

PART VI**Appendix T****Weld Metal/Welding Procedure Specification Notch Toughness
Verification Test****T.1 Scope**

This Appendix provides a standard method for qualification testing of weld filler metals required to have specified notch toughness for service in joints designated as demand critical.

Testing of weld metal to be used in production shall be performed by filler metal manufacturer's production lot, as defined in AWS A5.01, Filler Metal Procurement Guidelines, as follows:

- (1) Class C3 for SMAW electrodes,
- (2) Class S2 for GMAW-S and SAW electrodes,
- (3) Class T4 for FCAW and GMAW-C, or
- (4) Class F2 for SAW fluxes.

Filler metals produced by manufacturers audited and approved by one or more of the following agencies shall be exempt from these production lot testing requirements, provided a minimum of 3 production lots of material, as defined above, are tested in accordance with the provisions of this appendix:

- (1) American Bureau of Shipping (ABS),
- (2) Lloyds Register of Shipping,
- (3) American Society of Mechanical Engineers (ASME),
- (4) ISO 9000,
- (5) US Department of Defense, or
- (6) A quality assurance program acceptable to the engineer of record.

Under this exemption from production lot testing, the filler metal manufacturer shall repeat the testing prescribed in this appendix at least every three years on a random production lot.

T.2 Test Conditions

Tests shall be conducted at the range of heat inputs for which the weld filler metal will be qualified under the welding procedure specification (WPS). It is recommended that tests be conducted at the low heat input level and high heat input level indicated in Table 6.T.1.

Table 6.T.1 WPS Toughness Verification Test Welding and Preheat Conditions

Cooling Rate	Heat Input	Preheat (°C)	Interpass (°C)
Low heat input test	31.2 kJ/mm	21 ± 14	93 ± 28
High heat input test	3.1 kJ/mm	149 ± 14	260 ± 28

Alternatively, the filler metal manufacturer or contractor may elect to test a wider or narrower range of heat inputs and interpass temperatures. The range of heat inputs and interpass temperatures tested shall be clearly stated on the test reports and user data sheets. Regardless of the method of selecting test heat input, the WPS, as used by the contractor, shall fall within the range of heat inputs and interpass temperatures tested.

T.3 Test Specimens

Two test plates, one for each heat input, shall be welded following Table 6.T.1. Five CVN specimens and one tensile specimen shall be prepared per plate. Each plate shall be steel, of any AISC-listed structural grade. The test plate shall be 19 mm thick with a 13 mm root opening and 45° included groove angle. The test plate and specimens shall be as shown in Figure 2A in AWS A5.20, or as in Figure 5 in AWS A5.29. Except for the root pass, a minimum of two passes per layer shall be used to fill the width.

All test specimens shall be taken from near the centerline of the weld at the mid-thickness location, in order to minimize dilution effects. CVN and tensile specimens shall be prepared in accordance with AWS B4.0, Standard Methods for Mechanical Testing of Welds. The test assembly shall be restrained during welding, or preset at approximately 5° to prevent warpage in excess of 5°. A welded test assembly that has warped more than 5° shall be discarded. Welded test assemblies shall not be straightened.

The test assembly shall be tack welded and heated to the specified preheat temperature, measured by temperature indicating crayons or surface temperature thermometers one inch from the center of the groove at the location shown in the figures cited above. Welding shall continue until the assembly has reached the interpass temperature prescribed in Table 6.T.1. The interpass temperature shall be maintained for the remainder of the weld. Should it be necessary to interrupt welding, the assembly shall be allowed to cool in air. The assembly shall then be heated to the prescribed interpass temperature before welding is resumed.

No thermal treatment of weldment or test specimens is permitted, except that machined tensile test specimens may be aged at 93 °C to 104 °C for up to 48 hours, then cooled to room temperature before testing.

T.4 Acceptance Criteria

The lowest and highest Charpy V-Notch (CVN) toughness values obtained from the five specimens from a single test plate shall be disregarded. Two of the remaining three values shall equal, or exceed, the specified toughness of 54 J energy level at the testing temperature. One of the three may be lower, but not lower than 41 J, and the average of the three shall not be less than the required 54 J energy level. All test samples shall meet the notch toughness requirements for the electrodes as provided in Section 10.20.7.3.2.

For filler metals classified as E70, materials shall provide a minimum yield stress of 400 MPa, a minimum tensile strength of 480 MPa, and a minimum elongation of 22 percent. For filler metals classified as E80, materials shall provide a minimum yield stress of 470 MPa, a minimum tensile strength of 550 MPa, and a minimum elongation of 19 percent.

PART VI**Appendix U****Volume Fraction of Reinforcement and Types of Steel Wire Meshes
Used in Ferrocement****U.1 Calculation of Volume Fraction of Reinforcement**

The volume fraction of reinforcement in a ferrocement section can be readily calculated if the density of the mesh material and the weight of mesh per unit area are known.

For ferrocement section reinforced with expanded metal mesh, the volume fraction of mesh reinforcement may be calculated from the following relationship.

$$V_f = \frac{\text{Volume of mesh}}{\text{Volume of ferrocement section}} = \frac{\omega_m N}{\gamma_m h} \times 100 \text{ per cent}$$

For ferrocement reinforced with square or rectangular mesh, the volume fraction of mesh reinforcement may be calculated from the following relationship:

$$V_f = \frac{N \pi d_b^2}{4 h} \left(\frac{1}{D_t} + \frac{1}{D_l} \right) \times 100 \text{ per cent}$$

Where,

N	=	number of layers of mesh reinforcement
d_b	=	diameter of mesh wire
h	=	thickness of ferrocement
D_t	=	centre to centre spacing of wires aligned transversely in reinforcing mesh, mm
D_l	=	centre to centre spacing of wires aligned longitudinally in reinforcing mesh, mm
ω_m	=	weight of mesh per unit area, N/mm ²
γ_m	=	unit weight of steel, N/mm ²