	(3) Base metal **flaws** used for length sizing demonstrations shall be oriented circumferentially. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
1.1(f) Sizing Specimen (4) Depth sizing specimen sets shall include at least two distinct locations where cracking in the base metal extends into the overlay material by at least 0.1 inch. in the through-wall direction.	(4) Depth sizing specimen sets shall include at least two distinct locations where a base metal **flaw** extends into the overlay material by at least 0.1 inch in the through-wall direction. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
2.0 CONDUCT OF PERFORMANCE DEMONSTRATIONS	
The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of unmasked specimens after the performance demonstration is prohibited.	The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of unmasked specimens after the performance demonstration is prohibited. **The overlay fabrication flaw test and the base metal flaw test may be performed separately.** **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
2.1 Detection Test Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base or overlay) that are present for each specimen.	Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base **metal** or overlay **fabrication**) that are present for each

	specimen. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
2.2 Length Sizing Test (d) For flaws in base grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25 percent of the base wall thickness.	For flaws in base **metal** grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25 percent of the base **metal** wall thickness. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
2.3 Depth Sizing Test For the depth sizing test, 80 percent of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate. For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region.	The depth sizing test may be conducted separately or in conjunction with the detection test. When the depth sizing test is conducted in conjunction with the detection test and the detected flaws do not satisfy the requirements of 1.1(f), additional specimens shall be provided to the candidate. The regions containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region. For a separate depth sizing test, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code

3.0 ACCEPTANCE CRITERIA	
3.1 Detection Acceptance Criteria Examination procedures, equipment, and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. The criteria shall be satisfied separately by the demonstration results for base grading units and for overlay grading units.	a) Examination procedures are qualified for detection when: 1) All flaws within the scope of the procedure are detected and the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for false calls. (a) At least one successful personnel demonstration has been performed meeting the acceptance criteria defined in (c). (b) Examination equipment and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. (c) The criteria in (a), (b) shall be satisfied separately by the demonstration results for base metal grading units and for overlay fabrication grading units. **Basis:** Personnel and equipment are still required to meet the Supplement 11 requirement. Therefore, the program criteria exceed the ASME Code requirements for personnel, procedures, and equipment qualification.
3.2 Sizing Acceptance Criteria (a) The RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The length of base metal **cracking** is measured at the 75 percent through-base-metal position.	(a) RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The length of base metal **flaws** is measured at the 75 percent through-base-metal position. **Basis:** The revised wording clarifies the requirement and meets the intent of the ASME Code.
3.2 Sizing Acceptance Criteria (b) All extensions of base metal cracking into the overlay material by at least 0.1 inch are reported as being intrusions into the overlay material.	This requirement is removed. **Basis:** The requirement to report all extensions of

	cracking into the overlay is not included in the PDI Program because it already requires that cracks be depth-sized to the tolerance of 0.125 inch specified in the ASME Code. Reporting a crack extension into the overlay material is redundant for performance demonstration testing because of the flaw sizing tolerance.

FIGURE 1
PRESSURIZER NOZZLE SAFE END (Typical)



PRESSURIZER

- **Design**

The pressurizer is a vertically mounted, cylindrical vessel with hemispherical top and bottom heads, constructed of carbon steel with austenitic stainless steel cladding on all surfaces exposed to the reactor coolant.

The surge line nozzle is installed at the bottom head. A thermal sleeve is provided to minimize stresses in the surge line nozzle. The surge line connects the pressurizer to one reactor hot leg. The line enables continuous coolant volume and pressure adjustments between the RCS and the pressurizer. The surge line is sized to limit the pressure drop between the RCS and the safety valves with maximum allowable discharge flow from the safety valves.

The spray line nozzle is located at the top head of the pressurizer. Thermal sleeves are installed on the pressurizer spray nozzles where high thermal stresses could develop due to rapid changes in fluid temperature during normal operational transients.

Relief line nozzles for the four pressurizer relief tank connections are located at the top head of the pressurizer.

Overpressure of the RCS does not exceed 110 percent of the design pressure. The surge line and the thermal sleeve in the pressurizer surge nozzle are designed to withstand the thermal stresses resulting from volume surges of relatively hotter or colder water that may occur during operation.

Pressurizer and related piping design data are listed in Table 4.

- **Materials**

Degradation of safe end welds experienced at other plants has been attributed to primary water stress corrosion cracking (PWSCC). In place of the stainless steel weld material, a consumable welding wire resistant to PWSCC has been selected for the overlay weld material. This nickel-based alloy weld material, commonly known as Alloy 52 or equivalent, will be applied using a machine GTAW process. Alloy 52 or equivalent contains about 30% chromium which imparts excellent corrosion resistance. The material is suitable for welding over the low alloy steel nozzle, Alloy 82/182 weld material, stainless steel safe end, and stainless steel weld material. This alternative provides an acceptable level of safety and quality.

The pressurizer surge line conforms to SA-376 Grade 304, 304N, or 316 with supplementary requirements S2 (transverse tension tests) and S6 (ultrasonic test). The S2 requirement applies to each length of pipe. The S6 requirement applies to 100 percent of the piping wall volume. The ends of pipe sections, branches, and fittings are machined back to provide a smooth weld transition adjacent to the weld path.

FIGURE 2

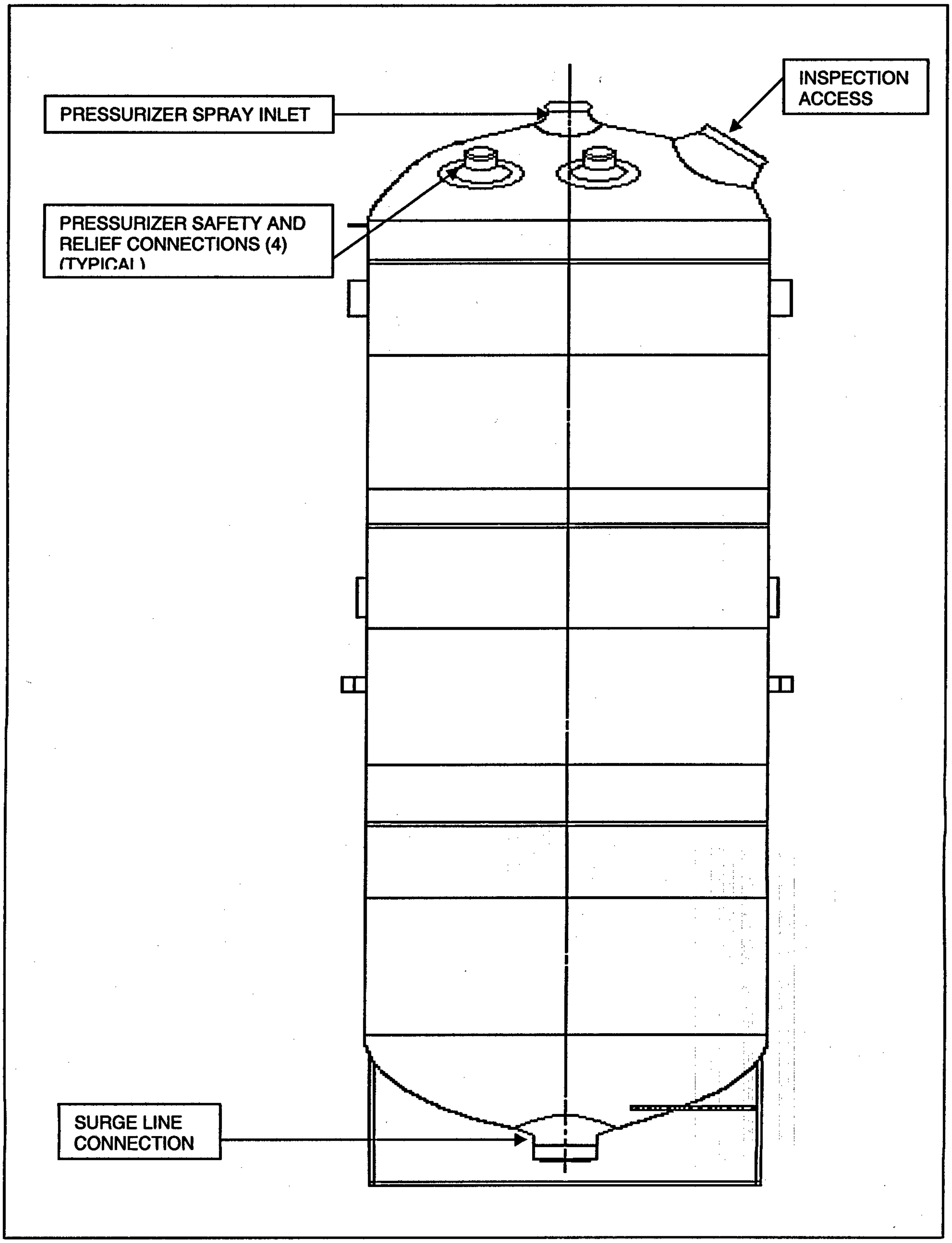

PRESSURIZER SPRAY INLET
INSPECTION ACCESS
PRESSURIZER SAFETY AND RELIEF CONNECTIONS (4) (TYPICAL)
SURGE LINE CONNECTION

TABLE 4

PRESSURIZER DESIGN DATA

Surge Line, nominal pipe size	16 inches
Surge Line, nominal thickness	1.593 inches
Pressurizer Spray Line, nominal pipe size	6 inches
Pressurizer Spray Line, nominal thickness	0.719 inch
Pressurizer Safety and Relief Line, nominal pipe size	6 inches
Pressurizer Safety and Relief Line, nominal thickness	0.719 inch
Design Pressure	2,485 psig
Design Temperature	680° F
Nozzle Material	SA-508 steel
Safe End Material	SA-182 F316L
Existing Nozzle Weld Material (Connects the low alloy steel nozzle to the austenitic stainless steel safe end)	Alloy 82/182