SC 1.5 – SPECIFIC CRITERIA FOR ACCREDITATION OF MECHANICAL TESTING AND NON-DESTRUCTIVE TESTING (NDT)
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JABATAN STANDARD MALAYSIA
Department of Standards Malaysia
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Items</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Scope</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Normative references</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Terms and definitions</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Management Requirements</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Technical Requirements</td>
<td>3</td>
</tr>
<tr>
<td>5.1</td>
<td>General</td>
<td>3</td>
</tr>
<tr>
<td>5.2</td>
<td>Personnel</td>
<td>3 &amp; 4</td>
</tr>
<tr>
<td>5.3</td>
<td>Accommodation and environmental conditions</td>
<td>4 &amp; 5</td>
</tr>
<tr>
<td>5.4</td>
<td>Test and calibration methods and method validation</td>
<td>6-8</td>
</tr>
<tr>
<td>5.5</td>
<td>Equipment</td>
<td>8 &amp; 9</td>
</tr>
<tr>
<td>5.6</td>
<td>Measurement traceability</td>
<td>10</td>
</tr>
<tr>
<td>5.7</td>
<td>Sampling</td>
<td>10</td>
</tr>
<tr>
<td>5.8</td>
<td>Handling of test and calibration items</td>
<td>10</td>
</tr>
<tr>
<td>5.9</td>
<td>Assuring the quality of test and calibration results</td>
<td>9 &amp; 10</td>
</tr>
<tr>
<td>5.10</td>
<td>Reporting the results</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Appendix 1</td>
<td>12-19</td>
</tr>
<tr>
<td></td>
<td>References</td>
<td>20</td>
</tr>
</tbody>
</table>
INTRODUCTION

This specific criteria document shall provide additional or more specific details about mechanical testing.

The document shall be read in conjunction with document:

(i) MS ISO/IEC 17025

(ii) SAMM policy documents

This document sets out the specific requirements a mechanical testing laboratory has to meet, in addition to the general requirements of ISO/IEC 17025 and SP Series documents.

1. SCOPE

STANDARDS MALAYSIA accreditation does not constitute a blanket approval of all laboratories’ activities. Therefore, it is necessary to identify those activities for which accreditation is granted. The classes of test provide the framework within which the scope of accreditation is expressed.

These classes and subclasses do not constitute any restriction on the work, which a laboratory can perform but provide a convenient means of expressing a laboratory's recognised capability.

Classes of test appropriate to mechanical testing laboratories are listed in Appendix 1. These classes are an arbitrary subdivision of the potential range of activities involved in mechanical testing laboratories on the basis of the types of samples being tested, the scientific disciplines involved and the test methods employed.

2. NORMATIVE REFERENCE

(i) MS ISO/IEC 17025 - ‘General Requirements For The Competence Of Testing And Calibration Laboratories’

3. TERMS AND DEFINITIONS

None.

4. MANAGEMENT REQUIREMENTS

Same as MS ISO/IEC 17025
5. TECHNICAL REQUIREMENTS

5.1 General
Same as MS ISO/IEC 17025

5.2 Personnel

5.2.1 Mechanical testing shall be performed by competent personnel or supervised by experienced personnel.

5.2.2 On-going competence should be monitored on regular basis. Records on competency shall be available on request. Where a method or technique is not in regular use, verification of personnel performance before testing is necessary.

5.2.3 Sound management is essential if a testing service is to operate to a satisfactory standard. Particular attention should be given to the following aspects of management:

(a) There must be clearly defined and recognisable lines of authority and responsibility within the organisation, with each officer being aware of both the extent and the limitations of their own responsibility.

(b) Staff members must be allocated only duties commensurate with their knowledge and experience. They must be provided with the direction or supervision they need for effective performance of their duties. Adequately authorised and up to date competency records (training records) must be available for all staff carrying out testing work.

(c) Competency of staff is assessed by peer review during practical demonstrations. Generally personal qualifications are not a prerequisite for signatory status. However, some areas of expertise, where tests involve technical judgement e.g. Non-Destructive Test (NDT), require personal qualifications as prerequisites to approved signatory status.

(d) It is important to emphasise that Approved Signatories be not only competent in carrying out the required tests, but also to be able to recognise when a test has gone wrong and take appropriate action. It is important for Approved Signatories to know their own limitations and the scope of testing work for which they are approved.

(e) It is important for management to recognise the need for keeping key staff up to date with technical developments within their area of expertise, and to provide access to appropriate ongoing training.
5.2.4 Approved signatory

Procedures, which select, train, retain, and develop appropriate staff, need to be in place. An accredited laboratory shall have at least one staff member who is awarded approved signatory in the testing being undertaken. Requirements for Approved Signatories are detailed in SAMM Policy 6.

The nominees for NDT Approved Signatories shall be certified to minimum Jabatan Pembangunan Kemahiran (Department of Skills Development) NDT certification Level II or equivalent certification scheme. Any rules related to radiation safety in radiography shall be referred to Atomic Energy Licensing Board (AELB).

* Note 1: Test personnel with a sound understanding of the principles of the test may be considered competent to approve test results from elemental composition of materials, for example in spectroscopy analysis.

5.3 Accommodation and environmental conditions

5.3.1 Accommodation requirements for laboratories working in the mechanical field vary widely depending upon the nature of the items to be tested and the uncertainty with which measurements are to be made. A formal laboratory area will be required for precise measurements but many measurements and tests can be satisfactorily performed in production areas or in the field.

Irrespective of where tests and measurements are performed there must be adequate space and storage facilities for carrying out the tests, recording of test data, report preparation, etc.

Formal laboratory areas must have good lighting, adequate bench space, freedom from excessive dust and fumes, freedom from unwanted vibration and acoustic noise and for some tests, control of temperature and humidity. The extent to which these environmental factors apply will vary according to the type and precision of the measurements. When highly precise measurements are to be made the following factors may assume greater importance:

(a) Isolation from sources of mechanical vibration and shock likely to have a detrimental effect on sensitive instruments (e.g. high accuracy balances).

(b) Adequate ventilation when fumes are created by the tests such as in bitumen testing.

(c) Temperature and humidity control of the laboratory as specified in the relevant test procedure (e.g. paper testing).
(d) Protection from excessive levels of dirt and dust.

(e) Suitable equipment and areas for the preparation of test specimens such as in tensile testing and metallography.

(f) Isolation from stray electric and magnetic fields, particularly for thermocouples, strain gauges and other sensitive low output devices.

(g) Electromagnetic interference between items of test equipment and computers.

5.3.2 Safety

Safety has taken on an ever-increasing emphasis of recent times and the safety of people within the testing environment must be of paramount concern to laboratory management.

Some types of tests have very specific safety requirements, which must be met, e.g. radiography, and these may be subject to regulatory requirements.

Other tests will have less specific but otherwise significant safety concerns, e.g. compression tests on concrete. It is expected that accredited laboratories will have considered, and provided appropriate safety procedures to cover items such as:

(a) Noise - from equipment such as mechanical sieve shakers and compaction hammers.

(b) Ventilation - adequate air flows in controlled environments - protection from corrosive or toxic fumes.

(c) Personal Protection - safety clothing, etc.

(d) Physical Protection - safety screens on equipment such as compression testers.

Notes:

Occupational Safety and Health Act 1994 (Act 512) places specific legal obligations on all employers, including laboratories. Safety is outside the scope of accreditation and will not be audited during an on-site laboratory accreditation assessment. If, in the opinion of the assessment team, a safety issue is observed during an assessment it will be reported to the laboratory, as required by the Act. The reporting of a safety issue will not indicate that a comprehensive safety audit has been carried out. Safety auditing is a specialist activity and the responsibility for ensuring compliance with the Act 512 rests entirely with laboratory management.
5.4 Test and calibration methods and method validation

5.4.1 Accreditation is normally granted only for internationally or nationally accepted standard test procedures or non-standard procedures (in-house methods) that have been appropriately validated, and which are performed regularly. The extent of a laboratory's scope of accreditation will therefore vary with the range of work performed, the scope and complexity of the tests involved, the competence and organisation of laboratory staff and the level of technology available in the laboratory.

In-house methods could include but not be restricted to:
(a) Methods developed in the laboratory
(b) Methods developed by customer/manufacturer
(c) Methods developed for an industry group
(d) Modified standard test methods
(e) Method published in the scientific literature with/without any performance data

Validation of test methods shall involve, as appropriate, the use of certified reference materials, participation in inter-laboratory comparison/proficiency test programmes, comparison with standard test procedures, determination of method precision, limits of detection, uncertainties of measurement etc.

Standard test methods should be used whenever possible in order to ensure inter-laboratory reproducibility of test results. Laboratories are discouraged from seeking accreditation for test methods that depart from recognised published standards. If however, approval of an in-house test method is required the following information must be provided:

(a) A copy of the fully documented test method
(b) Details of the origin of the in-house test method
(c) Details of the reason for its development
(d) The results of comparative tests with standard methods (if possible)
(e) Full details of test method validation including test reproducibility.
<table>
<thead>
<tr>
<th>Test Method Description</th>
<th>Validation or Verification requirements</th>
<th>Method Reference No/ID (Example)</th>
</tr>
</thead>
</table>
  e.g.:  
  MS 1: 1996 Clause 12.2  
  ASTM A370-03a  |
| In-house test method                                         |                                        | In-house test method  |
| Method developed by laboratory                               | Full validation                        | <In-house method>, <ref. no.>  
  e.g.:  
  In-house method: 1234-A  |
| Method developed by customer/manufacturer                    | Full validation                        | <In-house method>, <ref. no.>, based on xxxx  
  In House Method  
  e.g.:  
  MGT/001/ES-X 60210 (Rev. 4)  
  Clause 3.3 based on ES-X 60210 (Rev. M)  |
| Method develop for an industry group                         | Absence of performance characteristic  | Full validation  
  e.g.:  
  ASME VIII UCS (56)  |
  e.g.:  
  API 2H-1993 Annex S-4  
  ASME B30.20: 2006  
  Section 20-1.3.8  |
| Modified standard methods                                    | Full validation                        | <In-house method>, <ref. no.>, based on std. method,  
  technique (sample preparation & detection, where applicable)>  
  In-house method QMCL/014/2007 based on  
  MS 522: Part 2:2005 Clause 3  |
| Method published in the scientific literature without any performance data | Confirmation of published performance characteristic | <In-house method>, <ref. no.>, based on xxxx  
  e.g.:  
  In house method ABC, based on Practical Guidebook for Radioisotope-based Technology in Industry,  
5.4.2 It is important for testing laboratories to understand the concept of uncertainty of measurement. Laboratory management should be aware of the effect of their own uncertainty of measurement on the test results produced in their laboratory.

For mechanical testing laboratories there are two specific areas where the calculation of uncertainty may be required to be reported:
(a) When the customer requests this information
(b) When test results are used to determine if the sample conforms to a required numerical specification.

A great number of mechanical tests have quite large uncertainties of measurement and laboratories should be aware of the magnitude of these. Some test methods, notably ASTM’s, have included the repeatability and reproducibility at the end of the method. Accredited laboratories should be able to demonstrate, through an inter-laboratory trial or similar, that the uncertainty of the test results produced by them will be of similar precision.

Typical tests have high uncertainty include tests such as the vialet test, viscosity tests, skid resistance, bitumen penetration, liquid limit, hardness testing and ultrasonic thickness measurement.

It is strongly recommended that laboratories participate in as many inter-operator and inter-laboratory trials as possible. These are excellent means for establishing an awareness of uncertainty. Activity in these aspects will not only raise technical knowledge with regard to testing, but will aid in the appropriate selection and application of tests.

Those methods, which involve elements of subjective judgement, are not subjected to the determination of measurement uncertainty unless it is so required by a testing standard or customer’s specification.

5.5 Equipment

An accredited laboratory will be expected to possess and maintain, under a documented management system, all equipment necessary to carry out the tests requested for inclusion in the scope of accreditation.

Guidelines on calibration requirements and recalibration intervals for equipment are detailed in ILAC-G24 Document.

Reduced or extended calibration intervals may be accepted based on factors such as history of stability, accuracy required and ability of staff to perform regular checks. It is the responsibility of the laboratory to provide
clear evidence that its calibration system, and any changes to an existing system, will ensure that confidence in the equipment can be maintained.

Equipment that is sensitive to movement, such as force, impact, hardness testing machines, heat enclosures and balances, will generally require full recalibration if they are moved.

Records of calibrations carried out in-house must confirm traceability of measurement (see clause 5.6). This is normally achieved by the record specifically identifying the reference item used (this is the preferred method). Alternatively the documented calibration procedure may dictate the specific reference item to be used. The latter method does not allow any flexibility and the system will need to ensure that the procedure is updated when the reference item is changed.

A laboratory, which uses a computerised testing system, shall satisfy the following criteria:

(a) The system must be satisfactorily calibrated. The optimum calibration procedure for physical testing systems will depend upon the accessibility of individual components of the system, especially their input or output signals. If a testing instrument cannot be isolated from the data processing system, the system as a whole must be calibrated either statically or dynamically. Calibrating the complete system is the preferred alternative. If the testing instrument can be isolated from the data processing system, the opportunity is available to calibrate or verify each component of the system separately. The testing instrument can be calibrated (again, statically, or dynamically) in the conventional manner and a separate verification of the data processing system, including any interfacing systems, can be undertaken.

(b) The computer program must be comprehensive in its coverage of the testing process and must have been checked at points covering the whole range of likely inputs and outputs.

(c) The program must allow the operator to detect errors in data input and to monitor the progress of the test.

(d) The system must be capable of being checked for error-free operation with respect to data capture, data processing, and freedom from sources of external interference. Where appropriate, manually checked data sets (or artefacts) must be available for regular system checks.

Note: This requirement also applies for clause 5.4.7 Control of data.
5.6 Measurement traceability

Same as MS ISO/IEC 17025 and SP2 documents.

5.7 Sampling

Same as MS ISO/IEC 17025.

5.8 Handling of test and calibration items

Same as MS ISO/IEC 17025.

5.9 Assuring the quality of test and calibration results

Quality Control

It is important for laboratories to understand where tests can go wrong so that steps can be taken to either eliminate the potential error point, or put in a means for alerting the technicians when the test has gone wrong. Quality control in some form is possible over any test being performed. There is a disciplined approach required for the development of a suitable quality control plan and this approach can be applied on a test by test basis.

It is expected that accredited mechanical testing laboratories will have developed, documented, and implemented an appropriate quality control programme.

Proficiency Testing

For the reasons discussed in clause 5.4.2 (Measurement Uncertainty) and as an integral part of the laboratory’s quality control programme, STANDARDS MALAYSIA may require laboratories to participate in appropriate proficiency or inter-laboratory comparison programmes. The importance and value of proficiency testing programmes cannot be emphasised enough. Satisfactory performance in appropriate programmes assures both STANDARDS MALAYSIA and our international mutual recognition partners that any accredited laboratory is able to produce valid test results that may be accepted without further confirmation.

Proficiency programmes may be developed by the laboratory or offered by third parties such as Malaysian Rubber Board (MRB), Forest Research Institute of Malaysia (FRIM) Proficiency Testing (PT) Programmes, APLAC tensile and hardness testing, Cement and Concrete Association (C & CA). In the absence of third party PT programmes, laboratory is recommended to implement programmes with other laboratories in their own organisation or in their own area.
It is expected that accredited laboratories will take every opportunity to confirm the technical validity of the test results being produced by them.

The participation in a programme is of little value without the combined results being analysed to determine the nature of any discrepancies and the effect of this on any routine test results. Discrepancies may be in the order of expected uncertainty, or they may indicate a serious shortcoming in a laboratory’s procedure. It is important for laboratories to have undertaken this analysis and to have adequately determined any required corrective action. Records of all reviews are required, including those for which no further action is considered appropriate (i.e. satisfactory results). Interpretation of the results can be referred to ISO/IEC 17043.

Corrective actions for results that fall outside the acceptance criteria for a specific programme shall refer to SP 4 document.

5.10 Reporting the results

Same as MS ISO/IEC 17025.
Appendix 1:

CLASSES OF TEST: MECHANICAL & NDT

MECHANICAL
Mechanical and physical testing of material/products that includes metallurgical tests to determine the elemental analysis and microstructures.

NON-DESTRUCTIVE TESTING (NDT)
Examination of materials, components, and assemblies to detect discontinuities without damaging the material, component or assembly.

The "classes of test" below also serve to identify or to list the capability or expertise of the relevant laboratory assessors, technical assessors and technical expertise used in SAMM assessment.

* All tests referring to relevant products standard

**Mechanical Product**

1. Metals and metal products
   - Tension test on test pieces
   - Stress-rupture tests
   - Tension test on products
   - Brinell hardness tests
   - Rockwell hardness tests
   - Vickers hardness tests
   - Microhardness tests
   - Superficial Rockwell hardness tests
   - Rebound hardness tests
   - Impact tests
   - Drop-weight tests
   - Fracture toughness tests
   - Compression, transverse and shear tests
   - Bend tests
   - Tests on reinforcement for concrete
   - Tests on wire
   - Tests on tubes
   - Other test

2. Metal powders and sintered products

3. Welds and welded test specimens
   - Tension tests
   - Hardness tests
   - Impact tests
   - Drop-weight tests
   - Fracture toughness tests
   - Shear tests
   - Bend tests
   - Fillet-break tests
   - Nick-break test
   - Cracking tests
   - Corrosion test
   - Macroscopic examinations
   - Other tests

4. Lifting gear and tensioning and staying systems
   - Lifting appliances
   - Anchorages
   - Chain
   - Wire rope
   - Fibre rope
   - Synthetic webbing flat slings
   - Chain slings
   - Wire rope slings
   - Fibre rope slings
   - Fittings
   - Containers, pallets and nets
   - Other products

5. Fibre rope and cordage
   - Tension tests
   - Other test

6. Springs and energy absorbing devices
   - Tension tests
   - Compression tests
   - Torsion tests
   - Other test

7. Threaded fasteners
   - Tension test
   - Proof tests
   - Tension-torque tests
   - Stripping tests
   - Torsion tests
   - Drive tests
   - Other test
8. Building Products

* Dry pressed ceramic tiles
* Vitreous China Sanitary
* Vitreous China Closet Pan
* Other materials

Glazing
Staining
Crazing
Warpage
Tolerance
Dimensional
Flushing
Loading
Marking
Other test

9. Concrete

Sampling
Mixing concrete in the laboratory
Consistence
Air content of freshly mixed concrete
Mass per unit volume of freshly mixed concrete
Bleeding
Making and curing test specimens in the field
Curing test specimens in the laboratory
Compression tests on moulded specimen
Indirect tensile tests
Flexural strength tests
Mass per unit volume of hardened concrete
Drying shrinkage
Securing cores from hardened concrete
Cement content of hardened concrete
Creep tests
Modulus of elasticity determinations
Setting time
Mixer uniformity tests
Admixtures
Other test

10. Cement based products

Sampling
* Concrete bricks
* Concrete blocks
* Concrete masonry units
* Concrete pavers
* Concrete culverts
* Concrete roofing tiles
* Concrete pipes
* Concrete railway sleepers
* Calcium silicate building bricks
* Fibre cement pipes and fittings
* Fibre cement sheet
* Other products

11. Refractories

Sampling
Cold compressive strength
Cold modulus of rupture
Other test

12. Rocks

Petrographic examination
Strength tests
Other test

13. Cements and pozzolanic materials

Sampling
* Portland cement
* Blended cement
* Masonry cement
* Building lime
* Silica fume
* Fly ash
* GGBS
* Mortars
* Other materials

Unsound particle
Apparent particle density
Voids in dry compacted fillers
Iron unsoundness
Resistance to stripping
Frictional resistance
Crushed faces
Other test

14. Bituminous materials

Sampling
* Bitumens
* Bituminous mixtures
* Tars
* Fillers
* Cutback bitumens
* Bitumens emulsion
* Polymers modified bitumens
* Asphalts
* Other materials

15. Soils

Sampling
Classification tests
Compaction and density tests
Strength and consolidation tests
Outdoor weathering tests
Reactivity
Other test

16. Timber and timber products

Bending tests
Stress grading timber tests
Other test

17. Building boards and plywood

* Particle board
* Hardboard
* Plywood
* Fibreboard
* Other building boards

18. Glass and glass products

* Glass
* Glass products
* Glass fibres

19. Clays and clay products

* Clays
* Clay building bricks
* Masonry specimens
* Clay roofing tiles
* Clay pavers
* Clay pipes
* Other products
20. Aggregates
Bulk density and water absorption
Sieve analysis
Material finer than 5 µm
Material finer than 2 µm
Electrical insulating oils and compounds
Flakiness index
Angularity number
Fine particle size distribution in road materials
Aggregate crushing value
Wet/dry strength ratio
Los Angeles value
Soundness tests
Light particle
Friable particle
Clay and fine slit
Organic impurities other than sugar
Sugar
Sulphur in slag aggregate
Potential alkali reactivity by mortar bar
Potential alkali reactivity by chemical method
Petrographic examination of slag aggregate
Degradation tests
Moisture content
Polished stone value
Sampling
Tests on concrete aggregates
Tests on road aggregates

21. Pulpwood, pulp, paper, paperboard and products
Sampling
Tension tests
Tear tests
Burst tests
Compression tests
Permeability
Liquid absorption
Surface properties
Adhesives
Optical properties
Mechanical properties
Physical tests
Visual assessment
Other test

22. Rubber and related products
Sampling
Tension tests
Tear tests
Tension set tests
Compression tests
Hardness tests
Flexing tests
Low temperature brittleness
Ageing and environmental tests
Flammability tests
Swelling in liquids
Density and specific gravity
Other tests
Belting
Elastomeric bearings
Other products

23. Gypsum and gypsum products
*Gypsum plaster
*Plaster boards
*Other products

24. Textiles and related products
Sampling
Tension test
Tear test
Burst test
Flammability test
Wear test
Colour fastness test
Other test
*Coated fabric
*Webbing
*Carpets
*Wool packs
*Other products

25. Motor vehicle safety tests
*Door latches and hinges
*Seat anchorages
*Seat belt anchorages
*Hydraulic brake hoses
*Steering columns
*Sun visors
*Rear view mirrors
*Windscreen wipers and washers
*Fuel systems for goods vehicles
*Safety rims
*Instrument panels
*Head restraints
*Tyres
*Tyre selection
*Side door strength
*Hydraulic braking systems
*Child restraint anchorages
*Commercial vehicle braking systems
*Other test

26. Seat belts and similar devices
*Seat belt assemblies
*Child restraint
*Industrial safety harnesses
*Components for seatbelts
*Other devices

27. Personal Protective Equipment (PPE)
*Safety boots and shoes
*Safety gloves
*Safety helmets
*Eye protectors
*Hearing protectors
*Life jackets and buoyancy vests
*Other products

28. Environmental Tests (Conditioning Tests)

29. Packages and containers
*Metal drums for liquids
*Metal drums for solids
*Plastic drums for liquids
*Plastic drums for solids
*Plastic Jerrican for liquids
*Plastic Jerrican for solids
*Fibre drums for solids
*Boxes
*Plastic bags
*Composite packaging
*Other products
30. Plastics and related products

- Sampling
- Tension tests
- Tear tests
- Burst tests
- Impact tests
- Hardness tests
- Low temperature tests
- Heat distortion tests
- Bend tests
- Shear tests
- Compression tests
- Flammability tests
- Specific gravity
- Ageing and environmental tests
- Wear and abrasion tests
- Flow properties
- Other tests
- Flexible foams
- Rigid foams
- Plastics films
- Pipe and related products
- Decorative laminates
- Cables
- Fibre reinforced plastics products
- Other products

40. Plumbing and drainage fittings

- *Polyethylene (PE) pipes for water supply
- *Unplasticised PVC (UPVC) Pipes For Water Supply
- * Acrylonitrile Butadiene Styrene (ABS) and fittings for Pressure
- Other products

41. Furniture

- Determination of copper, chrome & arsenic content
- Penetration test of copper, chrome & arsenic in treated wood
- Determination of moisture content
- Determination of density
- Determination of boron
- Determination of permethrin
- Determination of cypermethrin
- Other test

42. Force measurements and weighing

- Weight of structures and assemblies
- Centre of gravity of structure and assemblies
- Other test

Metallurgical

43. Microstructural tests on metallic & non-metallic alloys

- Grain size
- Depth of cladding
- Macroscopic examination of wrought products
- Depth of surface defects
- Anodizing thickness
- Proportion of size
- Resistance to stress-corrosion cracking
- Hydrogen embrittlement
- Susceptibility of brass to dezincification
- Case depth of surface defects
- Non-metallic inclusion content
- Macroscopic examination of steels
- Other test

44. Corrosion tests

45. Coatings

- Metallic coatings
- Non-metallic coatings
- Other coatings

46. Elemental Analysis (Non-chemical Method)

- Ferrous
- Non-ferrous
- Metallic materials
**Mechanical Equipment**

47. Cylinders and other pressure vessels
   - Hydrostatic pressure tests
   - Pulsating pressure tests
   - Bomb calorimeters
   - Internal and external examinations

48. Air and gas filters

49. Respiratory protective devices
   - Respirators
   - Underwater breathing apparatus

50. Controlled environments
   - Clean rooms and workstations
   - Biological safety cabinets
   - Fume cupboards
   - Air-conditioning and ventilation systems
   - Other air handling systems

51. Hand tools
   - Open end and adjustable wrenches
   - Torque wrenches
   - Hand hammers
   - Screwdrivers
   - Pipes, pincers and nippers
   - Woodworking saws
   - Axes and hatches
   - Chisels
   - Other hand tools

52. Fans and blowers

53. Compressors

54. Pumps

55. Engines & generators

56. Industrial, earthmoving and agricultural vehicles

57. Cutting tools
   - Twist drills
   - Hacksaw blades

58. Toys and games

59. Sporting and recreational equipment

60. Gas equipment & related products
   - *LPG Cylinder Valve
   - *Gas Regulator –Low Pressure
   - * LPG Tubing (Type 1)
   - Other products

61. Other tests
## Non-Destructive testing (NDT)

1. **Radiographic examination of ferrous metals**
   - Welded joints
   - Castings
   - Forgings
   - Riveted and bolted joints
   - Other specified products

2. **Radiographic examination of aluminium alloys**
   - Welded joints
   - Castings
   - Riveted and bolted joints
   - Other specified products

3. **Radiographic examination of magnesium alloys**
   - Welded joints
   - Castings
   - Other specified products

4. **Radiographic examination of copper alloys**
   - Welded joints
   - Castings
   - Other specified products

5. **Radiographic examination of zinc alloys**
   - Die castings
   - Other specified products

6. **Radiographic examination of nickel, chromium, cobalt alloys**
   - Welded joints
   - Castings
   - Other specified products

7. **Radiographic examination of titanium alloy**
   - Welded joints
   - Castings
   - Other specified products

8. **Radiographic examination of rubber and plastics**

9. **Radiographic examination of timber**

10. **Radiographic examination of other specified non-metals**

11. **Radiographic determination of thickness**
   - Wall thickness and profile radiography
   - Corrosion pitting in pipe

12. **Radiographic examination of bonded metals**
   - Soldered and brazed joints
   - Hard faced components
   - Other specified components

13. **Radiographic examination of metals inserts in non-metals**
   - Reinforcing in concrete
   - Reinforcing in conveyor belts, hoses and other specified rubber products
   - Other specified products

14. **Radiographic examination of assemblies**
   - Machinery
   - Electrical circuitry and components
   - Munitions
   - Other specified assemblies

15. **Radiographic examination of specified dissimilar metals**

16. **Radiographic examination of other specified metals**
   - Extruded products
   - Other wrought products
   - Other specified products

17. **Ultrasonic examination of ferrite steels**
   - Flat rolled products
   - Welded joints
   - Castings
   - Forgings
   - Semi-finished rolled products
   - Other rolled products
   - Other specified assemblies

18. **Ultrasonic examination of austenitic steels**
   - Rolled products
   - Welded joints
   - Castings
   - Forgings
   - Other specified products

19. **Ultrasonic examination of clad steels**
   - Welded joints in clad and overlaid steels

20. **Ultrasonic examination of other specified metals**

21. **Ultrasonic examination of ceramics and refractories**

22. **Ultrasonic examination of rubber and plastics**
   - Rubber products
   - Plastics products
   - Plastics laminates

23. **Ultrasonic examination of timber**
   - Plywood

24. **Ultrasonic examination of other specified non-metals**

25. **Ultrasonic thickness measurement**

26. **Ultrasonic examination of bonded metals**
   - Machine bearings
   - Welded hard facings
   - Friction welded components
   - Other specified components

27. **Ultrasonic examination of finished components in-service**
   - Screw threaded components
   - Gears and splined components
   - Railway lines
28. Ultrasonic examination of specified dissimilar metals

2.9 Acoustic emission testing
   - Fibre composites
   - Other specified materials

30. Magnetic particle testing
   - Magnetic flow method
   - Current flow method
   - Coil method

3.1 Magnetic flux leakage testing by instrumental indication
   - Wire rope

32. Penetrant testing
   - Water washable method
   - Solvent removable method
   - Post emulsifiable method

33. Ultrasonic examination of aluminium alloys
   - Rolled products
   - Welded joints
   - Castings
   - Forgings
   - Other specified tests

34. Underwater non-destructive tests
   - Radiographic examination
   - Ultrasonic examination
   - Ultrasonic thickness measurement
   - Magnetic particle testing
   - Other specified tests

35. In-plant inspection

36. Visual inspection of
   - Rolled products
   - Welded joints
   - Castings
   - Forgings
   - Finished components and assemblies
   - Structure
   - Other specified tests

37. Automated non-destructive testing systems

38. Other specified non-destructive tests

39. Eddy current testing of ferromagnetic materials
   - Surface flow detection
   - Thickness measurement
   - Sorting of materials and components
   - Sub-surface flaw detection
   - Other specified tests

40. Eddy current testing of non-magnetic materials
   - Surface flow detection
   - Thickness measurement
   - Sorting of materials and components
   - Sub-surface flaw detection

41. Visual Inspection
   - Aluminium alloys
     - Welded joints
     - Coatings
     - Other specified surface conditions
   - Ferrous metals
     - Welded joints
     - Coatings
     - Other specified surface conditions
   - Other specified metals
     - Visual inspection of non-metals

42. Surface Methods by penetrant testing (including visible dye and fluorescent dye techniques)
   - Water washable method
   - Solvent removable method
   - Post emulsifiable method

43. Surface Methods by Magnetic flow method
   - Welded joints
   - Forgings
   - Castings
   - Other machined products

44. Surface Methods by Current flow method (specify amps AC/DC)
   - Welded joints
   - Forgings
   - Castings
   - Other machined products

45. Surface Methods by Coil method (specify amps AC/DC)
   - Welded joints
   - Forgings
   - Castings
   - Other machined products

46. Surface Methods by Magnetic rubber method
   - Welded joints
   - Forgings
   - Castings
   - Other machined products

47. Other specified surface techniques

48. Hand Tools
   - Open end and adjustable wrenches
   - Torque wrenches
   - Hand hammers
   - Screwdrivers
   - Pliers, pincers and nippers
   - Woodworking saws
   - Axes and hatchets
   - Chisels
   - Other hand tools
49. Metallographic Tests on Ferrous Materials

- Grain size
- Case depth and depth of decarburisation
- Depth of surface defects
- Non-metallic inclusion content
- Macroscopic examination of steels
- Graphite type and distribution in cast irons
- Corrosion resistance of austenitic stainless steels
- Tests on weld
- Other tests

50. Metallographic Tests on Aluminium and Aluminium Alloys

- Grain size
- Depth of cladding
- Macroscopic examination of wrought products
- Depth of surface defects
- Other tests

51. Coatings

- Metallic coatings
- Conversion coatings
- Organic coatings
- Other coatings

52. Corrosion Tests

53. Servicing of Mechanical Calibration Equipment

54. Other Specified Mechanical Tests
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