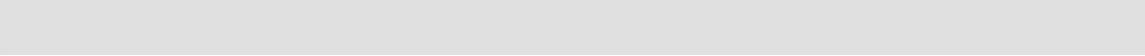




# **Mechanical Testing ISO/IEC 17025 Application Document**

## **Annex H: Microstructural tests**

**June 2015**



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## **Mechanical Testing Annex H: Microstructural tests**

This document provides interpretative criteria and recommendations for the application of ISO/IEC 17025 for both applicant and accredited facilities conducting microstructural testing under Mechanical Testing.

Applicant and accredited facilities must also comply with the ISO/IEC 17025 standard and Mechanical Testing field application document and any field annexes, policies and/or technical circulars (refer to *NATA procedures for accreditation*).

### **General**

In general, accreditation for microstructural and allied tests covers tests prescribed for assessment of compliance of materials, manufactured parts or articles with standard, defence or industry specifications.

Accreditation may be granted for those metallographic tests widely used in formulation of expert opinions on selection of manufacturing and treatment processes or in case of failures, but only to the extent that well defined test methods are used to obtain objective test data.

The terms 'objective' and 'subjective' are used in reference to tests and test methods. 'Objective test' means a test which produces a test result which is independent of the personal judgement or opinion of the operator. 'Subjective test' means a test which produces a test result dependent on the personal judgement or opinion of the operator. In practice, tests fall between these extremes and involve varying degrees of subjective judgement.

### **Preparation of specimens**

Many test methods recommend polishing or etching procedures but normally any procedure may be adopted while maintaining the integrity of microstructure.

Preparation, polishing and etching procedures shall be documented where necessary, in the relevant test methods.

### **Reporting of test results**

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

When a test method involves a significant subjective element, it may be necessary to include in the test document information to support the test results. Supporting information may take the form of photographs, sketches, or a detailed description. 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. This principle is especially important if the facility's subjective judgement has resulted in the conclusion that the sample does not conform to or just meets the requirements of the material specifications.

When photographs are included in test documents they shall be identified with the areas of the specimen they represent.

## **Accommodation**

The standard of accommodation for initial preparation work, final polishing, testing and film processing shall have no adverse effect on test results.

Initial preparation areas shall be isolated from the remainder of the facility.

## **Equipment**

A facility testing to a specification which involves specific equipment shall have equipment which complies with specification requirements in all aspects.

Facilities are responsible for establishing their own equipment assurance program. This is to ensure that all equipment used satisfies the need to produce consistent and reliable and where appropriate traceable results. In doing so facilities must ensure that where methods writing bodies have included equipment calibration and checking intervals in standard methods that these intervals must be followed if the methods are covered by the accreditation. Facilities should refer to the guidance documents available for equipment (General Equipment Table) for further information on calibrations and checks on equipment.

Microscopes shall be chosen to provide the magnifications specified for the various tests performed in the facility. A calibrated stage micrometer shall be available for verifying magnifications. Where necessary, a facility shall prepare a tabulation of the standard magnifications and the eyepiece, objective and bellows extension required for each magnification. A copy of this table shall be kept adjacent to the microscope.

## **Depth measurement**

### **General requirements**

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

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

### **Case depth and depth of decarburisation**

For measurements involving hardness testing, accreditation cannot be considered for case depth or depth of decarburisation unless a facility obtains accreditation for the relevant hardness tests on metals.

Hardness tests for determination of case depth or depth of decarburisation usually require light indentation forces. Indentation force must be chosen to enable adequate spacing of indentations and distance from the edge of the specimen.

For optical determinations attention is drawn to the equipment requirements as described in the previous sections.

### **Hardness scales for steels**

If a hardness conversion cannot be avoided, the facility shall include in the test report the original and converted hardness numbers and the authority chosen for the conversion.

## **Thickness of metallic and conversion coatings**

Where not specified in the product standard, measurements shall be taken in minimum of five locations including the location 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 and shall be verifiable.

## **Preparation of specimens**

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.

## **Equipment**

Depth 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.

## **Grain size**

### **Test methods**

There are three basic methods for grain size estimation:

- The Comparison Method;
- The Intercept (Heyn) Method;
- The Planimetric Method.

For all methods the fields chosen for examination shall be representative of the sample.

### **The Comparison Method**

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

A facility shall have a set of original charts or overlays printed by ASTM or other standards writing body. Photocopies are not permitted.

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

### **The 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. For non-equiaxed grains, measurements shall be taken in three directions mutually at right angles, that is, longitudinal, transverse and normal. Three counts shall be made in each direction and the results computed according to the relevant test method.

### **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 within the inscribed area. A minimum of three determinations shall be performed. For non-equiaxed grains, measurements shall be taken in three directions longitudinal, transverse and normal, and three counts shall be performed in each direction.

### **Equipment**

Suitable facilities for polishing and etching of specimens are essential.

The microscope shall permit realisation of the specific standard magnifications listed in the relevant test method.

### **Reporting of test results**

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 steel of uniform grain size, grain size is reported to the nearest number detailed in the relevant standard. In practice many cases of variable grain size occur and a report can state only 'grain size varies from 2 to 6'. When duplex grain sizes occur a report may state 'grain size predominantly 3 but some regions vary from 5 to 6'.

Where there are variations in grain size it is desirable to estimate and report approximate proportions. As such estimates are necessarily inaccurate they shall be rounded and reported to the nearest 10%.

## **Microstructure of graphite in cast iron**

### **Selection and preparation of specimens**

It is desirable 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.

Specimen preparation shall be of such a standard that prepared sections will show complete and undistorted retention of the graphite flakes.

### **Estimation of graphite flake size**

Comparison with Standard Charts:

A microscope, whose magnification has been checked with a stage micrometer, and an original Flake Size Chart are essential. It is essential to arrange the illustrations so that they can be placed closely adjacent to the microscope screen or photographic image.

### **Reporting of test results**

Estimation of graphite flake type 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. Approximate estimates of the proportion of the area of each graphite rating shall be made and reported. As such estimates are necessarily inaccurate they shall be rounded and reported to the nearest 10%.

## Macroscopic examination

### General

Macroscopic examination differs from microscopic examination in that larger areas of specimens are studied and a comparatively low magnification, usually ten diameters or less, is used. NATA uses the term 'macroscopic examination' to cover determination of gross features of samples such as laps, seams, cracks, inclusions, bursts, laminations, welds, hardening patterns and segregation.

### Accommodation

As hot corrosive etchants are normally used for these tests, provision shall be made for isolation of the macro-etch area from the main laboratory room.

Adequate ventilation of the macro-etch area and careful storage and usage of etchants will minimise dangers to staff and equipment.

### Proportion of phases

### Counting of intercepts

A grid which enables counting of the number of intercepts in a particular field is required.

### Reporting of results

Results shall be reported as the percentage of the phase under count and include the number of points counted.

### 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 would normally include:

- Joint type
- Weld preparation
- Section size(s)
- Material grade and/or standard
- Welder identification
- Welding position
- Welding process

## Amendment Table

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

Section or	Amendment
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Clause	
Annex title	Retitled as Annex H
Competence of staff	Deleted - ISO/IEC 17025 requirement
Case depth	Last sentence amended
Macroscopic examination	Requirement to report magnification deleted. Requirements for reports on welded specimens included.