(b) The heat-affected zone impact test specimens and testing methods shall conform to the requirements of 

**NB-2321.2.** The specimens shall be removed from a location as near as practical to a depth midway between the surface and center thickness. The coupons for heat-affected zone impact specimens shall be taken transverse to the axis of the weld and etched to define the heat-affected zone. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much heat-affected zone as possible in the resulting fracture. Where the material thickness permits, the axis of a specimen may be inclined to allow the root of the notch to align parallel to the fusion line. When a grain refining heat treatment is not performed on welds made by the electroslag or electrogas welding process, the notch for the impact specimens shall be located in the grain coarsened region.

(c) For the comparison of heat-affected zone values with base material values [**NB-4335.2(b)**], Charpy V-notch specimens shall be removed from the unaffected base material at approximately the same distance from the base material surface as the heat-affected zone specimens. The axis of the unaffected base material specimens shall be parallel to the axis of the heat-affected zone specimens, and the axis of the notch shall be normal to the surface of the base material. When required by **NB-4335.2(b),** drop-weight specimens shall be removed from a depth as near as practical to midway between the surface and center thickness of the unaffected base material and shall be tested in accordance with the requirements of **NB-2321.1.**

**NB-4335 Impact Test Requirements**

When materials are required to be impact tested per **NB-2300,** impact tests of the weld metal and heat-affected zone shall be performed in accordance with the following subparagraphs. The weld procedure qualification impact test specimens shall be prepared and tested in accordance with the applicable requirements of **NB-2330** and **NB-4334.** Retests in accordance with the provisions of **NB-2350** are permitted.

**NB-4335.1 Impact Tests of Weld Metal.**

(a) Impact tests of the weld metal shall be required for welding procedure qualification tests for production weld joints exceeding 7/64 in. (16 mm) in thickness when the weld will be made on the surface or penetrate base material that requires impact testing in accordance with **NB-2310.** In addition, such testing of the weld metal is required for the welding procedure qualification tests for any weld repair to base material that requires impact testing in accordance with **NB-2310,** regardless of the depth of the repair.

(b) The impact test requirements and acceptance standards for welding procedure qualification weld metal shall be the same as specified in **NB-2330** for the base material to be welded or repaired. Where two materials are to be joined by welding and have different fracture toughness requirements, the test requirements and acceptance standards of either material may be used for the weld metal except where this is otherwise specified by NCA-1280 or other parts of this Subsection.

**NB-4335.2 Impact Tests of Heat-Affected Zone.**

(a) Charpy V-notch tests of the heat-affected zone of the welding procedure qualification test assembly are required whenever the thickness of the weld exceeds 7/64 in. (16 mm) and either of the base materials require impact testing in accordance with the rules of **NB-2310.** The only exceptions to the requirements are the following:

1. the qualification for welds in P-Nos. 1 and 3 and SA-336 F12 materials that are postweld heat treated and are made by any process other than electroslag or electrogas.

2. the qualification for weld deposit cladding or hard-facing on any base material.

3. that portion of the heat-affected zone associated with GTAW root deposits with a maximum of two layers or 3/16 in. (5 mm) thickness, whichever is less.

(b) The required testing shall be in accordance with (c) for base material tested under **NB-2331** or **NB-2332(b)** and in accordance with (d) for base material tested under **NB-2332(a).**

(c) For heat-affected zones associated with base material tested under **NB-2331** or **NB-2332(b),** the required testing shall be in accordance with (1) through (7).

1. Determine the \( T_{NDT} \) of the unaffected base material to be used in the welding procedure qualification test assembly.

2. Charpy V-notch test specimens representing both the heat-affected zone and the unaffected base material shall be tested. The unaffected base material specimens shall be tested at the \( (T_{NDT} + 60{}^\circ \text{F}) \) \( (T_{NDT} + 33{}^\circ \text{C}) \) temperature.

3. The Charpy V-notch tests of the unaffected base material shall meet the applicable requirements of **NB-2331(a)** or additional testing shall be performed at higher temperatures until the requirements of **NB-2331(a)** are met.

4. The heat-affected zone specimens shall be tested at the test temperature determined in (3). The average lateral expansion value of the specimens shall equal or exceed the average lateral expansion value of the unaffected base material. For this case the qualification test is acceptable for the essential and supplemental essential variables recorded on the welding procedure qualification record (PQR). If the heat-affected zone average lateral expansion value is less than the unaffected base material lateral expansion value, the adjustment given in (5) through (7) shall be determined and applied as provided in (e).
(5) Additional Charpy V-notch tests shall be performed on either the heat-affected zone or the unaffected base material, or both, at temperatures where the lateral expansion value of all three specimens tested is not less than 35 mils (0.89 mm). The average lateral expansion value for each test meeting this requirement shall be plotted on a lateral expansion versus temperature graph. The difference in temperature $T_{HAZ}$ and $T_{UBM}$ where the heat-affected zone and the unaffected base material average lateral expansion values are the same and not less than 35 mils (0.89 mm) shall be used to determine the adjustment temperature $T_{ADJ}$ where:

$$T_{ADJ} = T_{HAZ} - T_{UBM}$$

If $T_{ADJ} \leq 0$, then $T_{ADJ} = 0$.

(6) As an alternative to (5), if the average lateral expansion value of the heat-affected zone specimens is no less than 35 mils (0.89 mm) and the average of the heat-affected zone specimens is not less than 5 mils (0.13 mm) below the average lateral expansion value of the unaffected base material specimens, $T_{ADJ}$ may be taken as 15°F (8°C).

(7) As a second alternative to (5), if the average lateral expansion value of the heat-affected zone specimens is no less than 35 mils (0.89 mm), the difference between the average lateral expansion of the heat-affected zone and the unaffected base material specimens shall be calculated and used as described in (e)(3).

(d) For heat-affected zones associated with base materials tested under NB-2332(a), the required testing shall be in accordance with (1) through (5).

(1) Three Charpy V-notch specimens shall be removed from both the unaffected base material and the heat-affected zone. The unaffected base material specimens shall be tested at a test temperature established in the design specification or additional testing shall be performed at higher temperatures until the applicable requirements of Table NB-2332(a)-1 are met for the thickness of material to be welded in production.

(2) The heat-affected zone specimens shall be tested at the test temperature determined in (1). The average lateral expansion value of the specimens shall equal or exceed the average lateral expansion value of the unaffected base material. For this case the qualification test is acceptable for the essential and supplemental essential variables recorded on the weld procedure qualification record. If the heat-affected zone average lateral expansion value is less than the unaffected base material lateral expansion value, the adjustment given in (e)(3) through (e)(5) shall be determined and applied as provided in (e). Alternatively, another test coupon may be welded and tested.

(3) Additional Charpy V-notch tests shall be performed on either the heat-affected zone or the unaffected base material, or both, at temperatures where the lateral expansion value of all three specimens tested is not less than the values shown in Table NB-2332(a)-1 for the thickness of base material to be welded in production. The average lateral expansion value for each test meeting this requirement shall be plotted on a lateral expansion versus temperature graph. The difference in temperature $T_{HAZ}$ and $T_{UBM}$ where the heat-affected zone and the unaffected base material average lateral expansion values are the same shall be used to determine the adjustment temperature where:

$$T_{ADJ} = T_{HAZ} - T_{UBM}$$

If $T_{ADJ} \leq 0$, then $T_{ADJ} = 0$.

(4) As an alternative to (3), if the average lateral expansion value of the heat-affected zone is no less than 35 mils (0.89 mm) and the average of the heat-affected zone specimens is not less than 5 mils (0.13 mm) below the average lateral expansion value of the unaffected base material, $T_{ADJ}$ may be taken as 15°F (8°C).

(5) As a second alternative to (3), if the average lateral expansion value of the heat-affected zone specimens is no less than 35 mils (0.89 mm), the difference between the average lateral expansion of the heat-affected zone and unaffected base material specimens shall be calculated and used as described in (e)(3).

(e) At least one of the following methods shall be used to compensate for the heat-affected zone toughness decrease due to the welding procedure.

(1) The $RT_{NDT}$ temperature established in NB-2331 or NB-2332(b) or the lowest service temperature specified in the Design Specification [NB-2332(a)] for all of the material to be welded in production weld procedure specifications (WPSs) supported by this PQR shall be increased by the adjustment temperature $T_{ADJ}$.

(2) The specified testing temperature for the production material may be reduced by $T_{ADJ}$.

(3) The materials to be welded may be welded using the WPS provided they exhibit Charpy V-notch values that are no less than the minimum required lateral expansion value required by NB-2300 plus the difference in average lateral expansion values established in (c)(7) or (d)(5).

(j) The Charpy V-notch testing results shall be recorded on the welding PQR and any offsetting $T_{ADJ}$ or increased toughness requirements shall be noted on the welding PQR and on the WPS. More than one compensation method may be used on a par basis.

NB-4336 Qualification Requirements for Built-Up Weld Deposits

Built-up weld deposits for base metal reinforcement shall be qualified in accordance with the requirements of NB-4331 through NB-4335.