(c) When the welding involves only minor non-pressure attachments to vessels having carbon content exceeding 0.35% but not exceeding 0.50% by ladle analysis, requirements of UF-32(b) shall govern.

In the case of austenitic steels, procedures followed shall be in accordance with UF-37.

(b) Liquid Quenched SA-372 forging material to be used in the manufacture of vessels shall be subjected to the heat treatment procedures followed shall be in accordance with Section IX, Figures QW-462.1(a) through QW-462.1(e), and Figures QW-462.2 and QW-462.3(a), shall be made. These tests shall meet the requirements of Section IX, QW-150 and QW-160. The radius of the mandrel used in the guided bend test shall be as follows:

<table>
<thead>
<tr>
<th>Specimen Thickness</th>
<th>Radius of Mandrel, B</th>
<th>Radius of Die, D</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{3}{8} ) in. (10 mm)</td>
<td>( 1 \frac{1}{2} ) in. (38 mm)</td>
<td>( 1 \frac{3}{4} ) in. (42 mm)</td>
</tr>
<tr>
<td>( t )</td>
<td>( 3 \frac{3}{4} t )</td>
<td>( 4 \frac{3}{4} t + \frac{7}{64} ) in. (1.5 mm)</td>
</tr>
</tbody>
</table>

NOTE: Other hardness testing methods may be used and converted to Brinell numbers by means of the Table in ASTM E140.

(3) For vessels which are integrally forged, having an overall length less than 5 ft (1.5 m) and a nominal thickness not exceeding \( \frac{3}{4} \) in. (13 mm), the requirements of (2) above may be modified by taking a minimum of two hardness readings at each end of the vessel. These four hardness readings shall satisfy the requirements of (2) above as if the four hardnesses were applicable to one section.

(c) Non-Heat-Treated Material. Postweld heat treatment of vessels fabricated by welding of forged parts not requiring heat treatment shall meet with the requirements of UCS-56.

**UF-32 WELDING FOR FABRICATION**

(a) All welding used in connection with the fabrication of forged vessels or components shall comply with the applicable requirements of Parts UW, UCS, and UHA and UF-5(b) except as modified in (b) and (c) below. Procedure qualification in accordance with Section IX shall be performed with the heat treatment condition of the base metal and weld metal as in UF-32 as contemplated for the actual work. This examination shall be made by liquid penetrant when the material is nonferromagnetic and by liquid penetrant or magnetic particle examination when the material is ferromagnetic.

(2) After final heat treatment, liquid quenched and tempered vessels, except as provided in (3) below, shall be subjected to Brinell hardness tests at 5 ft (1.5 m) intervals with a minimum of four readings at each of not less than three different sections representing approximately the center and each end of the heat-treated shell. The tests shall meet the following requirements:

- (a) The distance between adjacent test locations shall be no more than 5 ft (1.5 m).
- (b) A minimum of four hardness readings shall be taken at each location.
- (c) The average of the four readings (HB(avg)) at each location shall be calculated and the range of all average values shall not exceed 40 Brinell scale units.
- (d) The specified minimum and maximum tensile strengths of SA-372 forging shall be converted to Brinell hardness values as HB(min) and HB(max) respectively in accordance with ASME SA-370. HB(avg) values shall be no less than 90% of HB(min) and no more than HB(max).

Any cutting and gouging processes used in the repair work shall be included as part of the procedure qualification.

(2) Welders shall be qualified for fillet welding specified by making and testing a specimen in accordance with Section IX, QW-180 and Figure QW-462.4(b). Welders shall be qualified for repair welding by making a test plate in accordance with Section IX, Figure QW-461.3 from which the bend tests outlined in Section IX, QW-452 shall be made. The electrode used in making these tests shall be of the same classification number as that specified in procedure. The material for these tests can be carbon steel plate or pipe provided the test specimens are preheated, welded and postheated in accordance with the procedure specification for the type of electrode involved.

(3) The finished weld shall be postweld heat treated or given a further heat treatment as required by the applicable material specification. The types of welding permitted in (b) shall be performed prior to final heat treatment except for seal welding of threaded openings which may be performed either before or after final heat treatment.
6.7.5.3 Correction of Surface Irregularities to Meet Tolerances. Irregularities may be corrected in accordance with 6.7.4.2(a).

6.7.6 HEAT TREATMENT REQUIREMENTS FOR FORGED FABRICATION

6.7.6.1 Heat Treatment When Vessels Are Fabricated by Welding.

(a) Vessels fabricated by welding of forged parts requiring heat treatment shall be heat treated in accordance with the applicable material specification, as follows:

(1) after all welding is completed, or
(2) prior to welding, followed by postweld heat treatment of the finished weld in accordance with 6.4.2

(b) When the welding involves only minor nonpressure attachments to vessels having carbon content exceeding 0.35% but not exceeding 0.50% by ladle analysis, requirements of 6.7.7.2 shall govern.

6.7.6.2 Heat Treatment When Material Is to Be Normalized or Annealed. After all forging is completed, each vessel or forged part fabricated without welding shall be heat treated in accordance with the applicable material specification. When irregularities are corrected by welding, subsequent heat treatment shall be in accordance with 6.7.8.3(b).

6.7.6.3 Heat Treatment of Quenched and Tempered Ferritic Material. Vessels fabricated of SA-372 forging material to be liquid quenched and tempered shall be subjected to this heat treatment in accordance with the applicable material specifications after all forging and welding is completed, except for seal welding of threaded openings, which may be performed either before or after final heat treatment.

(a) Examination of Quenched and Tempered Vessels – After the final heat treatment, quenched and tempered vessels shall be examined for the presence of cracks on the outside surface of the shell and heads and on the inside surface where practicable. This examination shall be made by the liquid penetrant or a magnetic particle method in accordance with Part 7.

(b) Check of Heat Treatment by Hardness Testing – After the final heat treatment, liquid quenched and tempered forgings, except those made of austenitic steels, shall be subjected to Brinnell hardness tests at 1.5 m (5 ft) intervals with a minimum of four readings at each of not less than three different locations representing approximately the center and each end of the heat-treated forgings. The tests shall meet the following requirements:

(-a) The distance between adjacent test locations shall be no more than 5 ft (1.5 m).
(-b) A minimum of four hardness readings shall be taken at each location.
(-c) The average of the four readings (HBave) at each location shall be calculated and the range of all average values shall not exceed 40 Brinnell scale.
(-d) The specified minimum and maximum tensile strengths of SA-372 forging shall be converted to Brinnell hardness values as HBmin and HBmax, respectively in accordance with ASME SA-370. HBave values shall be no less than 90% of HBmin and no more than HBmax.

6.7.7 Other Hardness Testing

Other hardness testing methods except superficial or micro hardness may be used and converted to Brinnell numbers in accordance with ASME SA-370. Reheat treatment is permitted if the hardness test results do not meet the above requirements.

6.7.7.1 Applicable Materials. The hardness test shall be performed on the actual work and the test shall be performed in at least three different locations representing approximately the center and each end of the heat-treated shell. The tests shall meet the following requirements:

(a) The distance between adjacent test locations shall be no more than 5 ft (1.5 m).
(b) A minimum of four hardness readings shall be taken at each location.
(c) The average of the four readings (HBave) at each location shall be calculated and the range of all average values shall not exceed 40 Brinnell scale.

6.7.7.2 Restrictions on Austenitic Material. In the case of austenitic steels, the heat treatment procedures followed shall be in accordance with 6.4.

6.7.7.3 Heat Treatment of Austenitic Material. In the case of austenitic steels, the heat treatment procedures followed shall be in accordance with 6.4.

6.7.7.4 Heat Treatment of Ferrous Material Not Requiring PWHT. Postweld heat treatment of vessels fabricated by welding of forged parts not requiring heat treatment shall meet the requirements of 6.4.