

SCOPE

- I 1.1 This practice covers special materials requirements relating to the fabrication of equipment in the areas of hardness testing, carbon steel chemistry requirements, hydrostatic and wash water quality, and impact testing.
- I 1.2 **An asterisk (*)** indicates that a decision by the Purchaser is required or that additional information is specified by the Purchaser.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 **Table 1** lists the practices, codes, and standard which shall be used with this practice.

TABLE 1

PRACTICES			
IP 20-1-1	Inspection of Equipment and Materials		
IP 20-1-3	Quality Programs		
CODES AND STANDARDS			
API Standard		AWS	
661	Air-Cooled Heat Exchangers for General Refinery Service	A5.XX Series	Filler Metal Specifications
ASME Codes		BSI	
Section VIII	Pressure Vessels, Division 1	BS 5500	Specification for Unfired Fusion Welded Pressure Vessels
B31.3	Pressure Vessels, Alternative Rules, Division 2	SNCT and AFIAP	
ASTM	Process Piping	CODAP	French Code for the Manufacture of Unfired Pressure Vessels
A833	Standard Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers	STOOMWEZEN	Rules for Equipment Under Pressure (Netherlands)
A956	Standard Test Methods for Equotip Hardness Testing of Steel Products	NACE	
		MR0175	Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment

DEFINITIONS

- I 3.1 **Heat Affected Zone (HAZ)** - The zone of the base metal affected by the heat input of welding.
- I 3.2 The term **Inspector**, used in this practice, refers to the Owner's Representative.
- I 3.3 **Hardness Test** - A single hardness reading in either the weld metal, base metal, or HAZ.
- I 3.4 **Stainless Steel** - A steel that meets one of the following descriptions:
 - a. Martensitic or ferritic chromium stainless steels containing more than 10% chromium (typically AISI 400 series).
 - b. Austenitic chromium-nickel stainless steels containing more than 16% chromium and more than 6% nickel (typically AISI 300 series). This also includes the super austenitic stainless steels (with 6% Mo) and the alloys with nominally 20% Cr and 35% Ni such as Incoloy 825 or Alloy 20.
 - c. Duplex ferritic-austenitic stainless steels containing approximately 15-30% chromium and 2-8% nickel (typically the 2205 and 2507 alloys).

- I * 3.5 The **Critical Exposure Temperature (CET)** is defined as the lowest metal temperature derived from either the operating or atmospheric conditions. The CET may be a single temperature at an operating pressure or an envelope of temperatures and pressures. The CET is determined for different types of equipment as follows:
- Pressure Vessels** (including heat exchangers and pressure storage spheres): The CET is defined as the lowest metal temperature at which a component will be subjected to a general primary membrane tensile stress greater than 8 ksi (55.2 MPa). The CET may also be defined according to the following options:
 - The minimum metal temperature at which a component could be subjected to a pressure greater than 40% of the design pressure for vessels constructed to the ASME Code Section VIII Division 1.
 - The minimum metal temperature at which a component could be subjected to a pressure greater than 35% of the design pressure for vessels constructed to the ASME Code Section VIII Division 1, with a 3.5 safety factor as recognized in the 1999 addenda.
 - The minimum metal temperature at which a component could be subjected to a pressure greater than 30% of the design pressure for vessels constructed to the ASME Code Section VIII Division 2.
 - For pressure vessels designed to a higher allowable stress than that permitted in these codes, the CET may be taken as the lowest metal temperature at which the vessel will be subjected to a pressure no greater than 25% of the design pressure or a membrane stress of no greater than 8 ksi (55.2 MPa).

The CET for pressure vessels is determined from the anticipated process and atmospheric conditions.
 - Piping**: The CET for systems constructed to the ASME B31.3 Piping Code is defined as the lowest metal temperature at which a component will be subject to either 30% of the MAWP at ambient temperature or a combined total longitudinal stress due to pressure, weight effects and displacement strains which does not exceed 55.2 MPa (8 ksi). The CET for piping is determined from the anticipated process and atmospheric conditions.
 - Machinery**: The CET for Machinery pressure containing components to be supplied by the Owner's Engineer.

HARDNESS TESTING

PERSONNEL AND PROCEDURE QUALIFICATION

- R * 4.1 Personnel performing hardness testing shall demonstrate their capabilities to the satisfaction of the Inspector. Qualification of the hardness testing personnel, including training and experience, shall be made available to the Inspector.

TESTING EQUIPMENT

- R * 4.2 The following is a list of the acceptable hardness testers. The Owner's Engineer shall approve the hardness tester if it is not listed below.

BRINELL TYPE HARDNESS TESTERS	
Telebrineller Teleweld, Inc. 416 North Park St. Streator, IL 61364	Newage Calibrated Pin Tester Newage Ind., Inc. 2300 Maryland Rd. Willow Grove, PA 19090
Minibrineller Electromechanical Components P.O. Box 159 Gillette, NJ 07933	L.C. Eitzen Brinell Meter L.C. Eitzen Co. Inc. P.O. Box 1210 Glenwood Springs, CO 81601

DYNAMIC / REBOUND TYPE HARDNESS TESTER
EQUOTIP EQUOTIP Associates 140 Industry Drive Pittsburgh, PA 15275

TESTING PROCEDURE

- R 4.3 Testing procedures using the **Brinell Type Hardness Tester** shall be as follows:
- Brinell hardness test methods shall be in accordance with ASTM A 833 and manufacturer's recommendations.
 - Hardness tests shall be conducted in the specific zone of the weld joint.
 - The diameter of the indentation ball shall not be smaller than 7 mm and not larger than 10 mm.
 - If a hardness reference bar is used, the bar hardness shall be within 12.5% of the maximum hardness required for the specific material.
 - The surface to be hardness tested shall be ground so that the edge of the impression shall be clearly defined to permit the measurement of the diameter to ± 0.02 mm.
 - Grinding shall be conducted in such a manner that overheating of the material is prevented.
 - Adjacent readings shall be at least 0.25 in. (6.4 mm) apart, edge to edge.
 - When hardness testing of the HAZ is required, the weld cap shall be ground so that the indentation ball can be placed in the center of the HAZ. This hardness test shall represent a composite of weld metal, HAZ and base metal.
- R 4.4 Testing procedures using the **Dynamic / Rebound Type Hardness Tester** shall be as follows:
- The hardness test method shall be in accordance with ASTM A 956 and manufacturer's recommendations.
 - Five hardness tests shall be conducted in the specific zone of the weld joint. The five readings and the average shall be reported. If there is a variation in readings greater than $\pm 15\%$, testing with a Brinell-type hardness tester is required.
 - The hardness test instrument shall be calibrated in the same position as intended for production testing.
 - The minimum wall thickness shall be 0.47 in. (12 mm).
 - The surface of the component being tested must be prepared with a fine file or small grinder to the surface finish required in ASTM A956 or 32 micro-inch, whichever is smoother.

GENERAL REQUIREMENTS / ACCEPTABLE HARDNESS VALUES

- R 4.5 The **hardness of hot-formed bends**, and of the **base metal, weld metal, and the related HAZ** of all welds shall not exceed the limits given below.

MATERIAL P-NUMBER	BRINELL HARDNESS ⁽¹⁾
P-1	200 ⁽²⁾
P-3, P-4	225
P-5 ⁽³⁾ , P-6, P-7	235
P-10A, B, C & F	225
P-11	225

Notes:

- (1) For piping base metal, use the lower of the value shown, or the value given in the specific **ASTM** standard. For weld metal and HAZ, use the lower of the value shown or the value in **ASME B31.3**.
- (2) For piping 225 HB is acceptable in the bend area of hot-formed bends.
- (3) Hardness requirements for P91 and F91 materials shall be designated by the Owner's Engineer.

- R 4.6 **Hardness testing on welds in P-1 material** is not required if **any** of the following conditions are met:
- Shielded Metal Arc Welding (SMAW) process with AWS A5.1 Class E60XX and/or E70XX electrodes.
 - Gas Tungsten Arc Welding (GTAW) process or Gas Metal Arc Welding (GMAW) process with AWS A5.18 Class ER 70S - 2 through ER 70S-5 filler metal.
 - Flux Cored Arc Welding (FCAW) process using filler metal E7XT-1, -5, -9, -12 with CO₂ or E7XT-1M, -5M, -9M, -12M with either CO₂ or Ar/CO₂ mixture.
 - Submerged Arc Welding (SAW) process using filler metal combinations of ELX or EMX wires in accordance with AWS A 5.17 and a neutral flux approved by the Owner.