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HARDNESS TESTING

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1.0 PURPOSE

This procedure specifies the standard methods and locations for hardness testing and reporting of SARA SAE products.

2.0 APPLICABILITY

This procedure is directive to all personnel performing hardness tests of SARA SAE equipment.

3.0 REFERENCE DOCUMENTS

3.1 SARA SAE Quality Assurance Manual

(R) 3.2 SARA SAE SES 26-704, "Training"

(R) 3.3 SARA SAE SES 26-704, "Process Routing Generation"

(R) 3.4 SARA SAE SES 26-704, "Control of Nonconforming Material"

4.0 GENERAL

4.1 Hardness testing is conducted at Receiving Inspection, Final Inspection, or where specified by the Process Routing.

4.2 Hardness testing and reporting is conducted in accordance with this procedure.

5.0 RESPONSIBILITY

5.1 Design Engineering is responsible for including this procedure as a design requirement when hardness testing is specified on product drawings. This requirement is effective with the original release of this procedure.

5.2 Hardness testing is the responsibility of properly qualified Quality Control and production personnel.

(R) 5.3 Personnel performing hardness tests at SARA SAE shall be qualified per SES 26-704.

5.4 Hardness testing is conducted according to this procedure where specified on the drawing, router, quality plan, or specification.



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6.0 METHODS

Hardness testing and reporting is conducted in accordance with the following procedures: (1) determine method and equipment to be used; (2) prepare the test surface; (3) operate the machine; (4) interpret the results; and (5) report the hardness.

6.1 Determining the Location of the Hardness Test

- 6.1.1 Unless otherwise specified by the design drawing, all hardness readings will be located in the most readily available position on the part. The operator will take care not to locate the hardness test in any area that will cause any detrimental harm to be done to the part (i.e., sealing surfaces, threaded surface, polished finishes, etc.).
- 6.1.2 API 8A and 8C equipment will have hardness readings taken on the most accessible position of the part.
- 6.1.3 API 6A and API 16A equipment will have hardness readings taken on the most accessible position of the part. Additionally, all accessible welds shall be tested and the face of each end connection.
- 6.1.4 All weldments that require hardness testing shall have the hardness reading taken at the most accessible position of the part. Additionally, one hardness reading shall be taken on each different material designation connected by the weld.

6.2 Final Acceptance Hardness

Final acceptance hardness will be conducted after all heat treating, post weld heat treating, and machining operations are completed.

6.3 Surface Preparation

Surfaces will be prepared in the following manner:

- 6.3.1 Castings/Forgings (raw/heat treated) -- remove rough surface by grinding below decarbonized layer approximately 3/32". The grinding should be deep enough to remove the carburized surface, slag, or surface scale and should leave a flat area for hardness testing.



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6.3.2 Machined Surfaces -- should not require any preparation before hardness tests are performed.

6.3.3 Hot Rolled Steel -- grind as stated in 6.3.1 and smooth deep enough, if necessary, to remove any surface scale.

6.3.4 Accessible Welded Surface -- grind approximately 1/16" deep to smooth the surface of the weld. The grinding should leave a flat, smooth surface for hardness testing.

6.4 Hardness Testing - Base Metal

6.4.1 Hardness measurements may be taken with any industry recognized testing equipment that meets customer and design engineering requirements. The hardness measurements shall be taken in the following manner:

6.4.1.1 Verify that the hardness testing machine and the measuring microscope have current calibration decals.

6.4.2 Operate the hardness testing machine per manufacturer's instructions.

6.4.3 Interpret Results

6.4.3.1 Interpret results if Brinell hardness test machine was used in the following manner:

- A. Place the measuring microscope in full contact with the metal on the area of hardness test indentation.
- B. Hold the microscope perpendicular to the test area.
- C. Measure two indentation diameters at right angles to each other.
- D. Determine the average diameter of the two readings.
- E. Consult Table I to determine the Brinell hardness value corresponding to the average diameter.

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Example: The actual hardness of the part is the Brinell equivalent shown for the reading obtained from the measuring microscope, i.e., a 4.0 microscope reading is 228 BH.

F. Reverify equipment accuracy in accordance with paragraph 8.0 of this procedure if an out-of-tolerance hardness reading is observed.

6.4.3.2 Interpret results of any other equipment used per manufacturer's instructions

6.4.4 Report the hardness as indicated in Section 7.0 of this procedure.

6.4.4.1 Hardness conversion to other measurement units shall be in accordance with ASTM E-140.

6.4.5 Second Hardness Test -- If a second test must be taken at the same location, the following requirements shall be followed:

6.4.5.1 The distance between indentations shall be at least three (3) times the diameter of the previous indentation.

6.4.5.2 All other hardness test methods noted above shall be followed.

6.5 Hardness testing of accessible pressure containing, non-pressure containing and repair welds on API 6A, 16A equipment or as required by customers.

6.5.1 All accessible pressure containing, non-pressure containing, and repair welds shall be hardness tested in accordance with the proper procedural method listed above.

6.5.2 At least one hardness test shall be performed in the weld and one test in the adjacent unaffected base metal after all heat treatment and machining operations are completed.

7.0 HARDNESS REPORTS

7.1 Hardness measurements are verified on the Process Routing sheet, Receiving Inspection Receiver, or the Nonconformance Report.



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7.2 Other reports may be needed to comply with specific customer requirements. Test requirements are referenced on the Process Routing.

7.3 Acceptance/rejection criteria is shown on the Engineering drawing, Material Specification, or Weld Procedure Specification.

(R) 7.4 Hardness values not within the specified range are considered a nonconformance and processed in accordance with SARA SAE Operating Procedure 7.005.

7.5 The hardness recorded in the PQR shall be the basis for acceptance if the weld is not accessible for hardness testing.

8.0 VERIFICATION OF PRODUCTION HARDNESS TESTING SYSTEMS

8.1 A calibration check is performed when an out-of-tolerance reading is obtained on any material, or at any other time the operator has reason to question the accuracy of the equipment.

8.2 Verification methods use a certified standardized hardness test block and replicate the applicable test method procedure.

8.2.1 Based on the results, the reading on the parts is valid or invalid.

8.2.1.1 If the reading on the certified standardized test block is within the $\pm 3\%$ tolerance band, then the reading on the part is valid.

8.2.1.2 If the reading on the certified standardized test block is not within the $\pm 3\%$ tolerance band, then reading on the part is not valid.

8.2.1.3 Parts must be rechecked with a calibrated machine in accordance with Sections 6.2 as required.

8.3 As a machine is determined to be out of calibration:

8.3.1 Remove the machine from service.

8.3.2 Send the machine to the calibration laboratory for calibration or repair.



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8.3.3 Retest part which exhibited an out-of-tolerance hardness reading with a properly calibrated hardness testing machine.

TABLE I

BRINELL HARDNESS CONVERSION CHART

Indentation Diameter (mm)	Brinell Hardness Number	Indentation Diameter (mm)	Brinell Hardness Number
3.05	402	4.05	223
3.10	387	4.10	217
3.15	375	4.15	212
3.20	364	4.20	207
3.25	351	4.25	201
3.30	340	4.30	197
3.35	332	4.35	192
3.40	321	4.40	187
3.45	311	4.45	183
3.50	302	4.50	179
3.55	293	4.55	174
3.60	286	4.60	170
3.65	277	4.65	166
3.70	269	4.70	163
3.75	262	4.75	159
3.80	255	4.80	156
3.85	248	4.85	153
3.90	241	4.90	149
3.95	235	4.95	146
4.00	228	5.00	143

