Guideline for Accreditation of Bodies Performing Non-Destructive Testing

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Note: The numbering of the clauses is based on the numbering of the current ISO/ISC 17025 and 17020 (to be in line with the so called "high level structure"). Therefore chapters 2, 3 and 5 have been omitted intentionally.

PREAMBLE

Non-Destructive Testing (NDT) methods are commonly used under accreditation according to ISO/IEC 17025 as well as to ISO/IEC 17020, depending on the particular circumstances and requirements.

The paper gives guidelines to a number of aspects ensuring that the requirements and criteria to NDT methods are aligned irrespective whether ISO/IEC 17025 or ISO/IEC 17020 are applied. Central element of the conformity assessment systems is the accredited certification of personnel according to ISO/IEC 17024 as it is described in ISO 9712.

The order of the chapters have been aligned with the common structure of ISO/IEC 17020 and ISO/IEC 17025.

PURPOSE

This publication provides guidance for accreditation bodies as well as for bodies carrying out NDT as an accredited activity or seeking accreditation, for testing and inspection purposes.

AUTHORSHIP

The publication has been derived from (EA-4/15:2015), which had been prepared jointly by the Laboratory Committee and the Inspection Committee of the European Co-operation for Accreditation. The ILAC Inspection Committee together with the AIC were appointed to check and approve the document as an ILAC Guidance.

This document currently refers to ISO/IEC 17025:2017 and ISO/IEC 17020:2012.

1. INTRODUCTION

Non - Destructive Testing (NDT) bodies may be accredited against the requirements of ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories* or ISO/IEC 17020, *Conformity assessment - Requirements for the operation of various types of bodies performing inspection.*
Whichever route is chosen the accreditation is carried out against the same technical criteria.

This paper addresses the three-tier personnel certification model that is fundamental to NDT, along with the expectation that testing personnel should hold certification that is specific to the particular NDT methods of interest. It makes explicitly reference to those particular technical functions associated with the company's Level 3 resources, which are generally expected to be defined within any credible NDT operation.
And there are some circumstances where ISO 9712 certification may not be the only valid option in regard to personnel certification. This is because not every ISO 9712 certification scheme provides the degree of sector/product/method specialisation which might be warranted in specific circumstances. It is recognised that in some circumstances there can be legitimate alternatives to ISO 9712, including employer-based schemes such as described for example in EN 4179, provided that certain controls have been defined for ensuring both the integrity of any employer-based qualification scheme and the credentials of the administering Level 3.

A body accredited for performing NDT under ISO/IEC 17025 or ISO/IEC 17020 may perform and report on the following activities: testing to appropriately defined standards and procedures, interpretation of test results against the agreed acceptance standard, determination of conformity and determination of significance of defects found, based on results.

Note: Determination of significance of defects found is to be considered as an opinion or interpretation, and according with ISO/IEC 17025 clause 7.8.7. The laboratory shall document the basis upon which the opinions and interpretations have been made (7.8.7.1).

This publication provides in its annexes guidance for bodies carrying out non-destructive testing as an accredited activity or seeking accreditation, for testing or inspection purposes using, for example, the most used NDT methods:

Eddy Current Testing (ET),
Liquid Penetrant Testing (PT),
Magnetic Particle Testing (MT),
Radiographic Testing (RT),
Ultrasonic Testing (UT).

This paper carefully addresses special aspects of calibration, verification and other methods of quality control in NDT.

Note: visual testing and other NDT testing (like acoustic emission, leak testing etc.) are not included in separate appendices of this document.

This guidance should be used as complement to the standards (ISO/IEC 17025 or ISO/IEC 17020).

In some specific situations specialised expertise may be required to ensure testing/inspection at the level of precision demanded by individual test/inspection, e.g. remote access eddy current and ultrasonic inspection. It is not intended to indicate all such topics in this publication, but they will be taken into account during the assessment.

All the sections of the document are applicable for NDT accredited bodies whether the accreditation is against ISO/IEC 17025 or ISO/IEC 17020, even where there is reference just to clauses of one of the standards (see also ILAC G27:2017-06 - Guidance on measurements performed as part of an inspection process).

Note: Although this document is guidance, as there are mandatory requirements in NDT standards, those requirements are identified by the term "shall".

4. GENERAL AND STRUCTURAL REQUIREMENTS

(4, 5 ISO/IEC 17025; 4, 5 ISO/IEC 17020)

The body shall ensure the integrity of staff involved in NDT test/inspection work and that staff are free from all pressures which might affect their impartiality and affect their judgement.

Due to the nature of NDT the body shall consider the impact on the body of errors and omissions in testing when considering liability insurance.

6. RESSOURCES

6.1 PERSONNEL

(6.2 ISO/IEC 17025; 6.1 ISO/IEC 17020)

The management shall define the minimum levels of qualification and experience necessary for the related staff within the body.

In all instances the body is required to demonstrate that the personnel qualifications specified in the standard / customer specification / applicable regulations are met. All certificates of personnel shall be valid.

The person(s) responsible for NDT shall hold a level 3 certification and, whenever available, issued by an accredited certification body against ISO/IEC 17024 to ISO 9712, for all NDT methods included in the scope of accreditation. Where the person who performs monitoring is not in the full-time employment of the body or the in-house level 3 certification does not cover all methods, the body shall have contracts with a person or with persons with needed competence for the sufficient monitoring.

This applies, as a minimum, in relation to the common NDT methods i.e. radiographic testing, ultrasonic testing, eddy current testing, magnetic particle testing and liquid penetrant testing (as described in this document before).

If level 3 certification issued by an accredited certification body is not available, may be considered as acceptable, in the absence of other requirements, a level 3 certification issued by the organisation under a recognized certification framework and approved by an independent body. Such body should not have commercial or other interest in the organisation to be assessed and shall involve persons holding ISO 9712 (or equivalent) level 3 qualifications in all relevant methods.

The person(s) responsible for NDT shall be responsible as a minimum for following activities:

- Authorization of NDT personnel as competent to perform specific inspections/tests and/or to release results;
- Approving test procedures and validating methods;

Note: According to ISO 9712 (see clause 6) the level 3 inspector is the formal authority for validation of the test procedure. Personnel of level 2 may be authorized to test and supervise routine test procedures according to testing standards or NDT work instructions. Level 1 personnel may be authorized to perform tests under supervision of personnel of level 2 or 3.

- Management of the in-house NDT competency program. The in-house competency program shall include job-specific training needed before authorization and procedures for regular controlling of the proficiency of personnel.

Personnel performing NDT should have qualifications from an accredited certification body meeting the requirements of ISO 9712 or of a standard that can be demonstrated to be equivalent to ISO 9712 are acceptable.
It is accepted that there are some circumstances where ISO 9712 certification may not be the only valid option in regard to personnel certification (e.g. in aviation industry or manufacturers having special unique expertise). Where personnel are qualified using an employer based scheme (or a mandatory legal or governmental scheme), the body is required to demonstrate that such arrangements for training and certification comply with recognised schemes, as appropriate approved by an independent body as established above for persons responsible for NDT. Irrespective of the base qualification chosen the body is required to demonstrate that NDT personnel used for inspection and testing have the knowledge, training, education and experience in the type of discontinuities, which may occur during manufacture, and /or use of the plant examined.

In the absence of suitable certification arrangements it may be necessary to establish qualification schemes (in-house or externally) e.g. UT testing for highly attenuative materials.

If personnel are responsible for the determination of significance of discontinuities found, based on test results they shall, in addition to the appropriate qualifications, experience, training and satisfactory knowledge of the examinations carried out, also have:

- Relevant knowledge of the technology used for the manufacture of the items tested (materials, products etc.) or the way they are used or intended to be used and of the discontinuities, defects or degradations which may occur during use;
- Knowledge of the general requirements expressed in the relevant legislation, codes, standards and specifications and an understanding of the significance of discontinuities or defects found with regard to the normal use of the items, material, product etc. concerned.

Bodies shall have formal documented arrangements for maintaining up-to-date records of all staff qualifications, training and competencies including eyesight checks as specified by the relevant personnel certification scheme. Records shall clearly identify whether staff can interpret the results in addition to carrying out examinations.

Where staff is contracted the body shall ensure that such personnel are competent, carry appropriate personnel certification, are effectively monitored and that they work in accordance with the bodies quality management system using bodies equipment and procedures.

The body shall check that the qualification and certification of NDT personnel is appropriate for the test/inspection to be carried out. This should include checking any limitations in the scope of competence certified and the resulting need for job specific training and authorisation.

Bodies are responsible for ensuring that staff has all the other relevant competencies, e.g. safety training, necessary for the performance of their duties.

Monitoring of staff shall include the on-site observation of personnel actually testing/inspecting both at any permanent facility and in a remote facility. This assists the body in establishing whether the inspector's knowledge of the plant or component that they are examining and the environment in which they are working is sufficient to enable the operator to perform their activities effectively and safely. It also enables the body to establish that personnel are working to procedures and agreed client's requirements.

6.2. EQUIPMENT AND METROLOGICAL TRACEABILITY

(6.4 to 6.5 ISO/IEC 17025; 6.2 ISO/IEC 17020)

As part of its quality management system, a body is required to operate a programme for the maintenance and calibration of equipment used for testing/inspection.
Note: The clear requirements regarding using the equipment are stated in ISO/IEC 17025 and ISO/IEC 17020.

6.2.1 Equipment

Equipment shall be protected as far as possible from deterioration and abuse. Equipment that is moved from one location to another should, where relevant, be checked verified according to a defined procedure that it conforms to specified requirements before use. Precautions shall be taken to ensure that, after transportation to a site, testing equipment remains in a serviceable state and that the calibration remains valid. Appropriate checks shall be performed on site to confirm calibration status before testing commences.
The body shall ensure that applicable legal provisions for the transportation of NDT equipment are met.

Equipment records shall be maintained up-to-date and include a list of all reference blocks, probes etc. held by the body.

Equipment includes:

- Standards: Devices (calibration block, reference block, etc.) with a known or assigned correctness.

- Calibration standards/blocks: Pieces of material of specified composition, heat treatment, geometric form and surface texture, by means of which the performance of NDT equipment can be assessed and calibrated for the examination of material of the same general composition.

- Reference standards: An aid to interpretation in a form of a test piece of the same nominal composition, significant dimensions and shape as a particular object under examination. Such test pieces may or may not contain natural or artificial imperfections. Such an imperfection is of predetermined dimensions, usually a notch or hole, used for the sole purpose to establish the best sensitivity of the NDT equipment.

6.2.2 Calibration and other Measures to demonstrate the Fulfilment of Equipment with Specified Requirements

The calibration of reference standards or measuring equipment used for in-house calibration or function check of NDT instruments, shall be traceable to (inter)national standards and, wherever possible, shall be evidenced by certificates issued by an ISO/IEC 17025 accredited calibration laboratory or a National Metrology Institute (NMI) in line with ILAC P10. The policy of metrological traceability has to be in line with ILAC P10.

Note: Function check is a measurement of at least one point in a range of a measuring instrument or system or material against a known value to confirm that it has not deviated significantly from its original calibrated value. It is also an examination of the condition of an artifact to determine that it has not been adversely affected by constant use.

Where in-house calibration or function check methods are adopted, the body shall have the necessary resources consistent with the accuracy required, and with any standard specifications relevant to the calibration/function check concerned.

Procedures for in-house calibration shall be adequately documented by work instructions. These work instructions shall thoroughly describe step by step the calibration procedure and shall be directly related to (inter)national calibration standards. Equipment records shall clearly define calibration intervals, which have to be in accordance with the calibration program. The required action shall be taken when the calibration results show an exceeding of the pre-determined limits of the accuracy of the instrument under calibration. Records of in-house calibrations shall be maintained (including details of the numerical results, date of calibration and other relevant observations).

Specific requirements on equipment calibration/function check and their intervals for various test disciplines are given in Appendices A to E.

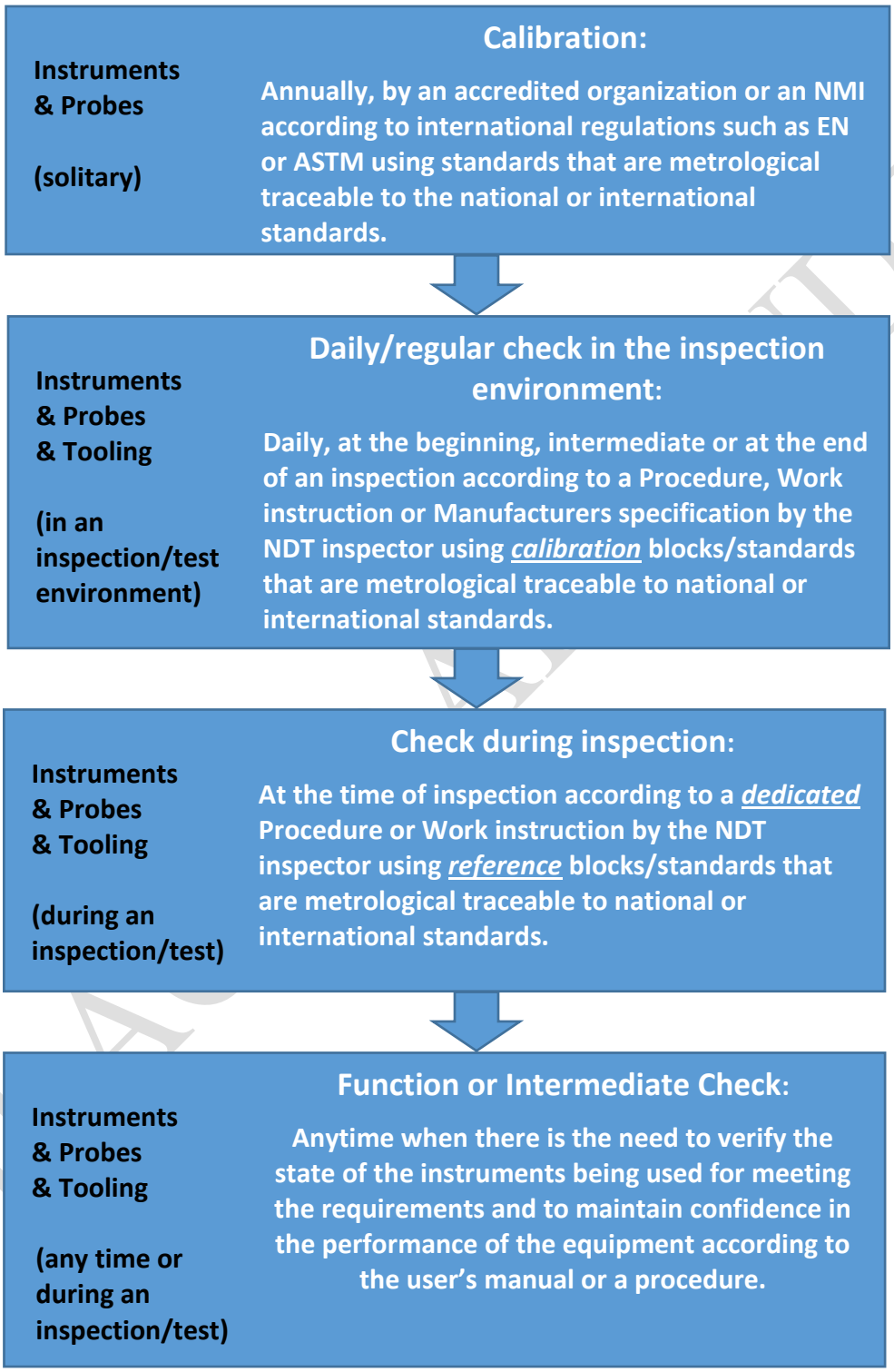
Currently the terminology for calibration and other means of quality control measures of the equipment mentioned above can represent different meanings. This terminology shall be harmonized. Fig. 1 gives an overview.
Applicable definitions of the VIM are reprinted in annex F.

Calibration intervals of NDT instruments and probes are often prescribed/advised by normative requirements like e.g. ISO 3059 (Non-destructive testing - Penetrant testing and magnetic particle testing – Viewing conditions) or EN 12668-1 (Non-destructive testing - Characterization and verification of ultrasonic examination equipment - Part 1: Instruments). If there are no given requirements intervals shall be defined by the user. Adjustment of the calibration intervals should be possible in order to optimise the balance of risks and costs due to a number of reasons, for example:

- Instruments may be less reliable than expected
- The usage may not be as anticipated
- It may be sufficient to carry out a limited calibration of certain instruments instead of a full calibration.

382 – The drift determined by the recalibration of the instruments may show that longer
383 calibration intervals may be possible without increasing risks.
384
385 Records of all calibrations/function checks shall be documented and retained and shall include
386 certificates providing evidence of traceability to (inter)national standards where required.
387

Fig. 1 Ensuring the Validity of Results of the NDT Equipment



Note: Not all parts of the figure are applicable to all methods. So, for example, for RT annual calibration is not relevant.

6.3 EVALUATION OF MEASUREMENT UNCERTAINTY

(7.6 ISO/IEC 17025)

Measurement uncertainty is determined by the equipment and procedures used but may also be affected by parameters such as the material, shape and surface finish of the object under test together with the shape and acuity of the defect. It shall be done according to the requirements of ISO/IEC 17025.

Formal evaluation and reporting of measurement uncertainty is not required for qualitative or semi quantitative tests, or for tests in which qualitative components are the major components of uncertainty. However, where situations arise that require compliance assessment in accordance with numerical test result criteria, measurement uncertainty must be considered. The body shall have written procedures for determination of measurement uncertainties for all quantitative tests performed(e.g. thickness measurement techniques and optical material density measurements).

For qualitative or semi-quantitative tests it is expected that body identifies those factors which contribute to uncertainty, to rank these based on significance and then take action to control them as far as is possible.
The acceptance criteria shall be in line with the measurement uncertainty. Acceptance criteria below the measurement uncertainty level should not be used.

7. PROCESS REQUIREMENTS

7.1 SELECTION, VERIFICATION AND VALIDATION OF METHODS

(7.2.1 ISO/IEC 17025; 7.1 ISO/IEC 17020)

Accreditation bodies will only accredit bodies for tests/inspections which have been fully documented and validated. These may include national and international standard methods, client and in-house methods. The accredited body shall satisfy itself that the degree of validation of a particular technique is adequate for its purpose. The body should justify using in-house method if there is a standard method.

Bodies are required to have documented procedures supplemented, where necessary, with detailed written instructions or techniques. Wherever possible the body shall use standardised procedures and techniques. The control and authorisation levels of these documents shall be covered in the body document control procedures.

Approval of procedures, i.e. in-house body procedures, shall only be undertaken by qualified personnel authorised by body, as stated on section 6 (Personnel). In certain circumstances, e.g. for UT testing of austenitic steels or Inconel the person approving the procedures may need to have specific knowledge of the type of inspection.

The body shall maintain a list of all those considered competent to approve procedures or test/inspection instructions.

Approval of techniques, i.e. in-house body written instructions, shall only be undertaken by qualified personnel authorised by the body.

Where the body finds it necessary to produce written instructions or to describe non-standard test methods the guidance given in Appendix F should be followed.

For specific applications procedures may be developed which incorporate non-standard inspection methods. Procedures developed in-house shall be validated and authorised before use. The body shall be able to provide objective evidence of the validation of the process. Design of the test should be such as to maximise the likelihood of detecting the defects of specific interest. When no validation for defects detection is available, it may be difficult to be confident that an inspection detects all potentially significant defects.

Developments in methodology and techniques may require procedures and techniques to be changed from time to time. Obsolete procedures and techniques should be withdrawn and should be retained for archive purposes and clearly labelled as obsolete. Procedures and techniques must indicate the body's representative who authorised its use and from what date.

The body shall be aware of any limitations of general procedures based on national standards and shall declare and / or report such limitations to the client if the specified procedures have not been demonstrated to be able to achieve the required level of reliability expected by the client.

7.2 ENSURING THE VALIDITY OF RESULTS

(7.7 ISO/IEC 17025)

An accredited body must have quality control activities to assess testing/inspection competency. Quality assurance in tests must be done in accordance with the requirements of ISO/IEC 17025.

The scope of the facility's plan for such external competency assessment is complementary to the in-house competency assessment of personnel, which should be based on the use of test specimens with known defects.

Bodies must ensure that any test specimens used are adequately validated and where it is impractical to provide a suitable range of test specimens, for example due to the nature of testing undertaken, alternative arrangements may be considered. In such cases, items available for testing in the normal course of the facility's operations may be tested by the candidate to be assessed, under monitoring, and then subsequently re-tested by a person authorized by the body for this purpose. This has to be part of routine internal quality control.

Each applicant or accredited body is required to participate in appropriate proficiency testing, as broad a range as practicable and available, considering the representativeness of major areas of test and different techniques.

7.3 CONTROL OF RECORDS

(7.5 and 8.4 ISO/IEC 17025; 7.3 and 8.4 ISO/IEC 17020)

Documented records shall be maintained of all actions and decisions made during the course of the testing/inspection process. These should typically include:

- contract review,
- change decisions,
- equipment records including servicing and repair,
- details of equipment used, process checks,
- calculations,
- location and detail of observed defects,
- copies of test/inspection reports.

7.4. REVIEW OF REQUESTS; TENDERS ANS CONTRACTS

(7.1 ISO/IEC 17025; 7.1.5 ISO/IEC 17020)

The process of contract review is assisted by the client providing a clear description of the range and type of defects to be detected and defining the client requirements (any test or acceptance criteria to be met) and risks.
The acceptance criteria and the particular defect characteristics (dimensions) should have a close relation with the measurement uncertainty (where applicable). No defect dimensions smaller than the measurement uncertainty shall be part of the requirements.

The contract review shall include as applicable:

- That the body has the necessary resources, equipment, qualified personnel to undertake the NDT work;
- Identification of the test/inspection method;
- Identification of any acceptance criteria;
- Any specific qualification requirements e.g. for non-standard test methods or high integrity testing;
- Any client approval requirements (particularly for non-standard methods);
- That the qualification and certification of NDT personnel is appropriate to the inspection to be carried out (This should include checking any limitations in the scope of competence certified and the resulting need for job specific training and authorisation);
- Any specific handling instructions for highly machined components;
- Any specific marking instructions, e.g. use of halogen free markers;
- Any specific reporting requirements including documentation requirements;
- Availability of drawings, inspection plans/programmes;
- Any specific quality control/monitoring arrangements;
- Client acceptance of any necessary sub-contracting.

Where activities on site are involved the review shall also include issues such as:

- Responsibility for removal of any cladding or coatings and preparation of the surface for testing;
- Access arrangements, working conditions and provision of stable working platforms;
- Hazards;
- Environmental requirements.

On completion of the review process the contractual responsibilities of both purchaser and supplier should be clear when contracts are placed.

7.5 HANDLING OF ITEMS AND COMPONENTS

(7.4 ISO/IEC 17025; 7.2 ISO/IEC 17020)

Items to be tested/inspected shall be identified such that traceability is maintained throughout the examination process. Identification shall be such that the areas specifically examined, e.g. welded seams can be precisely identified against test/inspection results.

The method of identification shall not damage the item in question, e.g. halogen free markers may be needed for some components.

Methods for the identification and location of reportable defects and, where appropriate, for the segregation of defective components should be clearly defined and understood.

The status of the test item (e.g. *accepted*, *rejected*, *tested*, *not tested*) shall be clearly indicated at all times.

7.6 REPORTING

(7.8 ISO/IEC 17025; 7.4 ISO/IEC 17020)

Clear and accurate reporting is essential. Where results from sub-contracted tests are included these must be clearly identified.

Sampling is often involved as part of the inspection. Reports must indicate the sampling basis (personnel, plan, procedures) where these are relevant to the validity or application of the results. .

Reports shall identify any factors which have prevented the inspection from being carried out as intended, e.g. restricted access, inadequate surface finish, surface temperature etc. Also, reports shall contain identification of the locations where the NDT testing has been applied.

8. MANAGEMENT REQUIREMENTS

(8. ISO/IEC 17025; and 8. ISO/IEC 17020)

The quality system shall describe the general and specific arrangements for the conduct of all accredited activities including non-destructive testing and should specifically incorporate:

- the arrangements for managing NDT work including the organisational interface and controls between the permanent facilities and remote or site locations;
- the control and authorisation of NDT specific procedures and techniques;
- the need to ensure that inspection procedures and techniques are available at the point of inspection, whether in the laboratory or on site;
- the need for audit and review to include remote locations and the interface controls.

Detailing particular aspects applicable to NDT which should to be examined during an internal audit is listed in Appendix H.

Management reviews should include NDT specific items such as suitability of personnel certification schemes and arrangements for managing site activities.

9. BIBLIOGRAPHY

Relevant list of documents at time of publication.

ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
ISO/IEC 17020	Conformity assessment - Requirements for the operation of various types of bodies performing inspection
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
ILAC P10	ILAC Policy on the Traceability of Measurement Results.
ILAC P15	Application of ISO/IEC 17020:2012 for the Accreditation of Inspection Bodies
ILAC G27	Guidance on measurements performed as part of an inspection process
VIM (BIPM JCGM 200:2012)	International vocabulary of metrology – Basic and general concepts and associated terms

APPENDICES

The appendices A to E contain specific guidance on equipment calibration /function check and equipment calibration/ function check intervals for each of the test methods covered by this document.

These appendices assume that testing/inspection is to be carried out to a specified international or national standard. Where such a standard has not yet been published, other specifications may be used until the relevant standard is published. If clients require testing to be carried out to other specifications, then the requirements of those specifications should be met in full. In the absence of specific guidance, the requirements of this Appendix may be adopted.

The responsibility for determining calibration intervals lies with the body carrying out the tests that shall ensure that they satisfy the requirement of the test specification and any specific client requirements. Inevitably different standards have slightly differing requirements. It is the responsibility of the body responsible for performing the inspection to ensure that the detailed requirements of those standards are met in full.

It is the responsibility of the body carrying out the inspection to ensure that the calibrations or function checks are carried out against the latest version of the appropriate standard unless specifically requested otherwise by the client. In both cases the requirements shall be met in full.

Appendix F reflects some relevant definitions taken from the International Vocabulary on Metrology (VIM).

Appendices G and H give guidance on management system activities.

678 ***APPENDIX A***
679
680 **Radiographic Equipment ("RT-equipment") - calibration and calibration intervals**
681
682 Focal characteristics shall be monitored for any significant changes.
683
684 The sensitivity of a radiograph shall be established by means of Image Quality Indicators (IQI) or
685 penetrameters appropriate to the material and thickness. It is necessary to hold manufacturer's
686 certificates of conformity for these IQIs. The condition of IQIs and penetrameters should be
687 monitored and damaged devices withdrawn from use.
688 Where digital radiographic equipment are used, the laboratory shall if relevant ensure that the
689 computerised results are Digital Imaging and Communication in Non-Destructive Examination
690 (DICONDE) compliant (reference to ASTM E 2339).
691
692 The type and location of the IQI or penetrometer shall be strictly in accordance with the
693 requirements of the agreed standard or code.
694
695 Radiographic film processors should be maintained in accordance with the manufacturer's
696 recommendations. Regular monitoring of the processor using pre-exposed film should take place
697 to ensure the correct operation of the processor and to verify that any film classification system
698 requirements are met.
699
700 The density of radiographs shall be ascertained using densitometers. The accuracy required
701 determines whether analogue or digital readouts are needed.
702
703 Densitometers shall be calibrated at defined intervals against a reference density strip or set of gray
704 filters of known (calibrated) densities. Hand-held densitometers should be zeroed each time they
705 are used, against the level of background illumination on which they are to be used.
706 The calibration of reference measuring equipment used for in-house calibration of NDT related
707 instruments and probes shall be traceable to (international) standards and shall be evidenced by a
708 certificate, issued by a body in accordance with the ILAC P10 policy.
709 *Intermediate Checks to establish that the densitometer is still operating correctly and is in*
710 *calibration shall be carried out between calibrations.*
711
712 Radiation safety meters shall be calibrated at defined intervals to ensure accuracy to check
713 personnel, equipment and facilities for radioactive contamination or to measure external or ambient
714 ionizing radiation fields to evaluate the direct exposure hazard to personnel.
715
716 Reference film density strips shall be uniquely identified and traceable by certificate to a
717 (inter)national standard of measurement and should carry a manufacturer's certificate which is less
718 than five years old unless otherwise specified.
719
720 Working density strips should have the density of each step ascertained using a calibrated and
721 certificated densitometer, and recorded either directly into the film or onto a card strip permanently
722 attached to the film. The date of first calibration should be recorded on the strip. All working
723 density strips which are more than three years old, or which have been subject to undue wear,
724 should be taken out of use and destroyed. The strips have to have valid certificates.

Film density strips are subject to discolouring or fading and should be carefully maintained and stored.

Radiographic viewers and illuminators shall be checked for intensity and eveness of illumination at such intervals to exclude any deterioriation or decay that may inversely effect the inspection result.

Controlling Radiographic Quality in RT

One of the methods of controlling the quality of a radiograph is through the use of image quality indicators (IQIs). IQIs, which are also referred to as penetrameters, provide a means of visually informing the film interpreter of the contrast sensitivity and definition of the radiograph. The IQI indicates that a specified amount of change in material thickness will be detectable in the radiograph, and that the radiograph has a certain level of definition so that the density changes are not lost due to unsharpness. Without such a reference point, consistency and quality could not be maintained and defects could go undetected.
Image quality indicators take many shapes and forms due to the various codes or standards that invoke their use. IQIs come in a variety of material types so that one with radiation absorption characteristics similar to the material being radiographed can be used.

APPENDIX B

Ultrasonic Equipment ("UT-equipment") - calibration and calibration intervals

Ultrasonic calibration blocks where applicable shall be used to set up the assembly of probe and sensory electronics, each time the equipment is used. The blocks shall be manufactured in accordance with the appropriate specification.
Those blocks, such as e.g. the International Institute of Welding (IIW, Type 1 or Type 2) block, are used to set up the assembly of probe and sensory electronics. It is used for the calibration of the ultrasonic instrument to adjust linearity of timebase, linearity of equipment gain, sensitivity, S/N ratio and pulse duration.
All calibration blocks shall be verified at specified intervals as follows:

- visual examination for deterioration such as corrosion or mechanical damage,
- radius and other dimensional checks using equipment traceable to national or international standards.

Where calibration blocks made from the material of the product under test are used for setting up, the final test report should indicate the calibration status of the test blocks. In all such cases the transmission velocity of the pulse through the block material shall be measured and recorded, unless the body has alternative methods to demonstrate the traceability of the block.
As applicable, manufacturing history of these blocks shall be available for at least five years after the last period of use.
The correct functioning of testing units, probes and connecting cables shall be checked at regular intervals; the results shall be documented. Verification shall be against the controlling specifications.

The ultrasonic test sets shall be periodically checked by the NDT inspector for compliance with the manufacturer's specifications, including:

- linearity of time base,
- linearity of equipment gain,
- sensitivity and signal to noise ratio,
- pulse duration.

The ultrasonic probes and systems shall be daily or before use checked by the NDT inspector for compliance with the manufacturer's specifications, including:

- probe index,
- probe beam angle,
- visual checks for damage.
-

Note: angle beam probes that exceed 2 degrees variation of the described angle shall be replaced.

Ultrasonic flaw detectors shall be calibrated at intervals not exceeding twelve months in accordance with the controlling specification, including:

- linearity of time base,
- linearity of amplifier and

- accuracy of calibrated attenuator.

The calibration of reference measuring equipment used for in-house calibration of NDT related instruments and probes shall be traceable to (international) standards and shall be evidenced by a certificate, issued by a body in accordance with the ILAC P10 policy.
Testing units, probes and connecting cables should be carefully stored. Reference blocks, and calibration blocks should be stored in such a way as to prevent corrosion occurring.

Where automated test equipment is used, special attention shall be paid to the qualifications and training of operators, the system for the identification of defects, and data storage. Checks should be made to ensure the correct geometric position of the probe in relation to the output signal.

In ultrasonic testing, several types of calibration must be carried out.

- It is usually necessary for the operator to perform a "user calibration" (“system check” acc. to e.g. EN 12668-1 to -3) of the equipment. This user calibration is necessary because most ultrasonic equipment can be reconfigured for use in a large variety of applications. The user must "calibrate" the system, which includes the equipment settings, the transducer, and the test setup, to validate that the desired level of precision and accuracy are achieved. This calibration is usually performed by the user/operator/inspector according to the operating manual, the procedure or work instruction and using a calibration standard/block.

- The term calibration standard/block is usually only used when an absolute value is measured and in many cases, the standards are traceable back to the International Standard.

- In ultrasonic testing, there is also a need for reference standards. There are requirements laid down in international standards for the quality/ traceability of the calibration standards/blocks and reference standards.

Reference standards are used to establish a general level of consistency in measurements and to help interpret and quantify the information contained in the received signal. Reference standards are used to validate that the equipment and the setup provide similar results from one day to the next and that similar results are produced by different systems. Reference standards also help the inspector to estimate the size of flaws. The inspector can use a reference standard with an artificially induced flaw of known size and at approximately the same distance away for the transducer to produce a signal. By comparing the signal from the reference standard to that received from the actual flaw, the inspector can estimate the flaw size.

There are other standards available and these specially designed standards may be required for many applications. Any other terminology as mentioned in this document used for a calibration and/or a reference standard shall be clearly explained when used.

Calibration standards/blocks and reference standards for ultrasonic testing are available in many shapes and sizes. The type of standard used is dependent on the NDT application and the form and shape of the object being evaluated. The material of the reference standard should be the same as

836 the material being inspected and the artificially induced flaw should closely resemble that of the
837 actual flaw.

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APPENDIX C

Magnetic Particle equipment - calibration and calibration intervals

Magnetic probes, prods of alternating current must be capable and verified of lifting 10 lbs of weight
Magnetic probes, prods of direct current must be capable and verified of lifting 40 lbs of weight

There must be a procedure to "demagnetize" tested items when such magnetization will affect the products usefulness. To demagnetize a part, the current or magnetic field needed must be equal to or greater than the current or magnetic field used to magnetize the part.

The solids content of bulk magnetic inks should be checked by a method specified in the controlling standard. In the case of aerosols, certificates of conformity shall be obtained from the manufacturer for each batch.
Note: ISO 9934-2 (Non-destructive testing – Magnetic particle testing – Part 2: Detection media) determines in service tests of aerosol material.

When using fluorescent inks and powders:

(a) the intensity of UV(A) light at the test surface shall be checked as frequently as necessary to monitor possible deterioration of the illumination. (Where grimy, dusty or other contaminating environments are involved, checking shall be carried out each time the equipment is used.) These checks require the use of a calibrated UV (A) light meter.
(b) the ambient white light level shall be checked at least once every three months where illumination is controlled on a long term basis, and should be checked each time the equipment is used in situations where illumination may vary from test to test (e.g. in daylight conditions). These checks require the use of a calibrated white light meter. The calibration intervals should not exceed 12 months.

When using non-fluorescent inks and powders, the level of illumination at the inspection surface should be checked at regular intervals where illumination is by artificial means, and should be checked each time the equipment is used where daylight illumination is employed. These checks require the use of a calibrated white light meter. The calibration intervals should not exceed 12 months.

The apparatus and ancillary equipment shall be checked at regular intervals.
Magnetic field meters shall be calibrated at defined intervals. The calibration intervals should not exceed 12 months.
The strength of permanent magnets and magnetic yokes shall be checked at regular intervals.
Flux indicators should be used to demonstrate the direction of flux. Traceability is not required.

Tests to check the sensitivity of the indications looked for should be carried out using suitable test pieces. Such test pieces have properties like the same material composition, size, (artificial) defects, magnetic properties, heat treatment, suface finish, etc. as the part to be inspected.

The calibration of reference measuring equipment used for in-house calibration of NDT related instruments and probes shall be traceable to (international) standards and shall be evidenced by a certificate, issued by a body in accordance with the ILAC P10 policy.

System Performance Check in MT
Particle Concentration

The concentration of particles in the suspension is a very important parameter in the inspection process and must be closely controlled. The particle concentration is checked after the suspension is prepared and regularly monitored as part of the quality system checks. Concentration checks (the word check in this context means that the conditions are measured and when these conditions do not comply with the demands a correction or an adjustment will be carried out) may be required to be performed every eight hours or at ever shift change.
The standard process used to perform the check requires agitating the carrier for a specified minimum of time to ensure even particle distribution. A sample is then taken in a pear-shaped centrifuge tube having different stems for fluorescent particles and visible particles. The sample is then demagnetized so that the particles do not clump together while settling. The sample must then remain undisturbed for a specified minimum time, unless shorter times have been documented to produce results similar to the longer settling times. The volume of settled particles is then read. Acceptable ranges for fluorescent particles and for visible particles must be specified. If the particle concentration is out of the acceptable range, particles or the carrier must be added to bring the solution back in compliance with the requirement.
Particle loss is often attributed to "dragout." Dragout occurs because the solvent easily runs off components and is recaptured in the holding tank. Particles, on the other hand, tend to adhere to components, or be trapped in geometric features of the component. These particles will be "drug out" or lost to the system and will eventually need to be replaced.

Particle Condition

After the particles have settled, they should be examined for brightness and agglomeration. Fluorescent particles should be evaluated under ultraviolet light and visible particles under white light. The brightness of the particles should be evaluated weekly by comparing the particles in the test solution to those in an unused reference solution that was saved when the solution was first prepared. The brightness of the two solutions should be relatively the same. Additionally, the particles should appear loose and not lumped together. If the brightness or the agglomeration of the particles is noticeably different from the reference solution, the bath should be replaced.

APPENDIX D

Liquid Penetrant Equipment - calibration and calibration intervals

The penetrant shall be suitable for the intended application and meet the requirements of ISO 3452-2 *(Non-destructive testing – Penetrant testing – Part 2: Testing of penetrant materials)*. A specific statement by the manufacturer is required, but this may be in the form of a letter, certificate, technical leaflet, or may be included in the labelling of the product.

When undertaking fluorescent penetrant examination, the intensity of UV (A) light illumination at the inspection surface shall be checked as frequently as necessary to monitor possible deterioration of the illumination. (Where grimy, dusty or other contaminating environments are involved, checking should be carried out each time the equipment is used). These checks require the use of a calibrated UV (A) light meter.

When non-fluorescent (i.e. colour contrast) penetrant examination is carried out, the intensity of illumination at the inspection surface shall be checked at least once every three months where illumination is controlled on a long term basis, and should be checked each time the equipment is used in situations where illumination may be variable from test to test (e.g. in daylight conditions). These checks require the use of a calibrated white light meter.

Standard flaw test pieces should be used to check the process. The use of test pieces is not normally specified for portable test kits.

The temperatures of baths and water washes should be monitored. Where the temperature of the test item is close to specification limits then the temperature of that item should be measured.

The pressure of water washes and compressed air blow-offs should be measured where values are specified in testing standards or procedures.

The calibration of reference measuring equipment used for in-house calibration of NDT related instruments and probes shall be traceable to (international) standards and shall be evidenced by a certificate, issued by a body in accordance with the ILAC P10 policy.

System Performance Check in PT

System performance checks involve processing a reference (test) specimen (panel) with known defects to determine if the process will reveal discontinuities of the size required. The specimen must be processed following the same procedure used to process production parts. A system performance check is typically required daily, at the reactivation of a system after maintenance or repairs, or any time the system is suspected of being out of control. As with penetrant inspections in general, results are directly dependent on the skill of the operator and, therefore, each operator should process a panel.

The ideal specimen is a production item that has natural defects of the minimum acceptable size. Some specifications mention the type and size of the defects that must be present in the specimen and to be detected. Surface finish affects the washability so the reference specimen should have

the same surface finish as the production parts being processed. If penetrant systems with different sensitivity levels are being used, there should be a separate reference specimen for each system.

There are some universal reference specimens that can be used if a standard part is not available. The most commonly used reference specimen is the TAM or PSM panel. These panels are usually made of stainless steel that has been chrome plated on one half and surfaced finished on the other half to produce the desired roughness. The chrome plated section is impacted from the back side to produce a starburst set of cracks in the chrome. There are five impacted areas to produce range of crack sizes. Each panel has a characteristic signature and variances in that signature are indications of process variance. Panel patterns as well as brightness are indicators of process consistency or variance.

Care of system performance check reference panels is critical. Panels should be handled carefully to avoid damage. They should be cleaned thoroughly between uses and storage in a solvent is generally recommended. Before processing a panel, it should be inspected under UV light to make sure that it is clean and not already producing an indication.

APPENDIX E

Eddy Current Equipment - calibration and calibration intervals

A list of all reference blocks, control specimens, reference pieces and calibration blocks should be kept with details of the main characteristics: (e.g. material, conductivity, manufacture, heat treatment).

For portable equipment, a reference or calibration block, dimensionally certified by the manufacturer for dimensional (including surface roughness) and material properties (such as alloy, heat treatment, electric conductivity permeability) should normally be used for checking the response of the equipment to known flaws. For specialised applications, such as tube testing, reference standards should be prepared from material of the same alloy and nominal dimensions as the product to be tested. The dimensions of holes or notches and the thickness of the calibration piece shall be certified by the manufacturer or established in-house by means which are traceable to national standards. Wear on the testing face may reduce the thickness of the sensitivity block or calibration piece and hence the slot depth.

For automatic eddy current testing of tubes, reference standards should be prepared from material of the same alloy and nominal dimensions as the tube to be tested. The dimensions of holes or notches and the thickness of the calibration piece shall be certified by the manufacturer or established in-house by means which are traceable to (inter)national standards. Wear on the testing face may reduce the thickness of the sensitivity block or calibration piece and hence the slot depth.

Where eddy current examination is used for sorting of materials or products, reference test standards shall be prepared from the same material, heat treatment and nominal dimensions as the materials or products to be tested.

Reference test standards shall be carefully maintained and shall not be used as working standards.

The calibration of reference measuring equipment used for in-house calibration shall be *traceable to (inter)national standards and shall be evidenced by* certificate *issued by* body in accordance with the ILAC P10 policy.

Testing units, probes and connecting cables should be carefully stored. Reference blocks, control specimens and calibration blocks should be stored to prevent corrosion occurring, mechanical damage, high temperature and, if appropriate, accidental magnetization.
Any change in the probe, extension cables, eddy current instruments, recording media or any parts of the equipment shall require re-calibration.

Where automated test equipment is used, special attention shall be paid to the qualifications and training of operators, the system for the identification of defects, and data storage. Checks and if necessary corrections should be made to ensure the correct geometric position of the probe in relation to the output signal.

Calibration in ET

In eddy current testing, several types of calibration must be carried out.

In eddy current testing, the use of calibration standards in setting up the equipment is particularly important since signals are affected by many different variables and slight changes in equipment setup can drastically alter the appearance of a signal.

The most useful information is obtained when comparing the results from an unknown object to results from a similar object with well characterized features and defects. In almost all cases, eddy current inspection procedures require the equipment to be configured using reference standards. In eddy current testing reference standards are used to setup the equipment to produce a recognizable signal or set of signals from a defect or set of defects. In many cases, the appearance of a test signal can be related to the appearance of a signal from a known defect on the reference standard to estimate the size of a defect in the test component. Signals that vary significantly from the responses produced by the reference standard must be further investigated to determine the source of the signal.

The reference standard should be of the same material as the test article. If this is not possible or practical, it should be of material that has the same electrical conductivity and magnetic permeability. Component features (material thickness, geometry, etc.) should be the same in the reference standard as those in the test region of interest. If the reference standard is the type with intentional defects, these defects should be as representative of actual defects in the test component as possible. The closer the reference standard is to the actual test component, the better. However, since cracks and corrosion damage are often difficult and costly to produce, artificial defects are commonly used. Narrow notches produced with electron discharge machining (EDM) and saw cuts are commonly used to represent cracks, and drilled holes are often used to simulate corrosion pitting.

In some cases the reference standard used in Eddy Current Testing is called Sensitivity block: reference block with dimensional and material relations with the part to be tested and the expected defects. In Eddy Current usually (sub) surface slots (EDM, electro discharged machined) in the block assure the possibility of adjusting the instrument-probe combination to apply the applicable inspection sensitivity.

Any other terminology as mentioned in this document used for a calibration and/or a reference standard e.g. “control specimen” shall be clearly explained when used.

APPENDIX F

For common understanding the definitions of the VIM are reprinted:

1. Calibration (VIM 2.39)
   operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties result from an indication.

2. Adjustment of a measuring system (VIM 3.10):
   set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured.

   NOTE 1 Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

   NOTE 2 Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

   NOTE 3 After an adjustment of a measuring system, the system must usually be recalibrated.

3. Measurement precision (VIM 2.15)
   closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions.

4. Measurement accuracy (VIM 2.13)
   closeness of agreement between a measured quantity value and a true quantity value of a measurand.

   NOTE 1 The concept ‘measurement accuracy’ is not a quantity and is not given a numerical quantity value. A measurement is said to be more accurate when it offers a smaller measurement error.

   NOTE 2 The term “measurement accuracy” should not be used for measurement trueness and the term measurement precision should not be used for ‘measurement accuracy’, which, however, is related to both these concepts.

   NOTE 3 ‘Measurement accuracy’ is sometimes understood as closeness of agreement between measured quantity values that are being attributed to the measurand.

5. Measurement trueness (VIM 2.14)
   closeness of agreement between the average of an infinite number of replicate measured quantity values and a reference quantity value.

NOTE 1 Measurement trueness is not a quantity and thus cannot be expressed numerically, but measures for closeness of agreement are given in ISO 5725.

NOTE 2 Measurement trueness is inversely related to systematic measurement error, but is not related to random measurement error.

NOTE 3 Measurement accuracy should not be used for ‘measurement trueness’ and vice versa.

APPENDIX G

Test/Inspection procedures

Test procedures should if relevant contain, or refer to, other documents containing the following, and supplemented by any further information necessary to fully specify the test:

(a) Title, unique reference number, issue or revision status and date of issue;
(b) Unique identification of organisation producing the procedure;
(c) On each page, the page number, the total number of pages in the procedure and the unique reference number;
(d) Preparation and approval signature, such that the author and the Approval authority can be readily identified;
(e) Scope of the procedure, giving precise description of the range of applicability (e.g. range of diameters and thickness);
(f) Reference test procedure (contractual) and/or European or national standard specifications the procedure is according to and its issue/revision status; work instructions should reference the controlling procedure;
(g) Terms and definitions used within the procedure and/or reference to a document defining such terms;
(h) Equipment to be utilised, including consumables, complying with relevant specification requirements;
(i) Calibration, function check and maintenance requirements, or reference to procedures controlling these activities;
(j) Personnel qualifications and/or certification needed for performance of test work/evaluation of results, complying with any specification requirements;
(k) Surface condition required prior to commencing test;
(l) Environmental conditions required, where applicable;
(m) Requirements for identification of test items (by reference to a general test procedure, if applicable);
(n) Test method, defining precisely how the test is to be performed, including method of establishment of appropriate datum levels. Drawings or sketches shall be added where helpful and applicable. Scales, positions and sizes shall be added. Also positions, restrictions and limitations in inspection areas shall be shown in the drawing or sketch.;
(o) Criteria for recording and reporting the results;
(p) Acceptance standards, where specified;
(q) Requirements for segregation or identification of samples according to status (by reference to general test procedure if applicable);

(r) Reporting methods, detailing all aspects that are required to be included in the Test Report (whether specified in the accreditation standard or the test standard) with provision for the operator to report any limitation of access or sampling encountered during the test.

APPENDIX H

Internal audit

May if relevant include but not be limited to the points below:

Staff

- Appropriateness of staff certification/ qualification / authorisation.
- Relevant certification and eyesight checks are current.
- Training records and competencies are being maintained up to date.
- Tests are only carried out by authorised personnel.
- Observation of staff carrying out NDT is made, at least on site.

Contract Review

- Effectively carried out.
- Includes all relevant factors.
- Client is involved where necessary.
- Specific responsibilities particularly relating to site work, such as access, surface preparation, are fully dealt with.

Equipment

- The equipment in use is suited to its purpose.
- Equipment is correctly maintained and records of this maintenance are kept.
- Traceable equipment, e.g. UT sets and blocks, densitometers, etc. are calibrated, and the appropriate calibration certificates demonstrating traceability to (inter)national standards are available.
- Calibrated equipment is appropriately labelled or otherwise identified.
- Only body controlled equipment is being used.
- Instrument calibration procedures are documented and records of calibration are satisfactorily maintained.
- Appropriate instructions for use of equipment are available.
- Instrument performance checks show that performance is within specification.

Procedures and techniques

- Procedures and techniques are adequately documented and appropriately validated if necessary.
- Alterations to procedures and techniques are appropriately authorised.
- Current versions of the procedure/technique are available and being used by the operator.

Quality Control

- Where control checks are used, data has been recorded and performance has been maintained within acceptable criteria.
- The results of interlaboratory comparisons or proficiency tests.

Items Handling

- Samples are adequately identified and housed.
- Reject and/or defective areas are adequately marked.

- The method of marking shall not inversely affect its usability.

Records

- Notebooks/worksheets include the date of test, operator, test procedure, test item details, test observations, all rough calculations and other relevant data.
- Notebooks/worksheets are adequately completed; mistakes are crossed out and not erased.
- Control and function check are documented.
- Where a mistake is corrected the alteration is signed by the person making the correction.
- The body's procedures for checking data transfers and calculations are being complied with.
- Records are readily retrievable.

Test reports

- The report meets the requirements of accreditation standard, the method and any additional requirements specified by the client or national/international standard.
- The test location is clearly identified and component identification is unambiguously defined.
- Test specifications and acceptance criteria are fully specified.
- Where sampling is involved this is clearly identified.

Miscellaneous

- There are documented procedures in operation for handling queries and complaints and system failures.
- The Quality Manual is up-to-date and is accessible to all relevant staff.
- Copies of up to date national international standards are accessible.
- There are documented procedures for sub-contracting work.
- Records of appropriate legal licensing as required within the jurisdiction for the type of equipment employed with the NDT method
- Test results presented as sizes (mm), positions mm), damping (dB) and other relevant values are to be accompanied with a measurement uncertainty. At least the measurement uncertainty of the accredited inspection methods shall be stated, if required by 39the customer.