



Specific Accreditation Criteria

ISO/IEC 17025 Application Document Manufactured Goods - Annex

Physical testing of metals

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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 - Vickers

The scope of accreditation for this test expresses the loads applied in SI units, i.e. N and the commonly used units gf or kgf.

Accreditation below 0.245 N [0.025 kgf] 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, elongation and reduction of cross-sectional area 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 requirements, 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 beyond the extension corresponding to the yield or proof stress and uniform elongation (Agt), as appropriate.

6.3.3

Non-ambient impact tests

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

Conditioning medium

Any liquid conditioning medium shall be of sufficiently low viscosity at the test temperature to enable rapid draining of the test piece as it is removed from the bath. Common examples of liquid conditioning media are:

- ethanol, methanol;
- acetone;
- isopentane;
- liquid nitrogen;
- water.

A gaseous medium requires substantially longer soak time at the test temperature.

Temperature uniformity and control

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

For liquid bath conditioning, all specimens shall be fully covered by at least 25 mm of liquid. Specimens shall be positioned on a suitable grid or mesh at least 25 mm above the bottom of the container and not in contact with the sides of the container.

To ensure temperature uniformity, the conditioning medium shall be constantly agitated, and tongs used for the transfer of test pieces must be pre-conditioned before use. The temperature shall be monitored throughout testing and care must be taken that the gripping ends of the tongs are not in contact with the container during conditioning.

6.4 Equipment

Mechanical testing of metals is commonly performed in accordance with a range of international standards, including AS, ASTM, and ISO. Accreditation is only available where it can be demonstrated that all equipment used complies with the requirements of the reported standard.

6.4.1

Impact tests - Charpy

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

Hardness testing

Facilities are required to hold a range of hardness reference test blocks to conduct regular checks to verify the performance of hardness testing machines. These hardness reference test blocks shall be suitable to check the laboratory's operational range for scale (Rockwell), load (Vickers) or ratio (Brinell) and at typical hardness values for which accreditation is held.

These reference test blocks are generally obtained from a supplier with a certified hardness value.

The hardness values of all test blocks shall be initially confirmed at the time of calibration of the testing machine. It is desirable that such test block verification be performed by, or in the presence of, the calibration authority and the results referenced in the calibration report. The purpose of these blocks is to ensure that the performance of the machine has not changed since calibration and during subsequent use.

Portable hardness testing instruments must demonstrate compliance with the requirements of the relevant hardness testing standards for accreditation to be granted (except for installation requirements).

Accreditation for impact/rebound velocity or ultrasonic contact impedance (UCI) hardness testing of metals is not available.

6.4.4

Impact tests - Charpy

The striker configuration shall comply with the requirements of the applicable test standard. For AS 1544.2, a 2 mm striker shall be used. For ASTM E23, an 8 mm striker shall be used unless a 2 mm striker is specified. For ISO 148-1, either striker configuration may be used at the discretion of the laboratory.

Note: Test results may be influenced by the striker geometry (2 mm or 8 mm).

Where lateral expansion measurement and/or fracture surface assessment is performed, the laboratory shall ensure that all additional requirements specified by the applicable standard are satisfied. This may be in relation to test machine configuration, calibration/verification and performance checking.

Annual calibration/verification of Charpy impact testing machines is required by each standard. It is the responsibility of the laboratory to ensure the verification of the testing machine conforms to the reported standard.

Test machine changes

If the striker, anvils, or pendulum is replaced, or the mass of the pendulum is adjusted, a direct and/or indirect verification of the testing machine is required as specified in the applicable standard.

Verification / Reference / Standardised test pieces

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.

Calibration authority

AS 1544.2 requires verification by testing standardised test pieces, which have certified values, typically low energy and/or high energy. The standard requires, and it is recommended to adopt this practice when conducting testing to other Charpy impact test standards, that this verification be performed by the facility in the presence of the calibration authority, with the results included in the calibration

report. The verification results are an integral part of the calibration report and must be included for compliance with the requirements of AS 1544.2.

6.4.7 & 6.4.10

Common equipment performance checks

Facilities must ensure that where method-writing bodies have included equipment calibration and checking intervals in standard methods, those intervals are followed.

Facilities should refer to NATA's *General Accreditation Guidance: 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
Universal Testing Machines			
Force	1 (recommended) 1.5 (maximum) or, immediately after dismantling or repair		ASTM E4 (to comply with ASTM E8)
	1 (recommended)		ISO 7500-1 (to comply with AS 1391 / ISO 6892-1)
Extensometer	1 (recommended) 1.5 (maximum)		ASTM E83 (to comply with ASTM E8)
	1 (recommended) 1.5 (maximum)		ISO 9513 (to comply with AS 1391 / ISO 6892-1)
Test rate controller (strain, stress, displacement)		Initial and 12 monthly	as applicable

Item of equipment	Calibration interval (years)	Checking interval (months)	Procedures and references
Hardness testers			
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 relevant scale, each day of use (Rockwell) ^{1,2}	AS 1815.1 (Rockwell)
		Each relevant load, each day of use (Vickers) ^{1,2}	AS 1817.1 (Vickers)
		Each relevant ratio, each day of use (Brinell) ^{1,2}	AS 1816.1 (Brinell)
Portable Brinell	As above	Each day of use if the magnification is adjustable ^{1,2}	Using a calibrated graticule or a graticule supplied by the microscope manufacturer, which has been checked against the microscope immediately after calibration.
Diamond indenters		12	Inspection by microscope for damage or wear.
Glass graticule	10		Initial calibration.
		12	Inspection by microscope for damage.

Item of equipment	Calibration interval (years)	Checking interval (months)	Procedures and references
Impact testing machines (metals testing)			
Charpy impact testers	Initial and after repair or relocation (complete)		Per relevant standard.
		12 (partial)	Per relevant standard.
		12 (indirect verification)	Using certified test pieces as specified in the relevant standard.
		Each day of use ¹	Zero check and friction loss check.
Notching tools		1 (or prior to test specimen manufacturing run if laboratory tests less frequently)	See 6.4.10 - <i>Specimen manufacturing and Notch checks</i> .

Note: 1. Commonly conducted by laboratory staff.
2. Hardness user checks should preferably be presented in graphical format.

6.4.10

Impact tests - Charpy

Each standard specifies the test piece requirements. While they are in principle the same, it is the responsibility of the laboratory to ensure the test pieces conform to the reported standard.

Specimen manufacturing

The facility shall verify the method employed to produce Charpy impact test specimens to ensure all requirements of the reported standard are met. Where any change is made to the manufacturing method or tooling, subsequent verification is required to ensure continued compliance. Verifications shall be performed at intervals not exceeding 6 months and records maintained (all specimen characteristics).

Notch checks

Charpy notches shall be checked at least monthly (or prior to any specimen manufacturing if the facility tests less frequently than monthly) for depth, centrality

and profile. Prior to determining notch depth, the squareness of the specimen faces shall be verified, as out of squareness will affect the depth measurement.

Factors influencing tool wear include, but are not limited to, the number of specimens produced, specimen material and hardness, and the notch machining process. Blunt or damaged notching tools will produce significant deformation of the notch. Accordingly, the notching tool shall be inspected prior to each specimen manufacturing run to ensure it is free from damage, burrs, adhering swarf, and that the cutting edge remains sharp.

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 hardness tester used for Vickers hardness 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 forces at which it is to be used;
- hardness numbers must be reported in the standard format (e.g. HBW/10/3000).

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

Hardness tests - Microhardness

Accreditation below 0.245 N [0.025 kgf] is not available.

Microhardness testing 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 shall 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

Impact tests - Charpy

Test reports shall include the striker geometry for each test specimen.

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 material type under test must be known and the applicability of the hardness conversion table to this material type confirmed, otherwise the report shall contain wording to alert any user of possible risk.

Tensile testing

Where an elongation result is less than the specified minimum requirement and the fracture location is outside the specified region of the gauge length, the test is considered invalid and a repeat test may be necessary. Refer to the applicable test standard for further details.

Note: Fracture occurring outside the specified region of the gauge length can result in elongation values that are unusually low and not representative of the material, leading to false rejection of test specimens.

Where the conformance of the elongation result cannot be conclusively determined and the result is reported, a note shall be included in the report regarding the validity of the reported elongation result.

When converting elongation results at a given gauge length to equivalents at other gauge lengths, it must be clear that the elongation conversion table used can reliably be applied to the material type, otherwise the report shall contain wording to alert any user of possible risk.

In addition, the reporting requirements of the standard must be met and 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 1391	Metallic materials - Tensile testing - Method of test at room temperature
AS 1544.2	Method for impact tests on metals, Part 2: Charpy V-notch
AS 1815.1	Metallic materials - Rockwell hardness test, Part 1: Test method
AS 1815.2	Metallic materials - Rockwell hardness test, Part 2: Verification and calibration of testing machines and indenters
AS 1816.1	Metallic materials - Brinell hardness test, Method 1: Test method
AS 1816.2	Metallic materials - Brinell hardness test, Method 2: Verification and calibration of testing machines
AS 1817.1	Metallic materials - Vickers hardness test, Method 1: Test method
AS 1817.2	Metallic materials - Vickers hardness test, Method 2: Verification and calibration of testing machines
ASTM E4	Standard Practices for Force Calibration and Verification of Testing Machines
ASTM E8	Standard Test Methods for Tension Testing of Metallic Materials
ASTM E23	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E83	Standard Practice for Calibration, Verification, and Classification of Extensometer Systems
ISO 148-1	Metallic materials - Charpy pendulum impact test, Part 1: Test method
ISO 6892-1	Metallic materials - Tensile testing, Part 1: Method of test at room temperature
ISO 7500-1	Metallic materials - Calibration and verification of static uniaxial testing machines, Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system
ISO 9513	Metallic materials - Calibration of extensometer systems used in uniaxial testing
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 table

Amendment Table

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

Section or Clause	Amendment
Whole document	Editorial and minor text changes throughout the document to improve readability and clarity.
Scope of accreditation	<p><u>Hardness testing:</u></p> <p>Renamed hardness sub-section from “Microhardness” to “Hardness tests - Vickers”.</p> <p>The public scope of accreditation of a facility to list N and commonly used kgf or gf under a facility’s limitation.</p> <p>Updated lower limit of accreditation from 1.96 N (0.2 kgf) to 0.245 N (0.025 kgf).</p>
6.3.3	<p>Updated "cooled/coolant" terminology for non-ambient impact tests to "conditioned/conditioning medium".</p> <p>Added examples of acceptable liquid conditioning media.</p> <p>Included new requirements for liquid bath conditioning.</p>
6.4	Added introductory paragraph noting that mechanical testing is commonly performed to various international standards, with equipment required to comply with the reported test standard.
6.4.1	<p><u>Hardness testing:</u></p> <p>Updated requirement for initial confirmation of hardness reference block values at the time of the testing machine calibration and recommendation that this verification be conducted by, or witnessed by, the calibration authority and the results referenced in the calibration report.</p> <p>Updated hardness methods for which accreditation is not available to include "impact/rebound velocity and ultrasonic contact impedance (UCI) hardness testing".</p>
6.4.4	<p><u>Impact testing:</u></p> <p>Added sub-section “Test machine changes” that outlines scenarios when direct or indirect verification of the testing machine is required.</p>

	<p><u>Tensile testing:</u></p> <p>Removed the dedicated extensometer paragraph and table that referenced AS 1545 as extensometer calibration standard. This is now covered in the equipment table in section 6.4.10.</p>
6.4.7 & 6.4.10 - Equipment table	<p>The equipment table has been revised to reflect the latest standards and best practice.</p> <p>Added "Universal Testing Machines" covering force calibration, extensometer calibration, and test-rate controller checks.</p> <p>Updated "complete" calibration of Charpy impact testing machines from "5-yearly" to "initial and after repair or relocation".</p> <p>Updated notching tools check intervals to monthly (or prior to specimen manufacturing run).</p> <p>Updated hardness tester check intervals.</p> <p>Added Note 2 recommending hardness user checks be presented in graphical format.</p>
6.4.10	<p><u>Impact testing:</u></p> <p>Added sub-sections "Specimen manufacturing" and "Notch checks" outlining requirements for specimen manufacturing methods and verification of specimen and notch geometry</p> <p><u>Hardness testing:</u></p> <p>Removed "Hardness tests – Rockwell" sub-section as the requirements are covered in section 6.4.1 - Hardness testing.</p>
7.2.1.1	<p>Updated vibration isolation requirement for microhardness testing machines.</p>
7.8.1.2	<p><u>Impact testing:</u></p> <p>Added new sub-section "Impact tests – Charpy" requiring reporting of the striker geometry.</p> <p><u>Hardness testing:</u></p> <p>Updated requirements when reporting hardness using conversion tables.</p> <p><u>Tensile testing:</u></p> <p>Added information covering tensile tests where fracture occurs outside the specified gauge-length region.</p> <p>Updated requirements when reporting elongation using conversion tables.</p>