Specific Accreditation Criteria

ISO/IEC 17025 Application Document

Manufactured Goods - Annex

Physical testing of metals

July 2018

[PUBLIC]

Table of Contents

Physical testing of metals

This document provides interpretative criteria and recommendations for the application of ISO/IEC 17025 for both applicant and accredited facilities conducting physical testing of metals.

Applicant and accredited facilities must comply with all relevant documents in the NATA Accreditation Criteria (NAC) package for Manufactured Goods (refer to NATA Procedures for Accreditation).

The clause numbers in this document follow those of ISO/IEC 17025 but since not all clauses require interpretation the numbering may not be consecutive.

Scope of accreditation

Hardness tests - Microhardness

The scope of accreditation for this test expresses the loads applied in SI units (i.e. N rather than the commonly used kg (f)).

ASTM E384 defines microhardness testing (Vickers) as indentation hardness tests conducted with indenting forces ranging from 0.001 kg(f) to 1 kg(f) (0.01 – 9.8 N). Tests in this range are also commonly known as low load hardness tests. Accreditation below 1.96 N (0.2kg (f)) is not available.

Impact tests

The scope of accreditation identifies the type of impact testing performed and the range of temperatures over which the facility holds calibrated measuring equipment.

Accreditation for assessment of fracture surface and lateral expansion is separately identified.

6 Resource requirements

6.3 Facilities and environmental conditions

6.3.1

Tensile testing

Facilities seeking accreditation for determining properties such as proof stress, yield stress, tensile strength and elongation of metals at elevated temperatures will be required to demonstrate that they meet the requirements specified in the test method standards.

Documented test procedures shall be available and they shall provide the necessary details of test equipment (including accuracy and any limitations), calibration procedures, test specimens and test assemblies.

An extensometer with the required accuracy shall be used for obtaining data required for the plotting of the force/extension diagram up to the extension corresponding to the lower yield stress or to the highest proof stress.

6.3.3

Non-ambient tests

While performing non-ambient Charpy impact tests, the following factors need to be satisfactorily controlled

Conditioning medium and coolant

Any liquid cooling medium should be of low viscosity at the test temperature to enable rapid draining of the test piece as it is removed from the bath. A gaseous medium requires substantially longer soak time at the test temperature.

Temperature uniformity and control

Test pieces shall be cooled in a manner that meets the specification requirements and the facility's practices must take into account different cooling requirements that may apply to the various standards used.

To ensure temperature uniformity, tongs used for the transfer of test pieces must be pre-cooled before use.

Fracture toughness tests

Pre-cracking stresses must be assessed in accordance with the requirements of the applicable standard.

6.4 Equipment

6.4.1

Impact tests - Charpy V Notch

Permanent test-piece end stops shall not be used in the test machine.

Hardness testing

Facilities are required to hold a range of hardness test blocks for the conduct of regular checks upon the performance of hardness testing machines. These hardness test blocks shall cover the range for the hardness scale or load and at typical hardness values for which accreditation is held.

These blocks are generally obtained from a manufacturer and are supplied with a nominal value. The hardness of these blocks should be confirmed at the time of calibration of the testing machine. The purpose of these blocks is to ensure that the performance of the machine has not changed since calibration.

Portable hardness testing instruments must demonstrate compliance with the requirements of the relevant hardness testing standards.

Accreditation for hardness using a velocity hardness tester is not available as it is not possible to calibrate the instrument.

6.4.4

Impact tests

The form of the striker must comply with the applicable standards, for example, a different striker is specified in AS 1544.2 from that in ASTM E23. When performing

lateral expansion and/or assessment of the fracture surface, particular standards may stipulate additional requirements in relation to test machine configuration, calibration and performance checking which must also be satisfied.

The standards commonly applicable to the calibration and/or verification of Charpy impact testing machines are ASTM E23 and AS 1544. Two quite different processes apply for the verification activity, depending on the standard used, which involve either a recognised calibration authority or a designated reference material provider. If ASTM E23 standardised specimens are used by a calibration authority when verifying equipment to AS 1544 as a means of satisfying both pathways, the calibration report must make clear that the requirements of both standards were met.

Calibration authority

AS 1544 requires the machine to be verified by the testing of standardised test pieces, which have certified values in the range of the material to be tested. It also requires this verification to be performed by the facility in the presence of the calibration authority and the results to be included in the calibration report. The verification results comprise an integral part of the calibration report and must be included for compliance with the standard's requirements.

Reference material provider

ASTM E23 compliance requires machines in use to undergo annual verification, including the testing of 'verification specimens' for which certified reference values from the National Institute of Standards and Technology (NIST) in the United States are available. Two sets of specimens are typically required, but some machine capacities may necessitate three sets.

Accreditation for Charpy impact testing is only available when it can be demonstrated that the use of standardised test pieces conforms to the requirements of the applicable test standard.

<u>Tensile testing</u>

In Australia, extensometers are commonly calibrated to AS 1545; however, some design codes call up alternative calibration requirements. For example, the ASME design codes call up ASTM requirements, which differ slightly from AS 1545.

Unless equivalence can be demonstrated, the extensometer must be calibrated in accordance with the requirements of the design code against which compliance is to be reported.

In relation to AS1545, the requirements in the following table are typical.

% Proof Stress	Grade of Extensometer per AS 1545
< 0.1 %	A or B
0.1 and above but less than 0.2%	A, B or C
0.2 % and above	A, B, C or D

6.4.7 & 6.4.10

Common equipment performance checks

Facilities must ensure that where methods writing bodies have included equipment calibration and checking intervals in standard methods that these intervals must be followed.

Facilities should refer to NATA's *General Accreditation Guidance: General Equipment - Calibration and Checks, General Equipment Table* for further information.

The following supplementary information pertains to equipment items having specific application to metals testing.

Item of equipment	Calibration interval (years)	Checking interval (months)	Procedures and references
Displacement transducers		24	Cross head speed (for constant rate of extension machines).
Hardness testers (metals testing)			
Brinell, Rockwell & Vickers machines, including portable hardness testers	Initial and after repair or relocation		Direct and indirect verification AS 1815.2, 1816.2, 1817.2
	1		Indirect verification.
		Each scale, each day of use (Rockwell)*	AS 1815 (Rockwell)
		Each scale, 1 week (Vickers)*	AS 1817 (Vickers)
		Each scale, 1 month (Brinell)*	AS1816 (Brinell)
Portable Brinell	As above	Each day of use if the magnification is adjustable*	Using a calibrated graticule or a graticule supplied by the microscope manufacturer, which has been checked against the microscope immediately after calibration.
Diamond indentors		12	Inspection by microscope for damage or wear.
Glass graticule	10		Initial calibration.

Item of equipment	Calibration interval (years)	Checking interval (months)	Procedures and references
		12	Inspection by microscope for damage.
Impact testing machines (metals testing)			
Charpy impact testers	5 (complete)		Per relevant standard.
		12 (partial)	Per relevant standard.
		12 (verification)	Using certified test pieces as specified in the relevant standard.
		Before use*	Zero check and friction loss check.
Izod and universal impact testers	5 (complete)		Per relevant standard
	1 (partial)		Per relevant standard
Notching tools		Initial check	Check profile and depth of notch on test piece. Regular inspection for wear and damage. Recheck profile after any sharpening of cutters.

Note: * Commonly conducted by laboratory staff.

6.4.10

Impact tests - Charpy V notch

Notches are typically produced by broaching or milling. Notches must be checked for depth and profile. The frequency of checking will be dependent on the process used. If the tooling controls the depth then a depth check needs to confirm that the tooling produces notches of satisfactory depth. Notch profile checks shall be made at sufficient frequency to ensure that test specimens meet the requirements of the standard and a record kept of these checks. The notch radius is most critical and shall be checked at least as frequently as the notch depth.

Inspection of notch broaches or milling cutters to ensure that these are in good condition shall be undertaken.

Blunt cutters will produce significant deformation of the specimen material in the notch region.

Hardness tests - Rockwell

For accreditation for A to K scales the partial calibration must include an additional check on user hardness test block for the relevant scale.

The hardness test block must be checked immediately after calibration. If this has not been done when accreditation is sought then user checks on the B and C scale hardness test blocks must not show any deviation trends. It is acceptable for the partial calibration to be only undertaken using B and C scales. However, the complete calibration must include calibration of all loads.

7 Process requirements

7.2 Selection, verification and validation of methods

7.2.1 Selection and verification of methods

7.2.1.1

Hardness tests - Brinell

Application of force may be affected by operator technique in hydraulic hand-pumped machines. Testing procedures must carry specific operator instructions for application of force in these machines and the use of a test block to verify operator technique. For portable machines, circumstances related to use in the field must be considered.

A Vickers hardness tester may be used to conduct Brinell hardness tests. The following requirements must be met:

- actual machine readings must be recorded;
- the accuracy of the eyepiece must be checked over the range of values determined
- where there is more than one eyepiece and/or objective lens the equipment identification must be recorded
- any ‘factors’ used for conversion of results when a different objective is used must be documented
- the machine must be calibrated at the force at which it is to be used (e.g. 120 kg (1176 N)) for the correct $0.102F/D^2$ ratio
- hardness numbers must be reported in the standard format (e.g. HBS/2/120)

Brinell hardness testing may also be undertaken using a compression testing machine.

Hardness tests - Microhardness

Hardness testing in the range from 0.001 kg(f) to 1 kg(f) (0.01 – 9.8 N) suffers decreased accuracy due to:

- the increased relative error in measuring the indentation;
- surface effects such as microstructural homogeneity, elastic recovery of the indentation and surface finish;
- vibration.

NATA accreditation is available for microhardness testing under the following conditions:

- personnel shall have extensive microhardness testing and metallography experience;
- the facility shall have specimen preparation facilities that allow a 1 µm diamond finish. This level of finish shall be used in the conduct of the test;
- the test machine shall not be subject to vibration and should be vibration isolated. If the vibration level is in doubt it shall be measured.

7.8 Reporting of results

7.8.1 General

7.8.1.2

Hardness testing

When hardness test results are converted to other hardness scales the report must cite the conversion table used, the original hardness value (which cannot be an inferred hardness resulting from measurement of a related property) and the converted value.

When converting hardness test results, the specific type of material under test must be known and it must be clear that the hardness conversion table used can reliably be applied to this material type.

Tensile testing

When converting elongation at a given gauge length to equivalents at other gauge lengths the reporting requirements of the standard must be met. In addition the following information shall be reported:

- the source of the conversion table or algorithm;
- the original elongation and gauge length;
- the converted value.

References

This section lists publications referenced in this document. The year of publication is not included as it is expected that only current versions of the references shall be used.

Standards

AS 1544.2	Methods for impact tests on metals - Charpy V-notch
AS 1545	Methods for the calibration and grading of extensometers
AS 1815	Metallic materials - Rockwell hardness test
AS 1816	Metallic materials - Brinell hardness test
AS 1817	Metallic materials - Vickers hardness test
ASTM E23	Standard test methods for notched bar impact testing of metallic materials
ASTM E384	Standard Test Method for Microindentation Hardness of Materials
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

NATA publications

NATA Accreditation Criteria (NAC) package for Manufactured Goods

General Accreditation Guidance	General Equipment - Calibration and Checks, General Equipment Table

Amendment Table

The table below provides a summary of changes made to the document with this issue.

Section or Clause	Amendment
Whole document	Clauses numbers have been introduce to align text with ISO/IEC 17025:2017. Any criteria included in the previous issue that are now covered by ISO/IEC 17025:2017 have been removed. No new interpretative criteria or recommendations have been included other than editorial changes. Addition of Security Classification Label