# Specific Accreditation Criteria

## ISO/IEC 17025 Application Document

## Materials - Annex

## Metallographic testing

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# Table of Contents

# Metallographic testing

In addition to the *ISO/IEC 17025 Standard Application Document* (SAD), this document provides interpretative criteria and recommendations for metallographic testing for both applicant and accredited facilities.

Facilities must comply with all relevant documents in the NATA Accreditation Criteria (NAC) package for Materials (refer to *NATA Procedures for Accreditation).*

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

## Introduction

Accreditation for metallographic testing covers tests prescribed for assessing compliance of materials and manufactured parts/articles with standard or industry specifications.

Accreditation may be granted for those metallographic tests widely used in formulation of expert opinions (e.g., selection of manufacturing and treatment processes, and failure analysis), but only where well-defined test methods are used to obtain objective test data.

Metallographic testing consists of visual examinations at macroscopic or microscopic scales. Macroscopic examination differs from microscopic examination in that larger areas of specimens are studied visually at comparatively lower magnifications (e.g., typically 50x or less). NATA uses the term ‘macroscopic examination’ to cover determination of gross features of samples such as laps, seams, cracks, inclusions, bursts, laminations, weldments, hardening patterns, segregation, etc.

# 6 Resource requirements

## 6.3 Facilities and environmental conditions

**6.3.1** The accommodations for initial preparation work, final polishing, and testing shall have no adverse effect on test results.

**Note**: Consideration should be given to isolating rough preparation areas where there may be effects on delicate instruments.

**Note**: As flammable and corrosive etchants may be used for these tests (e.g., hydrofluoric acid, nitric acid, ferric chloride, strong alkalis, organic solvents, picric acid), consideration should be given to isolate the macroetch area and the use of fume control systems.

## 6.4 Equipment

**6.4.4** A calibrated device (e.g. stage micrometer) shall be used to verify magnifications.

Facilities shall prepare a tabulation (or equivalent reference) of the standard magnifications and the required eyepiece, objective, and extension for each magnification.

Dimensional measurements

Dimensional measurements require differing orders of accuracy depending on the nature of the test and the type of specimen.

For determination of case depth up to 0.5 mm, an instrument with minimum readability of 0.001 mm shall be used.

For determination of case depth of 0.5 mm and above, an instrument with minimum readability of 0.02 mm shall be used.

For determination of electrodeposited coatings, an instrument with minimum readability of 0.0005 mm shall be used.

Microstructure of graphite in cast iron

Specimens shall be prepared such that assessed sections show complete and undistorted retention of graphite.

Original graphite type, distribution, and size charts or verified inlays are essential. Illustrations must be placed closely adjacent to the microscope screen or photographic image or overlaid on an image.

# 7 Process requirements

## 7.2 Selection, verification and validation of methods

### 7.2.1 Selection and verification of methods

#### 7.2.1.1

Depth measurement — Case depth and depth of decarburisation

For measurements incorporating determination of hardness, accreditation cannot be considered for case depth or depth of decarburisation by such methods unless a facility also holds accreditation for the relevant hardness tests.

Hardness tests for determination of case depth or depth of decarburisation usually require light indentation forces. The indentation force must be chosen to enable adequate spacing of indentations, distance from the edge of the specimen, and containment within a desired phase when required.

Depth measurement — Thickness of metallic and conversion coatings

Where not specified in the product standard, measurements shall be taken at a minimum of five locations, including where the minimum thickness might reasonably be expected to occur. The location of each thickness measurement and the coating thickness determined at each location shall be reported.

Measurements shall be made with a metallurgical microscope.

Where sections examined are not normal to the surface of the article, facilities shall measure the angle between the examined plane and the plane of the coating.

Grain size — All methods

There are three basic methods for grain size estimation. For all methods, the fields chosen for examination shall be representative of the sample.

For non-equiaxed grains, measurements shall be taken in mutually perpendicular directions, i.e., longitudinal, transverse, and normal. Three counts shall be made in each direction.

Grain size — Comparison method

The comparison method shall be applied to completely recrystallised or cast materials with equiaxed grains.

A facility shall have suitable means of comparison, e.g., grain size charts or overlays. Any working copies of charts shall be verified against specified requirements.

The grain size comparison shall be determined on a projection screen, microscope, or by using a photographic image adjacent to the standard grain size charts.

Grain size — Intercept method

The line inscribed on the microscope screen or photographic image shall be sufficiently long to intercept at least 50 grains, and at least three counts shall be averaged.

Grain size — Planimetric method

Determination shall be carried out using a projection screen or a photographic image. Magnification for each determination shall be sufficient to ensure between 50 and 100 grains are within the inscribed area. A minimum of three determinations shall be performed.

Volume fraction — Manual method

The magnification of examined fields shall be verifiable. Where possible, a scale is to be shown on all images used for the examination. Critical details of the counts performed (e.g. spacings, subsequent calculations) shall be recorded.

**7.2.1.3** Many test methods recommend specific polishing and/or etching procedures, but facilities may adopt other procedures where the integrity of microstructure is not compromised.

**Note**: Particular attention should be given to the removal of soft phases and edge rounding.

Preparation, polishing, and etching procedures shall be documented where not detailed in the applicable test standard or specification.

Depth measurement

As all depth measurements are made from reference surfaces, it is essential to avoid edge rounding or other damage to those surfaces.

As metallic and conversion coatings are usually very thin and often comparatively soft, it is essential to avoid distortion, loss or damage during testing.

## 7.8 Reporting of results

### 7.8.3 Specific requirements for test reports

**7.8.3.1** In addition to other reporting requirements, the polishing and etching procedures shall be included.

When a test method involves a significant subjective element, it is necessary to include supporting information in the test report. Supporting information may take the form of photographs, sketches, or detailed description(s). The aim shall be to give the customer all available facts so that they will know the basis adopted by the facility for its subjective judgement.

When photographs are included in test reports, they shall be annotated with the areas of the specimen they represent, the associated magnification, and any etchant(s) used.

Depth measurement

All the relevant definitions shall be included in the test report if they are not already included in the stated material specification or test method. This is particularly important for reports on case depth and depth of decarburisation.

An image of the area concerned shall be included in the report.

Reports shall include the location and orientation of the specimen(s) in relation to the sample.

Grain size

Estimation of grain size is not a precise measurement and is often complicated by the fact that grain size of the sample is variable. For a material of uniform grain size, grain size is reported to the nearest number detailed in the relevant standard.

Where there are variations in grain size, it is permissible to estimate and report approximate proportions. Such estimates shall be rounded and reported to the nearest 10% of the evaluated area.

**Note**: In practice, many specimens do not have uniform grain size. In such cases, reports may describe the observed range or predominant grain size. For example, reports may include statements such as '…grain size number varies from 2 to 6…'. Where duplex grain sizes are present, results may be reported as '…grain size number is predominantly 3 but some regions vary from 5 to 6…'.

Macroscopic examination

For macroscopic examination of welded specimens, test reports shall contain applicable details of the welded test plate. Where testing is conducted for the purposes of weld procedure qualification, such details may include as a minimum:

- joint type;
- weld preparation;
- etchant used and application method;
- section size(s);
- material grade and/or standard;
- welder identification;
- welding position;
- welding process;
- reference to the associated welding procedure or specification.

Microstructure of graphite in cast iron

Estimating graphite type, distribution and size is not a precise measurement and may be complicated by the presence of more than one type and/or size of graphite in the specimen. Where the location of concern shows a varying microstructure, approximate estimates of the proportion of these areas shall be made and reported.

It is required to state the position of the specimen in relation to the sample or casting in test reports, and to record the thickness of the section from which the specimen was cut.

Where a representative sample such as a keel block or test bar is used, this shall be noted in test reports.

Volume fraction

Reports shall detail all points counted, locations, calculated results, and representative image(s) of the examined locations.

# 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**

| | |
|---|---|
| ASTM E112 | *Standard Test Methods for Determining Average Grain Size* |
| ASTM E562 | *Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count* |
| ISO/IEC 17025 | *General requirements for the competence of testing and calibration laboratories* |

**NATA publications**

NATA Accreditation Criteria package for Materials

# Amendment Table

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

| Section or Clause | Amendment |
|---|---|
| Whole document | Some requirements from the previous edition have been editorially revised for clarity.<br>Requirements that have since been superseded and/or made redundant by the current NATA Accreditation Criteria have been removed. |
| 7.2 | Added requirements for depth measurement of coatings, grain size, volume fraction. |
| 7.8 | Added mandatory supporting information in test reports (e.g. photographs). |