ARTICLE VIII-3000
QUALIFICATION REQUIREMENTS

VIII-3100 QUALIFICATION TEST REQUIREMENTS

VIII-3110 DETECTION

(a) Qualification test specimens shall meet the requirements of the appropriate Supplement listed in Table VIII-3110-1.

(b) Qualification test specimens may be segments of full-scale mock-ups or separate specimens cut from full-scale segments. Additional specimens can be generated by altering the flow direction or by changing reference points. Divulgence of full-scale mock-up identification to the candidate is acceptable, provided the flaw locations and specimen identifications are not provided.

(c) The examination procedure, equipment, and personnel are qualified for detecting flaws upon successful completion of the performance demonstration specified in the appropriate Supplement listed in Table VIII-3110-1.

(d) For piping welds whose requirements are in course of preparation, the requirements of Mandatory Appendix III, as supplemented by Table I-2000-1, shall be met.

VIII-3120 SIZING

(a) Qualification test specimens shall meet the requirements of the appropriate Supplement listed in Table VIII-3110-1.

(b) Qualification test specimens may be segments of full-scale mock-ups or separate specimens cut from full-scale segments. Additional specimens can be generated by altering the flow direction or by changing reference points. Divulgence of full-scale mock-up identification to the candidate is acceptable, provided the flaw locations (unless allowed by the specific supplement) and specimen identifications are not provided.

(c) The examination procedure, equipment, and personnel are qualified for sizing flaws upon successful completion of the performance demonstration specified in the appropriate Supplement listed in Table VIII-3110-1. When the applicable piping supplement contains no provisions for a performance demonstration using axially oriented flaws, examination personnel, equipment, procedures, and the associated techniques qualified for

---

Table VIII-3110-1
Component Qualification Supplements

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Applicable Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping Welds</td>
<td></td>
</tr>
<tr>
<td>Wrought austenitic</td>
<td>2</td>
</tr>
<tr>
<td>Ferritic</td>
<td>3</td>
</tr>
<tr>
<td>Cast austenitic</td>
<td>[Note (1)]</td>
</tr>
<tr>
<td>Structural weld inlay (corrosion- resistant clad)</td>
<td>[Note (1)]</td>
</tr>
<tr>
<td>austenitic</td>
<td></td>
</tr>
<tr>
<td>Dissimilar metal</td>
<td>10</td>
</tr>
<tr>
<td>Overlay</td>
<td>11</td>
</tr>
<tr>
<td>Coordinated implementation of Supplements 2 and 3</td>
<td>12</td>
</tr>
<tr>
<td>Coordinated implementation of Supplements 10, 2,</td>
<td>14</td>
</tr>
<tr>
<td>and 3 from the inside surface</td>
<td></td>
</tr>
<tr>
<td>Vessels</td>
<td></td>
</tr>
<tr>
<td>Clad/base metal interface region</td>
<td>4</td>
</tr>
<tr>
<td>Nozzle examinations from the outside surface</td>
<td>5</td>
</tr>
<tr>
<td>Reactor vessel welds other than clad/base metal</td>
<td>6</td>
</tr>
<tr>
<td>interface</td>
<td></td>
</tr>
<tr>
<td>Nozzle examinations from the inside surface</td>
<td>7</td>
</tr>
<tr>
<td>PWR Reactor Vessel Upper Head Penetrations</td>
<td>15</td>
</tr>
<tr>
<td>Bolts and Studs</td>
<td>8</td>
</tr>
</tbody>
</table>

NOTE:
(1) In the course of preparation.

---

BLUE text approved under Record# 18-1874
RED text added in THIS Record# 18-1691
SUPPLEMENT 12  REQUIREMENTS FOR
COORDINATED IMPLEMENTATION OF
SELECTED ASPECTS OF
SUPPLEMENTS 2 AND 3

1.0 SCOPE

This Supplement provides for expansion of Supplement 2 qualifications to permit coordinated qualification for Supplement 3.

2.0 DETECTION AND LENGTH SIZING

2.1 Ferritic Piping. Examination personnel, equipment, and procedure qualification requirements for detection and length sizing for Supplements 2 and 3 are satisfied when the following requirements are met.

(a) For detection qualification, at least three additional flawed grading units and six additional unflawed units in ferritic piping shall be added to the test set. A grading unit shall include at least 3 in. (75 mm) continuous weld length. All nine ferritic grading units shall be correctly identified.

(b) The demonstration shall meet the requirements of Supplement 2, except that for length sizing qualification, the minimum number of flaws shall be ten, and the specimen set shall include at least three, but not more than four, flaws in ferritic material.

(c) The ferritic grading units added to expand the qualification are not required to span the full thickness and diameter ranges of the Supplement 2 test set.

3.0 DEPTH SIZING

Examination personnel, equipment, and procedure qualification requirements for depth sizing for Supplements 2 and 3 are met by the following demonstration.

(a) Specimens

(1) The minimum number of flaws shall be ten.

(2) The specimen set shall include at least four but no more than five Supplement 3 flaws.

(3) The overall flaw depth distribution shall meet the requirements of Supplement 2, 1.3(d).

(b) The demonstration shall be conducted in accordance with the requirements of Supplement 2, 2.2(b).

(c) The examination procedure, equipment, and personnel are qualified for depth sizing when the RMS error of the flaw depth measurements, as compared to the true flaw depths, does not exceed 0.125 in. (3.2 mm).

SUPPLEMENT 14  QUALIFICATION REQUIREMENTS FOR
COORDINATED IMPLEMENTATION OF
SUPPLEMENTS 10, 2, AND 3 FOR PIPING
EXAMINATIONS PERFORMED FROM THE
INSIDE SURFACE

1.0 SCOPE

This supplement is applicable to wrought austenitic, ferritic, and dissimilar metal piping welds examined from the inside surface. This supplement provides for expansion of Supplement 10 qualifications to permit coordinated qualification for Supplements 2 and 3.

2.0 SPECIMEN REQUIREMENTS

Qualification test specimens shall meet the requirements listed herein, unless a set of specimens is designed to accommodate specific limitations stated in the scope of the examination procedure (e.g., pipe size, access limitations). The same specimens may be used to demonstrate both detection and sizing qualification.

2.1 General. The specimen set shall conform to the following requirements.

(a) Specimens shall have sufficient volume to minimize spurious reflections that may interfere with the interpretation process.

(b) The specimen set shall include the minimum and maximum diameters and thicknesses for which the examination procedure is applicable. Applicable tolerances are provided in Supplements 2, 3, and 10.

(c) The specimen set shall include examples of the following fabrication conditions:

(1) geometric and material conditions that normally require discrimination from flaws (e.g., counterbore or weld root conditions, cladding, weld through, remnants of previous welds, adjacent welds in close proximity, and weld repair areas)

(2) typical limited scanning surface conditions (e.g., internal tapers, exposed weld roots, and cladding conditions)

2.2 Supplement 2 Flaws.

(a) At least 70% of the flaws shall be cracks, the remainder shall be alternative flaws.

(b) Specimens with IGSCC shall be used when available.

(c) Alternative flaws, if used, shall provide crack-like reflective characteristics and shall comply with the following.

(1) Alternative flaws shall be used only when implantation of cracks produces spurious reflectors that are uncharacteristic of service-induced flaws.

(2) Alternative flaws shall have a tip width of no more than 0.002 in. (0.05 mm).
2.3 Supplement 3 Flaws. Supplement 3 flaws shall be mechanical or thermal fatigue cracks.

2.4 Distribution. The specimen set shall contain a representative distribution of flaws. Flawed and unflawed grading units shall be randomly mixed.

3.0 PERFORMANCE DEMONSTRATION

Personnel and procedure performance demonstration tests shall be conducted according to the following requirements.

(a) The same essential variable values, or, when appropriate, the same criteria for selecting values as demonstrated in Supplement 10 shall be used.

(b) The flaw location and specimen identification shall be obscured to maintain a “blind test.”

(c) 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.

3.1 Detection Test.

(a) The specimen set for Supplement 2 qualification shall include at least five flawed grading units and ten unflawed grading units in austenitic piping. A maximum of one flaw shall be oriented axially.

(b) The specimen set for Supplement 3 qualification shall include at least three flawed grading units and six unflawed grading units in ferritic piping. A maximum of one flaw shall be oriented axially.

(c) Specimens shall be divided into grading units.

(i) Each grading unit shall include at least 3 in. (76 mm) of weld length.

(ii) The end of each flaw shall be separated from an unflawed grading unit by at least 1 in. (25 mm) of unflawed material. A flaw may be less than 3 in. (76 mm) in length.

(iii) The segment of weld length used in one grading unit shall not be used in another grading unit.

(iv) Grading units need not be uniformly spaced around the pipe specimen.

(d) All grading units shall be correctly identified as being either flawed or unflawed.

3.2 Length-Sizing Test.

(a) The coordinated implementation shall include the following requirements for personnel length-sizing qualification.

(b) The specimen set for Supplement 2 qualification shall include at least four flaws in austenitic material.

(c) The specimen set for Supplement 3 qualification shall include at least three flaws in ferritic material.

(d) Each reported circumferential flaw in the detection test shall be length sized. When only length sizing is being tested, the regions of each specimen containing a flaw to be sized may be identified to the candidate. The candidate shall determine the length of the flaw in each region.

(e) Supplement 2 or Supplement 3 examination procedures, equipment, and personnel are qualified for length sizing when the flaw lengths estimated by ultrasonics, as compared with the true length, do not exceed 0.75 in. (19 mm) RMS, when they are combined with a successful Supplement 10 qualification.

3.3 Depth-Sizing Test. The coordinated implementation shall include the following requirements for personnel depth-sizing qualification.

(a) The specimen set for Supplement 2 qualification shall include at least four circumferentially-oriented flaws in austenitic material.

(b) The specimen set for Supplement 3 qualification shall include at least three circumferentially oriented flaws in ferritic material.

(c) For a separate depth sizing test, the regions of each specimen containing a flaw to be sized may be identified to the candidate. The candidate shall determine the depth of the flaw in each region.

(d) Supplement 2 or Supplement 3 examination procedures, equipment, and personnel are qualified for depth sizing when the flaw depths estimated by ultrasonics, as compared with the true depths, do not exceed 0.125 in. (3 mm) RMS, when they are combined with a successful Supplement 10 qualification.

4.0 PROCEDURE QUALIFICATION

Procedure qualification shall include the following additional requirements.

(a) The specimen set shall include the equivalent of at least three personnel performance demonstration test sets. Successful personnel performance demonstrations may be combined to satisfy these requirements.

(b) Detectability of all flaws in the procedure qualification test set that are within the scope of the procedure shall be demonstrated. Detection, length sizing, and depth sizing shall meet the requirements of 3.1, 3.2, and 3.3.

(c) At least one successful personnel demonstration shall be performed.

(d) To qualify new values of essential variables, at least one personnel performance demonstration is required. The acceptance criteria of (b) shall be met.

Insert: Supplement 15
SUPPLEMENT 15 QUALIFICATION REQUIREMENTS FOR PWR REACTOR VESSEL UPPER HEAD PENETRATIONS

1.0 SCOPE
This Supplement is applicable to PWR reactor vessel upper head penetrations fabricated from one of the following:
(a) UNS N06600 material with UNS N06082 or UNS W86182 partial penetration welds or
(b) Primary Water Stress Corrosion Cracking (PWSCC) resistant materials, such as UNS N06690 base metal with UNS N06052 or UNS W86152 partial-penetration welds.

2.0 SPECIMEN REQUIREMENTS
Qualification test specimens shall meet the requirements of this supplement, except that the specimen set may be designed to accommodate specific limitations stated in the scope of the examination procedure (e.g., penetration housing size, joint configuration, access limitations). The same specimens may be used to demonstrate both detection and sizing qualification.

2.1 General. The personnel specimen set shall conform to the following requirements.
(a) Specimens shall have sufficient volume to minimize spurious reflections that might interfere with the interpretation process.
(b) Specimens shall be fabricated using the base material specified in 1.0 (a) or 1.0 (b).
(c) The set shall include specimens not more than 40% thicker than the minimum thickness nor 25% thinner than the maximum thickness for which the examination procedure is applicable. The specimen set shall include the minimum and maximum inside diameters, within 3%, for which the examination procedure is applicable.

(d) The specimen set shall include examples of the following fabrication conditions:
(1) geometric and material conditions that normally require discrimination from flaws (e.g., threads, transitions, weld region, shrinkage)
(2) typical limited scanning surface conditions (e.g., threaded surface, transitions, weld region, other geometric features)
(e) Qualification requirements shall be performed separately for penetration housing outside surface and inside surface procedures, if applicable.

2.2 Flaw Location. All flaws shall be connected to the penetration housing inside or outside surfaces. The flaw locations shall be within the required examination volume. Flaws coincident with geometric features similar to those described in 2.1 (d) (1) shall be included in the specimen set. At least 20% of the flaws shall be connected to the inside surface. At least 20% of the flaws shall be connected to the outside surface. The flaws may be on either surface.

2.3 Flaw Type.
(a) The minimum number of flaws in a specimen set shall be ten.
(b) All flaws in the penetration housing shall be notches that have been compressed by using hot or cold isostatic pressing.
(c) At least two areas of leak paths shall be included in the personnel detection demonstration set to evaluate the leak path assessment capability.
(d) Leak path samples shall have areas designed to simulate conditions such as the following:
(1) Indications above the weld between the penetration housing and the head that result in meandering patterns coupled with high-amplitude responses as compared to the
surrounding material and span the annulus region and connect to the weld area (2) regions within the annulus between the penetration housing and the head with low amplitude responses compared to the surrounding material (3) combinations of both conditions described in (d)(1) and (d)(2).

2.4 Flaw Depth. All flaw through-wall depths shall be at least 10% of the nominal penetration housing wall thickness. Flaws in the specimen set shall be distributed as follows:
(a) At least 20% of the flaws shall be in the range of 10% to 30% of the wall thickness.
(b) At least 20% of the flaws shall be in the range of 31% to 50% of the wall thickness.
(c) The remaining flaws may range from 10% to 100% of the wall thickness.

2.5 Length Sizing The specimen set shall include a range of flaw sizes with varying aspect ratios.

2.6 Flaw Orientation At least 20% and no more than 60% of the total number of flaws shall be oriented axially.

3.0 PERFORMANCE DEMONSTRATION
Personnel and procedure performance demonstration tests shall be conducted according to the following requirements.
(a) The flaw location and specimen identification shall be obscured to maintain a “blind test.” All examinations shall be completed prior to grading the results and presenting the results to the candidate.
(b) For Leak Path - Scanning access above the weld shall be restricted to the minimum scan distance specified in the examination procedure (e.g., 2.0 in. (50 mm) above the weld), to effectively evaluate the leak path assessment capabilities at that distance.

3.1 Detection Test.
(a) The detection specimen set shall include unflawed surface area within the examination volume, not less than 1.5 times the combined area of all demonstration flaws, including their associated location tolerances defined in Table VIII-S15-1.

<table>
<thead>
<tr>
<th>Table VIII-S15-1 Location Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Housing Inside Diameter</td>
</tr>
<tr>
<td>in. (mm)</td>
</tr>
<tr>
<td>&lt; 2.0 (50)</td>
</tr>
<tr>
<td>2.0 -3.0 (50 - 76)</td>
</tr>
<tr>
<td>&gt;3.0 - 6.0 (76 - 152)</td>
</tr>
</tbody>
</table>

(b) Examination equipment and personnel are qualified for detection if personnel demonstrations satisfy the combined detection criteria of Table VIII-S15-2 and the false call criteria of 3.1(c).

<table>
<thead>
<tr>
<th>Table VIII-S15-2 Flaw Detection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Flaws in Test Set</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>
(c) The allowable number of false calls shall be less than or equal to 20\% of the number of flaws in the demonstration test set.

3.2 Length Sizing Test
(a) Each reported flaw in the detection test shall be length sized.
(b) The length sizing test may be performed separately or in conjunction with the detection test.
(c) If the length sizing test is performed in conjunction with the detection test, and fewer than 10 flaws are detected, additional flaws shall be provided to the candidate, such that at least 10 flaws are sized. The regions containing a flaw to be sized may be identified to the candidate, provided it does not compromise the sample or data set confidentiality. The candidate shall determine the length of the flaw in each region.
(d) For a separate length sizing test, the regions containing a flaw to be sized may be identified to the candidate, provided it does not compromise the sample or data set confidentiality. The candidate shall determine the length of the flaw in each region.
(e) Examination equipment and personnel are qualified for length sizing if the RMS error of the flaw length measurements, compared with the true flaw lengths, does not exceed 0.375 in. (9.5 mm).

3.3 Depth Sizing Test
(a) The depth sizing test may be performed separately or in conjunction with the detection test.
(b) If the depth sizing test is performed in conjunction with the detection test, and fewer than 10 flaws are detected, additional specimens shall be provided to the candidate such that at least 10 flaws are sized. The regions containing a flaw to be sized may be identified to the candidate, provided it does not compromise the sample or data set confidentiality. The candidate shall determine the maximum through-wall extent of the flaw in each region.
(c) For a separate depth sizing test, the regions containing a flaw to be sized may be identified to the candidate, provided it does not compromise the sample or data set confidentiality. The candidate shall determine the maximum through-wall extent of the flaw in each region.
(d) Examination equipment and personnel are qualified for depth sizing if the RMS error of the flaw depth measurements, compared to the true flaw depths, does not exceed 0.125 in. (3 mm).

4.0 PROCEDURE QUALIFICATION
Procedure qualification shall include the following additional requirements.
(a) The specimen set shall include the equivalent of at least three personnel performance demonstration test sets (minimum of 30 flaws). Successful personnel performance demonstrations may be combined to satisfy these requirements.
(b) Detectability of all flaws in the procedure qualification test set that are within the scope of the procedure shall be demonstrated. The allowable number of false calls shall be less than or equal to 20\% of the number of flaws in the demonstration test set. Length and depth sizing shall meet the RMS error requirements of 3.2(e) and 3.3 (d), respectively.
(c) At least one successful personnel performance demonstration shall be performed.
(d) To qualify new values of essential variables, at least one personnel performance demonstration set is required. The demonstration acceptance criteria of (b) shall be satisfied.
(e) The procedures used to perform volumetric examination for leak path assessments shall be qualified in accordance
with the low rigor requirements of Section V, Article 14.

5.0 GRADING CRITERIA

(a) The reported orientation of a recorded flaw is not considered essential when determining flaw detection capabilities. However, any procedure limitations in properly orienting detected flaws shall be documented accordingly (e.g., “unable to determine the orientation of flaws less than a defined length”).

(b) Flaw location tolerances are defined in Table VIII-S15-1.

(c) If any part of a reported flaw falls within the location tolerance of a demonstration flaw, the demonstration flaw shall be considered detected. However, any portion of the flaw that is reported outside the location tolerance shall be considered a false call. If a reported indication does not intersect any of the demonstration flaw’s location tolerances, the reported flaw shall be considered a false call.

(d) Flaws smaller than 70% of wall thickness shall be reported on the correct surface of the penetration housing (inside or outside). Failure to correctly report the position of these flaws shall be considered a false call and a missed detection.

(e) Leak Path - No missed detection or false calls are allowed for leak path personnel demonstrations. Any part of the reported leak path area that falls within the location of a demonstration flaw is considered a detection. If any part of the reported leak path area extends outside the location of the demonstration flaws by more than the tolerances defined in Table VIII-S15-1, it shall be considered a false call. Sizing is not required.