(e) The flaws shall be oriented parallel or perpendicular to the clad direction.

3.0 CONDUCT OF PERFORMANCE DEMONSTRATIONS

3.1 Detection Test.
(a) Flaw locations shall be obscured so as to maintain a "blind test." Divulging particular specimen results or candidate viewing of unmasked specimens is prohibited.
(b) If a flaw is reported within the greater of 1 in. (25 mm) or 10% of the metal path length to the flaw from its true location (x, y, and z) it shall be considered detected. All other reported flaws shall be considered false calls.

3.2 Length and Depth Sizing Test.
(a) Each reported flaw in the detection test shall be length sized.
(b) When only length sizing is being tested, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the length of the flaw in each region.
(c) For the 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.

3.3 Single-Side Access.
(a) Qualification of personnel and procedures for single-side access shall be performed as in 3.1, except that access shall be restricted to one direction parallel and one direction perpendicular to the weld.
(b) The procedure shall demonstrate that it is capable of detecting flaws described in 2.3. This need not be a blind demonstration.
(c) The procedure shall define specific evaluation criteria for detection, such that an independent evaluator can make an unbiased decision.

4.0 ACCEPTANCE CRITERIA

4.1 Detection Acceptance Criteria.
(a) Procedure qualification shall demonstrate detectability of each flaw within the scope of the procedure.
(b) Personnel are qualified if the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S4-1 and no flaw greater than 0.25 in. (6 mm) depth is missed.
(c) For procedure and personnel demonstrations, the number of false calls shall not exceed A/10, rounded to the next whole number, where A is the total scan area of specimens in the test measured in square feet. The total scan area is defined as the area that would be scanned when scanning from all four directions.

4.2 Sizing Acceptance Criteria. Examination procedures, equipment, and personnel are qualified for sizing if the results of the performance demonstration satisfy the following criteria:

(a) The RMS error of the flaw lengths estimated by ultrasonics, as compared to the true lengths, shall not exceed 0.75 in. (19 mm)
(b) The RMS error of the flaw depths estimated by ultrasonics, as compared to the true depths, shall not exceed 0.15 in. (4 mm)

4.3 Single-Side Acceptance Criteria.
(a) Demonstrations performed according to 3.3(a) shall meet the applicable requirements of 4.1 for flaws located within the inner 10% of the vessel thickness.
(b) The supplemental procedure demonstration of 3.3 is acceptable when all flaws described in 2.3 are detected in accordance with the evaluation criteria qualified in 3.3(c).

SUPPLEMENT 5 QUALIFICATION REQUIREMENTS FOR NOZZLE EXAMINATION FROM THE OUTSIDE SURFACE

1.0 SCOPE

This Supplement is applicable to examination of ferritic nozzle inside-corner regions and the inner 15% of ferritic nozzle-to-shell welds when scanning for flaws oriented perpendicular to the weld. Demonstration on clad nozzle mockups may be used for examination of unclad nozzles. Demonstrations performed on unclad nozzle mockups shall not be used for examination of clad nozzles. Supplement 4 qualification is required when scanning for flaws oriented parallel to ferritic nozzle-to-shell welds. Supplement 6 qualification is required for the outer 85% of ferritic nozzle-to-shell welds.

2.0 MODELING REQUIREMENTS

The examination procedure shall include or provide for the following.

2.1 A computational model that calculates misorientation angles, the maximum metal path distance to the required examination volume, and the angle at the flaw (nominal inspection angle). Misorientation angle and the angle at the flaw is shown in Fig. VIII-S5-1. These calculations apply to the central ray of the ultrasonic beam. The modeling process and associated essential variables shall be identified and defined.

2.2 A statement that specifies the examination surface and the associated maximum acceptable misorientation angle and metal path, and the range of angles at the flaw for the examinations.

2.3 Division of the surface of the required examination volume into grids of 1.0 in. (25 mm) or less in the nozzle axis direction and 10 deg or less of azimuth.

2.4 The misorientation angle, metal path distance, and angle at the flaw in each grid cell location for each search unit or scan shall be documented. Alternatively, when multiple search units with different skew or incident angles are used, the search unit or scan that produces the
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Parts Examined¹</th>
<th>Examination Requirements/ Fig. No.</th>
<th>Examination Method²</th>
<th>Acceptance Standard</th>
<th>Extent and Frequency of Examinations</th>
<th>Deferral of Examination to End of Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6.10</td>
<td>Reactor Vessel</td>
<td>Surfaces</td>
<td>Visual, VT-1</td>
<td>IWB-3517</td>
<td>All bolts, studs, nuts, bushings,</td>
<td>Same as for 1st interval</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>threads in flange stud holes</td>
<td></td>
</tr>
<tr>
<td>B6.20</td>
<td>Closure Head Nuts</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6.40</td>
<td>Threads in Flange</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6.50</td>
<td>Closure Washers, Bushings</td>
<td>Surfaces</td>
<td>Visual, VT-1</td>
<td>IWB-3517</td>
<td></td>
<td></td>
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<tr>
<td>B6.60</td>
<td>Pressurizer</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td>All bolts, studs, nuts, bushings,</td>
<td>Same as for 1st interval</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and flange surfaces</td>
<td></td>
</tr>
<tr>
<td>B6.70</td>
<td>Bolts and Studs</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td></td>
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<tr>
<td>B6.80</td>
<td>Nuts, Bushings, and Washers</td>
<td>Surfaces</td>
<td>Visual, VT-1</td>
<td>IWB-3517</td>
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<tr>
<td>B6.90</td>
<td>Steam Generators</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td>All bolts, studs, nuts, bushings,</td>
<td>Same as for 1st interval</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>and flange surfaces</td>
<td></td>
</tr>
<tr>
<td>B6.100</td>
<td>Bolt and Studs</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
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<tr>
<td>B6.110</td>
<td>Flange Surface, when connection disassembled</td>
<td>Surfaces</td>
<td>Visual, VT-1</td>
<td>IWB-3517</td>
<td>All bolts, studs, nuts, bushings,</td>
<td>Same as for 1st interval</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and flange surfaces</td>
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<tr>
<td>B6.120</td>
<td>Heat Exchangers</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
<td>All bolts, studs, nuts, bushings,</td>
<td>Same as for 1st interval</td>
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<td></td>
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<td>and flange surfaces</td>
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<tr>
<td>B6.130</td>
<td>Bolt and Studs</td>
<td>IWB-2500-12</td>
<td>Volumetric</td>
<td>IWB-3515</td>
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<tr>
<td>B6.140</td>
<td>Flange Surface, when connection disassembled</td>
<td>Surfaces</td>
<td>Visual, VT-1</td>
<td>IWB-3517</td>
<td>All bolts, nuts, bushings,</td>
<td>Same as for 1st interval</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>and flange surfaces</td>
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</tbody>
</table>
(4) Selected samples of welded attachments shall be examined each inspection interval. All welded attachments selected for examination shall be those most subject to corrosion, as determined by the Owner, such as welded attachments of the Service Water or Emergency Service Water systems. For multiple vessels of similar design, function and service, the only one welded attachments of only one of the multiple vessels shall be selected for examination. For single vessels, only one welded attachment shall be selected for examination. The attachment selected for examination on one of the multiple vessels or the single vessel, as applicable, shall be an attachment under continuous load during normal system operation, or an attachment subject to a potential intermittent load (seismic, water hammer, etc.) during normal system operation if an attachment under continuous load does not exist. For welded attachments of piping, pumps, and valves, a 10% sample shall be selected for examination. This percentage sample shall be proportional to the total number of nonexempt welded attachments connected to the piping, pumps, and valves in each system subject to these examinations.
Ultrasonic examination personnel shall be certified in accordance with the Owner's written practice. Procedures and personnel shall be qualified in accordance with Appendix VIII.

Q-4100 EXAMINATION

(a) The weld overlay shall have a surface finish of 250 microinch (6.3 micrometers) RMS or better and a flatness sufficient to allow for adequate examination in accordance with procedures qualified in accordance with Mandatory Appendix VIII. The weld overlay shall be examined to verify acceptable configuration.

(b) The weld overlay and the adjacent base material for at least \( \frac{1}{2} \) in. (13 mm) from each side of the weld shall be examined using the liquid penetrant method. The weld overlay shall satisfy the surface examination acceptance criteria for welds of the Construction Code or NB-5300. The adjacent base metal shall satisfy the surface examination acceptance criteria for base material of NB-2500.

(c) The examination volume in Fig. Q-4100-1 shall be ultrasonically examined to assure adequate fusion (i.e., adequate bond) with the base metal and to detect welding flaws such as interbead lack of fusion, inclusions, or cracks. Planar flaws in Class 1 piping shall meet the preservice examination standards of Table IWB-3514-1, and planar flaws in Class 2 or 3 piping shall meet the preservice examination standards of Table IWC-3514-1. Laminar flaws shall meet the following:

1. Laminar flaws shall meet the acceptance standards of Table IWB-3514-3.

(2) The reduction in coverage of the examination volume in Fig. Q-4300-1, due to laminar flaws, shall be less than 10%. The dimensions of the uninspectable volume are dependent on the coverage achieved with the angle beam examination of the overlay.

(3) Any uninspectable volume in the weld overlay shall be assumed to contain the largest radial planar flaw that could exist within that volume. This assumed flaw shall meet the inservice examination standards of Table IWB-3514-1 for Class 1 piping or Table IWC-3514-1 for Class 2 or 3 piping. Alternatively, the assumed flaw shall meet the requirements of IWB-3640, IWC-3640, or IWD-3640, as applicable. Both axial and circumferential planar flaws shall be assumed.

(4) As an alternative to (3), radiography in accordance with the Construction Code shall be used to examine the uninspectable volume. The radiographic acceptance criteria of the Construction Code shall apply.

(d) After completion of all welding activities, affected restraints, supports, and snubbers shall be VT-3 visually examined to verify that design tolerances are met.

Q-4200 PRESERVICE INSPECTION

(a) The examination volume in Fig. Q-4300-1 shall be ultrasonically examined. The angle beam shall be directed perpendicular and parallel to the pipe axis, with scanning performed in four directions to locate and size cracks that have propagated into the upper 25% of the pipe base material or into the overlay.

(b) For Class 1 piping, the preservice examination acceptance standards of Table IWB-3514-1 shall be satisfied, and for Class 2 or 3 piping, the preservice examination acceptance standards of Table IWC-3514-1 shall be satisfied for the weld overlay. Cracks in the outer 25% of the pipe base metal shall meet the design analysis requirements of Q-3000.

Q-4300 INSERVICE INSPECTION

(a) The weld overlay examination volume in Fig. Q-4300-1 shall be added to the inspection plan and shall be ultrasonically examined during the first or second refueling outage following application.

(b) The weld overlay examination volume in Fig. Q-4300-1 shall be ultrasonically examined to determine if any new or existing cracks have propagated into the upper 25% of the pipe base material or into the
ARTICLE IWB-5000
SYSTEM PRESSURE TESTS

IWB-5200 SYSTEM TEST REQUIREMENTS

IWB-5210 TEST

(a) Pressure retaining components shall be tested at the frequency stated in, and visually examined by the method specified in Table IWB-2500-1, Examination Category B-P.

(b) The system pressure tests and visual examinations shall be conducted in accordance with IWA-5000 and this Article. The contained fluid in the system shall serve as the pressurizing medium.

IWB-5220 SYSTEM LEAKAGE TEST

IWB-5221 Pressure

(a) The system leakage test shall be conducted at a pressure not less than the pressure corresponding to 100% rated reactor power.

(b) The system test pressure and temperature shall be attained at a rate in accordance with the heat-up limitations specified for the system.

IWB-5222 Boundaries

(a) The pressure retaining boundary during the system leakage test shall correspond to the reactor coolant boundary, with all valves in the position required for normal reactor operation startup. The visual examination shall, however, extend to and include the second closed valve at the boundary extremity.

(b) The pressure retaining boundary during the system leakage test conducted at or near the end of each inspection interval shall extend to all Class I pressure retaining components within the system boundary.

IWB-5230 HYDROSTATIC TEST

(a) The hydrostatic test may be conducted at any test pressure specified in Table IWB-5230-1 corresponding to the selected test temperature, provided the requirements of IWB-5240 are met for all ferritic steel components within the boundary of the system (or portion of system) subject to the test pressure (see IWA-5245).

(b) Whenever a hydrostatic test is conducted in which the reactor vessel contains nuclear fuel and the vessel is within the system test boundary, the test pressure shall not exceed the limiting conditions specified in the plant Technical Specifications.

IWB-5240 TEMPERATURE

(a) The minimum test temperature for either the system leakage or system hydrostatic test shall not be lower than the minimum temperature for the associated pressure specified in the plant Technical Specifications.

(b) The system test temperature shall be modified as required by the results obtained from each set of material surveillance specimens withdrawn from the reactor vessel during the service lifetime.

(c) For tests of systems or portions of systems constructed entirely of austenitic steel, test temperature limitations are not required to meet fracture prevention criteria. In cases where the components of the system are constructed of ferritic and austenitic steels that are nonisolable from each other during a system leakage or system hydrostatic test, the test temperature shall be in accordance with IWB-5230(a).
ARTICLE IWB-5000
SYSTEM PRESSURE TESTS

Table IWB-5230-1
TEST PRESSURE

<table>
<thead>
<tr>
<th>Test Temperature, °F</th>
<th>Test Pressure[^1,2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 or less</td>
<td>1.10P_n</td>
</tr>
<tr>
<td>200</td>
<td>1.08P_n</td>
</tr>
<tr>
<td>300</td>
<td>1.06P_n</td>
</tr>
<tr>
<td>400</td>
<td>1.04P_n</td>
</tr>
<tr>
<td>500 or greater</td>
<td>1.02P_n</td>
</tr>
</tbody>
</table>

NOTES:
(1) P_n is the nominal operating pressure corresponding with 100% rated reactor power.
(2) Linear interpolation at intermediate test temperatures is permissible.

IWB-5240 TEMPERATURE

(a) The minimum test temperature for either the system leakage or system hydrostatic test shall not be lower than the minimum temperature for the associated pressure specified in the plant Technical Specifications.

(b) The system test temperature shall be modified as required by the results obtained from each set of material surveillance specimens withdrawn from the reactor vessel during the service lifetime.

(c) For tests of systems or portions of systems constructed entirely of austenitic steel, test temperature...
ARTICLE IWB-5000
SYSTEM PRESSURE TESTS

IWB-5200 SYSTEM TEST REQUIREMENTS

IWB-5210 TEST

(a) Pressure-retaining components shall be tested at the frequency stated in and visually examined by the method specified in Table IWB-2500-L Examination Category B-1.

(b) The system pressure tests and visual examinations shall be conducted in accordance with IWA-5000 and this Article. The contained fluid in the system shall serve as the pressurizing medium.

IWB-5220 SYSTEM LEAKAGE TEST

A00 IWB-5221 Pressure

(a) The system leakage test shall be conducted at a pressure not less than the pressure corresponding to 100% rated reactor power.

(b) The system test pressure and temperature shall be attained at a rate in accordance with the heat-up limitations specified for the system.

IWB-5222 Boundaries

(a) The pressure-retaining boundary during the system leakage test shall correspond to the reactor coolant boundary, with all valves in the position required for normal reactor operation startup. The visual examination shall, however, extend to and include the second closed valve at the boundary extremity.

(b) The pressure-retaining boundary during the system leakage test conducted at or near the end of each inspection interval shall extend to all closed pressure-retaining components within the system boundary.

IWB-5230 HYDROSTATIC TEST

(a) The hydrostatic test may be conducted at any test pressure specified in Table IWB-5230-L corresponding to the selected test temperature, provided the requirements of IWB-5240 are met for all pertinent steel components within the boundary of the system (or portion of system) subject to the test pressure (see IWA-5245).

(b) Wherever a hydrostatic test is conducted in which the reactor vessel contains nuclear fuel, and the vessel is within the system test boundary, the test pressure shall not exceed the limiting conditions specified in the plant technical specifications.

IWB-5240 TEMPERATURE

(a) The minimum test temperature for either the system leakage or system hydrostatic test shall not be lower than the minimum temperature for the associated pressure specified in the plant technical specifications.

(b) The system test temperature shall be modified as required by the results obtained from each set of material surveillance specimens withdrawn from the reactor vessel during the service lifetime.

(c) For tests of systems or portions of systems constructed entirely of austenitic steel, test temperature...
# Table IWD-2500-1

**Examination Categories**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Parts Examined [Note (3)]</th>
<th>Examination Requirements / Fig. No.</th>
<th>Examination Method</th>
<th>Acceptance Standard</th>
<th>Extent of Examination [Note (3)], [Note (4)]</th>
<th>Frequency of Examination [Note (4)], [Note (5)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressure Vessels</td>
<td>IWD-2500-1</td>
<td>Visual, VT-1</td>
<td>IWD-3000</td>
<td>100% of required areas of each weld attachment</td>
<td>Each identified occurrence and each inspection interval</td>
</tr>
<tr>
<td>D1.10</td>
<td>Welded Attachments</td>
<td>IWD-2500-1</td>
<td>Visual, VT-1</td>
<td>IWD-3000</td>
<td>100% of required areas of each weld attachment</td>
<td>Each identified occurrence and each inspection interval</td>
</tr>
<tr>
<td>D1.20</td>
<td>Welded Attachments</td>
<td>IWD-2500-1</td>
<td>Visual, VT-1</td>
<td>IWD-3000</td>
<td>100% of required areas of each weld attachment</td>
<td>Each identified occurrence and each inspection interval</td>
</tr>
<tr>
<td>Pumps</td>
<td>D1.30</td>
<td>Welded Attachments</td>
<td>IWD-2500-1</td>
<td>Visual, VT-1</td>
<td>IWD-3000</td>
<td>Each identified occurrence and each inspection interval</td>
</tr>
<tr>
<td>Valves</td>
<td>D1.40</td>
<td>Welded Attachments</td>
<td>IWD-2500-1</td>
<td>Visual, VT-1</td>
<td>IWD-3000</td>
<td>Each identified occurrence and each inspection interval</td>
</tr>
</tbody>
</table>

**Examination Category D-B, Welded Attachments for Vessels, Piping, Pumps, and Valves**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Parts Examined</th>
<th>Examination Requirements / Figure No.</th>
<th>Examination Method</th>
<th>Acceptance Standard</th>
<th>Extent of Examination</th>
<th>Frequency of Examination</th>
</tr>
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<tbody>
<tr>
<td>D2.10</td>
<td>Pressure retaining components</td>
<td>System leakage test (IWD-5220)</td>
<td>Visual, VT-2</td>
<td>IWD-3000</td>
<td>Pressure retaining boundary</td>
<td>Each inspection period</td>
</tr>
</tbody>
</table>

**NOTES:**

1. These requirements do not apply to atmospheric or 0 psig to 15 psig (0 kPa to 100 kPa) storage tanks.
2. Examination is limited to those welded attachments that meet the following conditions:
   - (a) the attachment is on the outside surface of the pressure retaining component;
   - (b) the attachment provides component support as defined in NF-1110;
   - (c) the attachment weld joins the attachment either directly to the surface of the component or to an integrally cast or forged attachment to the component; and
   - (d) the attachment weld is full penetration, fillet, or partial penetration, either continuous or intermittent.
3. The extent of the examination includes essentially 100% of the length of the attachment weld at each attachment subject to examination.
4. Selected samples of welded attachments shall be examined each inspection interval. All welded attachments selected for examination shall be those most subject to corrosion, as determined by the Owner, such as the welded attachments of the Service Water or Emergency Service Water systems. For multiple vessels of similar design, function and service, the welded attachments of only one of the multiple vessels shall be selected for examination. For single vessels, only one welded attachment shall be selected for examination. The attachment selected for examination on one of the multiple vessels or the single vessel, as applicable, shall be an attachment under continuous load during normal system operation, or an attachment subject to a potential intermittent load (seismic, water hammer, etc.) during normal system operation if an attachment under continuous load does not exist. For welded attachments of piping, pumps, and valves, a 10% sample shall be selected for examination. This percentage sample shall be proportional to the total number of non exempt welded attachments connected to the piping, pumps, and valves in each system subject to these examinations.
5. Examination is required whenever component support member deformation, e.g., broken, bent, or pulled out parts, is identified during operation, refueling, maintenance, examination, or testing.