UHT-27 THICKNESS OF SHELLS UNDER EXTERNAL PRESSURE

Cylindrical and spherical shells under external pressure shall be designed by the rules in UG-28, using the applicable figures in Section II, Part D, Subpart 3 and the temperature limits of UG-20(c).

UHT-28 STRUCTURAL ATTACHMENTS AND STIFFENING RINGS

(a) Except as permitted in (b) and (c) below, all structural attachments and stiffening rings which are welded directly to pressure parts shall be made of materials of specified minimum yield strength within ±20% of that of the material to which they are attached.

(b) All permanent structural attachments welded directly to shells or heads constructed of materials conforming to SA-333 Grade B, SA-334 Grade B, SA-353, SA-522, SA-553, and SA-645, Grade A, shall be of the material covered by these specifications or austenitic stainless steel of the type which cannot be hardened by heat treatment. If suitable austenitic stainless steel is used for permanent attachments, consideration should be given to the greater coefficient of expansion of the austenitic stainless steel.

(c) Minor attachments made from material that does not conform to a material specification permitted in this Division may be used and may be welded directly to the pressure part, provided the requirements shown below are satisfied. Minor attachments are defined as parts of small size, less than or equal to 0.375 in. (10 mm) thick or 5 in.³ (82 cm³) in volume, that carry no load or an insignificant load such that a stress calculation in the designer’s judgment is not required; examples include nameplates, insulation supports, and locating lugs.

(1) The minimum specified tensile strength of the material shall be identified and suitable for welding in accordance with UW-5(b). The material shall be compatible insofar as welding is concerned with that to which the attachment is to be made.

(2) The minimum yield strength of minor attachments shall be within +20% and −60% of that of the material to which they are attached.

(3) The material shall be identified and suitable for welding in accordance with UW-5(b).

(4) If the continuous fillet weld is used, the leg dimension of fillet weld shall not be less than 0.25t, where t is the thickness of the minor attachment.

(5) The effect of differential thermal expansion shall be considered when the thermal expansion coefficient of the minor attachment differs from that of the pressure part to which it is attached.

(6) Welding materials with the equivalent room-temperature tensile strength as that of quenched and tempered steels shall be used.

(8) If the continuous fillet weld is used, the leg dimension of fillet weld shall not be less than 0.25t, where t is the thickness of the minor attachment.

(9) The welds shall be postweld heat treated when required by UHT-56.

UHT-29 STIFFENING RINGS FOR SHELLS UNDER EXTERNAL PRESSURE

Rules covering the design of stiffening rings are given in UG-29. The design shall be based on the appropriate figure in Section II, Part D, Subpart 3 for the material used in the ring.

UHT-30 ATTACHMENT OF STIFFENING RINGS TO SHELLS

Rules covering the attachment of stiffening rings are given in UG-30. Attachments shall be made using a welding procedure qualified to Section IX for vessels constructed to Part UHT.

UHT-32 FORMED HEADS, PRESSURE ON CONCAVE SIDE

Except as provided in UG-32(d), 1-4(c), and 1-4(d), formed heads shall be limited to ellipsoidal and/or hemispherical heads designed in accordance with UG-32(c) or UG-32(e).
(1) Coupons not containing welds shall meet the complete tensile requirements of the material specification and impact requirements of this part.

(2) Coupons containing weld metal shall be tested across the weld and shall meet the ultimate tensile strength requirements of the material specifications; in addition, the minimum impact requirements shall be met by samples with notches in the weld metal. The form and dimension of the tensile test specimen shall conform to Section IX, Figure QW-462.1(d). Yield strength and elongation are not a requirement of this test. Charpy impact testing shall be in accordance with the requirements of UHT-6.

UHT-82 WELDING

(a) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX, and such qualification tests shall be performed on post-weld heat-treated specimens when a postweld heat treatment is used.

(b) Due consideration shall be given to electrodes and filler metals for all welding processes to minimize the sources for hydrogen. When low-alloy steel electrodes and filler metals are used, the classification shall include an H4 supplemental diffusible hydrogen designator (4 ml of hydrogen max. per 100 g of weld metal) for each of the following:

(1) electrodes for shielded metal arc welding conforming to SFA-5.5
(2) electrodes and fluxes for submerged arc welding conforming to SFA-5.23
(3) electrodes and rods for gas-shielded arc welding conforming to SFA-5.28 or SFA-5.36
(4) electrodes for flux-cored arc welding conforming to SFA-5.29 or SFA-5.36

Practices used for controlling the storage of electrodes, rods, and fluxes shall be developed by the vessel manufacturer or those recommended by the electrode manufacturer.

(c) Filler metal containing more than 0.06% vanadium shall not be used for weldments subject to postweld heat treatment.

(d) For welded vessels in which the welds are not subject to quenching and tempering, the deposited weld metal and the heat-affected zone shall meet the impact test requirements of UG-84, except that the Charpy V-notch tests and requirements of UHT-6(a) shall apply.

(e) The following materials are exempt from production impact tests of the weld metal in accordance with UG-84 under the conditions given in (1) through (5) below:

<table>
<thead>
<tr>
<th>Specification No.</th>
<th>UNS No.</th>
<th>P-No./Group No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-353</td>
<td>KB1340</td>
<td>11A/1</td>
</tr>
<tr>
<td>SA-522 Type I</td>
<td>KB1340</td>
<td>11A/1</td>
</tr>
<tr>
<td>SA-533 Type I</td>
<td>KB1340</td>
<td>11A/1</td>
</tr>
<tr>
<td>SA-533 Type II</td>
<td>K71340</td>
<td>11A/1</td>
</tr>
<tr>
<td>SA-553 Type II</td>
<td>K61365</td>
<td>11A/1</td>
</tr>
<tr>
<td>SA-645, Grade A</td>
<td>K41583</td>
<td>11A/2</td>
</tr>
</tbody>
</table>

(1) One of the following high nickel alloy filler metals is used:

<table>
<thead>
<tr>
<th>Specification No.</th>
<th>Classification</th>
<th>F-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA-5.11</td>
<td>ENiCrMo-3</td>
<td>43</td>
</tr>
<tr>
<td>SFA-5.11</td>
<td>ENiCrMo-6</td>
<td>43</td>
</tr>
<tr>
<td>SFA-5.11</td>
<td>ENiCrFe-2</td>
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<tr>
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<td>ENiCrFe-3</td>
<td>43</td>
</tr>
<tr>
<td>SFA-5.14</td>
<td>ERNiCr-3</td>
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<td>ERNiCrFe-5</td>
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</tr>
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<td>ERNiCrMo-3</td>
<td>43</td>
</tr>
<tr>
<td>SFA-5.14</td>
<td>ERNiCrMo-4</td>
<td>44</td>
</tr>
</tbody>
</table>

(2) All required impact tests shall be performed as part of the procedure qualification tests as specified in UG-84.

(3) Production impact tests of the heat-affected zone are performed in accordance with UG-84(i).

(4) The welding processes are limited to gas metal arc, shielded metal arc, and gas tungsten arc.

(5) The minimum allowable temperature of the vessel shall be not less than -320°F (-195°C).

(f) For materials SA-508 and SA-543, the following, in addition to the variables in Section IX, QW-250, shall be considered as essential variables requiring requalification of the welding procedure:

(1) a change in filler metal SFA classification or to weld metal not covered by an SFA specification.
(2) an increase in the maximum interpass temperature or a decrease in the minimum specified preheat temperature. The specified range between the preheat and interpass temperatures shall not exceed 150°F (85°C).
(3) a change in the heat treatment (Procedure qualification tests shall be subjected to heat treatment essentially equivalent to that encountered in fabrication of the vessel or vessel parts including the maximum total aggregate time at temperature or temperatures and cooling rates.)
(4) a change in the type of current (AC or DC), polarity, or a change in the specified range for amp, volt, or travel speed.
(5) a change in the thickness T of the welding procedure qualification test plate as follows:

(-a) for welded joints which are quenched and tempered after welding, any increase in thickness [the minimum thickness qualified in all cases is 1/4 in. (6 mm)];

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for welded joints which are not quenched and tempered after welding, any change as follows:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T &lt; 5/8 in. (16 mm)</td>
<td>Any decrease in thickness (the maximum thickness qualified is 2T)</td>
</tr>
<tr>
<td>5/8 in. (16 mm) and over</td>
<td>Any departure from the range of 5/8 in. (16 mm) to 2T</td>
</tr>
</tbody>
</table>

(6) for the shielded metal arc, submerged arc, and gas-shielded and flux-cored arc welding processes, an increase in the supplemental diffusible hydrogen designator from that used during procedure qualification.

(7) Preheat shall be 100°F (38°C) minimum for material thickness up to and including 1/2 in. (13 mm); 200°F (95°C) minimum for material above 1/2 in. (13 mm) to and including 1 1/2 in. (38 mm); 300°F (150°C) minimum above 1 1/2 in. (38 mm). Preheat temperature shall be maintained for a minimum of 2 hr after completion of the weld joint.

(g) For SA-517 and SA-592 materials, the requirements of (f)(1), (f)(2), (f)(3), (f)(4), and (f)(6), in addition to the variables in Section IX, QW-250, shall be considered as essential variables requiring requalification of the welding procedure.

(h) The PWHT as required by Table UHT-56 may be waived for SA-517 and SA-592 materials with a nominal thickness over 0.58 in. to 1 1/4 in. (15 mm to 32 mm), inclusive, provided the following conditions are met:

1. A minimum preheat of 200°F (95°C) and a maximum interpass of 400°F (205°C) is used;
2. After completion of welding and without allowing the weldment to cool below the minimum preheat temperature, the temperature of the weldment is raised to a minimum of 400°F (205°C) and maintained at that temperature for at least 4 hr; and
3. All welds are examined by nondestructive examination in accordance with the provisions of this Part.

UHT-83 METHODS OF METAL REMOVAL

(a) Plate edges, welding bevels, chamfering and other operations involving the removal of metal shall be by machining, chipping, or grinding except as provided in (b) below.

(b) When metal removal is accomplished by methods involving melting, such as gas cutting or arc-air gouging, etc., it shall be done with due precautions to avoid cracking. Where the cut surfaces are not to be subsequently eliminated by fusion with weld deposits, they shall be removed by machining or grinding to a depth of at least 1/16 in. (1.5 mm) followed by inspection by magnetic particle or liquid penetrant methods.

CAUTION: The properties of the base metal may be adversely affected by excessive local heat inputs.

UHT-84 WELD FINISH

The requirements of UW-35(a) and UW-51(b) shall be met except that for SA-517 material, the maximum weld reinforcement shall not exceed 10% of the plate thickness or 1/6 in. (3.0 mm), whichever is less. The edge of the weld deposits shall meet all undercut requirements as well as all root welds.

UHT-85 STRUCTURAL AND TEMPORARY WELDS

(a) Welds for pads, lifting lugs and other nonpressure parts, as well as temporary lugs for alignment, shall be made by qualified welders in full compliance with a qualified welding procedure.

(b) Temporary welds shall be removed and the metal surface shall be restored to a smooth contour. The area shall be inspected by magnetic particle or liquid penetrant method for the detection and elimination of cracks. If repair welding is required, it shall be in accordance with qualified procedures, and the finished weld surface shall be inspected as required in UHT-57(b) or UHT-57(c).

UHT-86 MARKING ON PLATES AND OTHER MATERIALS

Any steel stamping shall be done with "low stress" stamps as commercially available. Steel stamping of all types may be omitted on material below 1/2 in. (13 mm) in thickness. For the use of other markings in lieu of stamping, see UG-77(b).

NOTE TO VOTERS: New paragraph (i) taken from UHT-82(e)(6) of the 2011 edition, but modified as follows: The 2011 edition required a flux coating moisture content limit of 0.2 % by weight in the as-received or "conditioned" condition. The supplemental hydrogen designator "R" specifies a maximum flux coating moisture content of 0.2 wt. % or less for electrodes in the as-received or reconditioned condition. The "R" designator meets the requirements specified in the 2011 edition of UHT-82. Flux coating hydrogen content is different from diffusible hydrogen designator (weld metal content) and requires specific testing by the manufacturer. See SFA-5.5 for the definition of "R" in E7018-H4R.