



## Functional Verification of NDT Equipment

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### Abstract

This paper presents an in-depth study of documentary base and literary sources applicable to functional fitness verification of equipment used in non-destructive testing (NDT). An attempt has been undertaken to make a difference between measurement and testing, as well as between calibration of measuring instruments and verification of testing equipment. Validated solutions for verification of non-destructive testing equipment are studied. This paper can be of use for non-destructive inspection bodies or non-destructive testing laboratories in drafting documented procedures functional fitness verification of non-destructive testing equipment.

**Keywords:** NDT Equipment, functional verification or validation, measurement, test, flaw characterization.

### Introduction

This study addresses functional fitness verification of non-destructive testing equipment, used by inspection bodies and testing laboratories.

The functional fitness verification of NDT equipment is not interpreted identically by technical experts and assessors of the National Accreditation Bodies. Sometimes no distinction is made between verification and calibration of equipment. Terms such as measurement and test are interpreted in an incorrect way, and sometimes no distinction is made between them.

A number of questions arise in some of inspection bodies and testing laboratories regarding the functional fitness verification of non-destructive testing equipment. Requirements for such verification are given in the accreditation standards for inspection bodies and testing laboratories [1, 2].

**The purpose of this study** is to identify, according to standards and their guidelines in force as well as technical specifications: differences between calibration and verification of measuring and test equipment; parameters to verify, criteria to be met by organization conducting verification and period of re-verification.

### 1. Terms and definitions

Terms “test result” and “measurement result” correspond to two well-defined concepts. In metrology, for measurement the word “quantity” is predominantly used as defined in ISO / IEC GUIDE 99 [3], and for test the word “characteristic” is preferred as defined in ISO 3534-2 [4].

#### *1.1. Terms and definitions in measurement*

According to ISO / IEC GUIDE 99 [3], art.1.1 “quantity” is a property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed as a number or a reference, and the term “measurement”, specified in art.2.1 of the same standard, is a

process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity.

The measurement process produces a result which does not depend on the method of measurement. Regardless of the use of a calibrated calliper or end block, the result of a measurement of the overall dimension of the same object and under the same conditions should be the same. Measured quantity quantifies the property. The measurement result is accompanied by uncertainty.

According to art. 2.39 of ISO/IEC GUIDE 99 [3], a **calibration of** measuring equipment is an 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 of equipment with associated measurement uncertainties,
- in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.

Calibration should not be confused with adjustment of a measuring system, nor with verification of calibration. Often, the first step alone in the above definition is considered as being calibration.

**Adjustment** is a 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. After an adjustment of a measuring system, the measuring system must usually be recalibrated.

## ***1.2. Terms and definitions for test***

According to art.1.1.1 of ISO 3534-2 [4], “characteristic” is distinguishing feature, which helps to distinguish between elements of a given set of phenomena, bodies or substances, and the term „test”, specified in art.3.2.3 of the same standard, is a technical operation that consists of determination of one or more characteristics of a given product, process or service according to a specified procedure.

The test result usually depends on the method and particular procedure used to determine the test characteristic, and sometimes to a large extent. During test, a given characteristic of the test object is indirectly determined by quantitative measurement of another physical information characteristic, depending on the test method and technology used. For example, in ultrasonic test for imperfection in a welded joint using ultrasonic flaw detector and probe the geometric (conventional) dimensions of the imperfection in the welded joint are characterized based on speed, amplitude and field of propagated in the material ultrasonic mechanical wave. In non-destructive testing, flaw characterisation is a process of quantifying size, shape, orientation, location, growth or other properties of a flaw which is based on information obtained from non-destructive testing.

Thus, the test equipment is an equipment for measurement of information characteristics depending on the physical phenomenon of the method used, on the basis of which test of the object is carried out to determine another characteristic (distinctive property). The physical phenomena used in NDT methods are propagation of electromagnetic waves throughout the spectrum of radiation, propagation of mechanical waves, induction of electromagnetic fields, capillary effect, etc.

According to ISO/TS 18173 [5], **calibration of** (non-destructive testing) **test equipment is a** comparison of an instrument with, or the adjustment of an instrument to, known reference(s). The definition of calibration of test equipment as per ISO/TS 18173 [5] gives the same meaning to terms calibration and adjustment, as long as this is in reference to test equipment. Types of adjustment of a **test** equipment include zero adjustment of a test unit measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

All equipment used to test or measure in general is an equipment for measuring certain quantities. When the measurement result is used to indirectly determine another characteristic equipment is used for testing. In this case, the equipment used is identified as the test equipment.

### ***1.3. Functional fitness verification of equipment for measurement and for test***

Verification NDT and measurement equipment can be divided in two types: verification and validation.

Verification is a provision of objective evidence that a given measurement equipment (process, measurement procedure, material, etc.) fulfils specified requirements, as given in Art. 2.44 of ISO /IEC GUIDE 99 [3]. Such specified requirements may be that the equipment meet a manufacturer's specifications indicating verification characteristics and their acceptance criteria.

Validation (validating, confirmation) is a verification where requirements are specified adequate for an intended use of the unit, according to Art. 2.45 of ISO /IEC GUIDE 99 [3]. Validated requirements can be the Standards for functional fitness verification of the relevant NDT equipment. Such requirements may also be laid down by the owner of the equipment by demonstrating, by written procedure and records thereof, that the verification characteristics are sufficient to carry out the tests with specified reliability.

Verification of test and measurement equipment shall not be confused with calibration. Not every verification is validation.

### ***1.4. Types of verification of measurement and test equipment***

A distinction must be made between the different types of equipment verification.

*Verification by manufacturer of measurement or test equipment* takes place during manufacture, on a representative sample of the same type of equipment produced. This one-off verification by the manufacturer to ensure the conformity of the same series of manufactured equipment with the validated characteristics of a standard or regulation.

*Initial functional fitness verification* of test or measurement equipment is conducted by the manufacturer before equipment delivery. This verification is done on every single piece of equipment supplied. Validated characteristics from standards and regulations are used for verification. Verification is evidenced by a valid certificate of compliance with a standard and a verification report.

*Verification (refers to testing equipment)/calibration (refers to measuring equipment) of equipment before putting into service* is made to ensure the requirements for its proper functioning in test equipment and demonstration of traceability to national and international standards for quantities in measuring equipment.

*Regular verification/calibration* at a certain time interval after the introduction into use of the measuring and test equipment can be carried out by the manufacturer, the owner of the equipment or a testing laboratory. It is done to check the functional fitness after a certain period of use of the test equipment and to check traceability to national and international standards for quantities after a certain period of use of measuring equipment.

*Post-repair verification/calibration of test equipment, or post-repair or post-adjustment of measuring equipment* is carried out as in the verification/calibration of equipment before putting into service.

*Intermediate verification of equipment* is done at a certain time interval between two regular verifications/calibrations. With test equipment, intermediate verification is carried out to preset characteristics before each testing or at a specified interval of time according to the

procedure of IB or standard for verification. The intermediate verification is performed by the operator of the device and proves that the result is suitable for use for the intended purposes of the test or measurement. This verification is different from the regular verifications. An example of verification of NDT equipment before the test is given in EN ISO 22232-3 [10]. These verification methods in the standard are not intended to prove the suitability of the equipment for specific applications (initial or regular functional fitness verification). The methods described are suitable for use by operators working in site or workshop conditions. The verification procedure must ensure that equipment is not used until compliance with the required specification has been verified.

Guidelines for determining the periods for regular verification/calibration of IB are found in ILAC – G 24 [8]. It does not specify requirements to initial verification following the one after the equipment is released. Regular verification/calibration is carried out following a documented procedure of IB.

The initial decision in determining the verification/calibration intervals can be taken based on the following factors:

- equipment manufacturer’s recommendations;
- range and requirements of use;
- uncertainty of measurement and maximum permissible deviations from specified criteria;
- validated decisions for interval of following verification/calibration specified in standard or regulation;
- extent and severity of operating conditions;
- frequency and type of intermediate checks;
- effects of environmental conditions.

These and other factors used to determine the initial verification interval are given in ILAC – G 24 [8]. A point system is introduced for each factor and the interval is evaluated according to the number of points collected. The greater the total number of points, the greater the interval for subsequent initial verification/calibration.

### ***1.5. Similarities and differences between calibration and verification***

Similarities between calibration and verification are:

- Provide information about the state of equipment;
- Calibrated standards are used, ensuring metrological traceability;
- They are valid under certain conditions, parameters, incl. environmental conditions;
- Obtaining credible and reliable results through equipment.

Differences between calibration and verification are given in table 1.

**Table 1. Differences between calibration and verification.**

<b>Calibration</b>	<b>Verification</b>
Assigns or corrects values reproduced by measuring equipment or the material measure / Certified Reference Material	Compliance with the tolerances of the tested technical characteristics is checked;
Result includes uncertainty of measurement;	It does not provide correction factors or uncertainty estimates
It plays a major role in performing the measurement	Of importance for the precision, stability and sensitivity of the testing.

## **2. Requirements to testing equipment in inspection bodies acc. to EN ISO/IEC 17020**

Art.6.2 of ISO/IEC 17020 [1] gives information about calibration of measuring equipment including standards, without reference to NDT equipment. As it became clear in the present study, each equipment is used to measure some characteristic, which significantly influences the result of another tested characteristic. Therefore, this information can also be accepted for NDT equipment, but the term “calibration” should be understood as functional fitness "verification". The same applies to the use of the term “calibration” in ILAC-P15 [6], ILAC-P10 [7] and ILAC-G24 [8], it should be understood as functional suitability “verification” when it comes to test equipment.

Before initial use, every measuring or test equipment should undergo verification/calibration, and then IB develops programme for subsequent verification/calibration and intermediate verifications. The programme of verification/calibration should be developed so that there is traceability to national and international standards. The equipment must be subjected to internal verification between regular verifications/calibrations.

The IB must have a developed program (rules) for calibrating standards and measuring equipment of environmental characteristics, as well as a program for selecting a supplier of verification/calibration service, if this is not performed by the IB itself. EN ISO/IEC 17020 [1] includes no requirements to organization performing verification/calibration of equipment. Such a requirement is given in ILAC – P 10 [7].

## **3. Policy for applying the requirements to the technical equipment according to ILAC – P 15**

When controlled environmental conditions are required, equipment used to monitor such conditions should be considered equipment that significantly affects the outcome of inspections. It must be calibrated or have a justification for its non-calibration. All measuring and/or test equipment determining the environmental conditions in performing the test should be verified/calibrated.

Guidance on how IB determines verification/calibration intervals can be found in ILAC – G 24 [8]. Validated decisions can be used to determine the intervals of equipment verification/calibration when there is such information in standards or regulations.

According to ILAC – P 10 [7], it is possible to perform in-house regular calibration of equipment used for measurements. National accreditation bodies are required to have a policy to ensure that such in-house verification/calibration services are carried out in compliance with the respective criteria for metrological traceability given in ISO/IEC 17025 [2].

IBs looking for external services for verification/calibration of their equipment can use any of the approaches defined in ILAC – P 10 [7]. Where equipment is subjected to intermediate verifications in service and between regular verifications/calibrations, the nature of these checks, frequency and acceptance criteria must be clearly defined by the IBs and records of the checks must be kept. The same applies to the calibration programs of reference materials.

NDT equipment is not used before its compliance with the specification defining the characteristics verified has been checked. This specification defining the characteristics for verification can be a technical specification of the device or another specification such as a standard, regulation, or validated procedure of the IB.

In any case, the IB in its verification procedure or the verification procedure of the service provider defines the verification characteristics.

#### **4. Policy of ILAC – P 10 concerning metrological traceability of measurement results for test**

Where verification/calibration service requires metrological traceability, the policy of ILAC is the measuring equipment (incl. reference materials) to be verified/calibrated by:

- National metrology institute (NMI), service of which is suitable for the intended use and is covered by the Mutual Recognition arrangement of International Committee of measures and weights (CIPM MRA). Services, covered by CIPM MRA, can be found in the key data comparison database of Bureau International des Poids et Mesures (BIPM KCDB), including CMC of every service specified;
- Accredited calibration laboratory, services of which are suitable for the intended use (i.e. the accreditation scope covers specific suitable verification/calibration), in the case when the National accreditation body is also covered by ILAC Arrangement or regional arrangements recognized by ILAC;
- NMI, service of which is suitable for the intended use, but not under the scope of CIPM MRA. In this case, the accreditation body sets a policy to ensure that these services meet the relevant metrological traceability criteria of ISO/IEC 17025 [2];
- Laboratory, calibration service of which is suitable for the intended use, but not covered by the ILAC Arrangement or regional arrangements, recognised by ILAC. In this case, the accreditation body sets a policy to ensure that these services meet the relevant metrological traceability criteria of ISO/IEC 17025 [2].

The last two approaches are applicable only when the first or the second are not possible for a specific calibration.

In the last case of the above, a guideline is given for performing verification/calibration of equipment by a non-accredited IB for its own needs, as well as using an external non-accredited provider of this service.

For non-accredited IB or Laboratories of verification/calibration services (regardless of whether the service is for internal or external use) it should be noted that a practical assessment can be necessary similar to the one undertaken by an accreditation body to standard ISO/IEC 17025 [2], in order to ensure that a competent verification/calibration is actually carried out.

When metrological traceability to SI is not technically practical it is the responsibility of the accredited organization to select a method to fulfil the metrological traceability requirements using certified values of certified materials provided by competent manufacturer or record the results of suitable comparison with referent measurement procedures, specified methods or consensus standards that are clearly described and accepted as providing measurement results suitable for their purpose. The Accreditation Body assesses the evidence for this comparison.

When metrological traceability only to SI units is not suitable or applicable for the application, a clearly defined measured quantity should be selected. Establishing metrological traceability includes both the proof of identity of the measured property and the comparison of the results with an appropriate declared reference. The comparison is made by ensuring that the measurement procedures are properly validated and/or verified, that the measuring equipment is properly calibrated, and that the measurement conditions (such as environmental conditions) are under sufficient control to ensure a reliable result.

#### **5. Guidelines for the determination of recalibration intervals of measuring equipment according to ILAC – G 24**

The laboratory should select the appropriate methods for determining initial and re-verification/recalibration intervals and should document those methods used. The

verification/calibration results should be collected and retained as historical data, in order to form the basis of future decisions for reverification/recalibration intervals of equipment. ILAC – G 24 [8] document provides five methods for determining intervals of regular reverification/recalibration of equipment.

Method 1: Automatic adjustment or “staircase” approach. Each time a piece of measuring equipment is calibrated on a routine basis, the subsequent recalibration interval is extended (or kept unchanged) if the deviation from the reference value is found to be within an appropriately defined percentage of the range between the maximum permissible errors.

Method 2: Control chart. Significant calibration points are chosen, and the results are plotted against time. From these plots, both the dispersion of the results and the instrumental drift are calculated. The instrumental drift is the mean drift normally over one reverification/recalibration interval, although several intervals may be considered in the calculation for very stable measuring equipment. From these figures, the optimum interval may be calculated.

Method 3: “In-use” time. Method 3 is a variation of Method 1 and Method 2. The basic method remains unchanged, but the recalibration interval is expressed in hours of use, rather than in calendar time, e.g. months. Measuring equipment, for example thermocouples used at extreme temperatures, standard lamps of which the drift is subject to their burning time, and dead weight testers for gas pressure or length gauges (i.e. measuring equipment that may be subject to mechanical wear).

Method 4: In service checking, or “black box” testing. Method 4 is also a variation of Method 1 and Method 2 and is especially suitable when a quick/easy verification of the NDT equipment or one of its components is possible. Critical parameters are checked frequently (e.g. once a day or even more often) by portable calibration gear, or preferably, by a “black box” designed specifically to verify the selected parameters. If the measuring equipment is found to be outside the maximum permissible error (or any other set of limits as required) by the “black box” or portable calibration equipment, it is returned for a full calibration and adjustment if necessary.

Method 5: Other statistical approaches.

Methods for determining recalibration intervals developed by or adapted from the laboratory can also be used if they are appropriate and validated.

Verification/calibration records from an accredited Laboratory or IB can be used to determine recalibration intervals.

Where there is a standard for functional fitness verification and a minimum re-verification period is specified, it can be used as a validated solution to determine the re-verification period. When there is no given period for re-verification in the standard, it is determined by IB according to one of the above methods.

## **6. Characteristics for functional verification of non-destructive testing equipment**

### ***6.1. Selection of characteristics for functional fitness verification of non-destructive testing equipment***

Characteristics for functional fitness verification of NDT equipment can be determined from:

- technical specification of the NDT equipment;
- validated characteristics specified in standards and regulations on verification of NDT equipment;
- other characteristics defined by IB in a validated written procedure for equipment verification.

In all cases, characteristics are specified by IB in its documentation. Whichever path chooses the IB for verification (in-house verification or using a supplier) they must demonstrate that the verification characteristics they choose ensure the reliability and precision of the test results. The verification characteristics specified by IB must be validated. IB may choose to use only a part or all validated characteristics from the standards or to use such from technical specifications, proving (validating) that they are sufficient for the purposes of the tests conducted using NDT equipment. They must demonstrate that the result obtained is reliable and accurate for the purposes of the test carried out.

## **6.2. Validated characteristics for functional fitness verification of non-destructive testing equipment**

In table 2, an example is given for validated characteristics through a standard on verification of ultrasonic non-destructive testing equipment. Validated characteristics for verification of equipment used for other non-destructive testing methods can be found in [12 ÷ 22].

**Table 2. Validated characteristics for functional fitness verification of ultrasonic test unit (conventional and multichannel) and ultrasonic thickness meter.**

<b>Method</b>	<b>Equipment</b>	<b>Standard</b>	<b>Characteristics and their criteria</b>	<b>Reverification time interval</b>
UT	Ultrasonic test unit (conventional)	EN ISO 22232-1 [9]	Group 2: 1. Physical state and external aspects (9.2); 2. Transmitter (voltage, pulse rise time and duration) (9.3); 3. Receiver (Frequency response, Noise level, Gain linearity, Vertical display linearity) (9.4)	1 year
UT	Ultrasonic test unit (multi-channel)	EN ISO 18563-1 [10]	Group 2: 1. Physical state and external aspects (9.2); 2. Transmitter (voltage, pulse rise time and duration, time delays linearity) (9.3); 3. Receiver (Frequency response, Noise level, Gain linearity, differences in channel gain, Vertical display linearity, time delays linearity) (9.4)	1 year
UT	Ultrasonic thickness meter	EN 15317 [11]	Group 2: Physical state and external aspects (10.4); General characteristics (low battery warning (9.4), Operating voltage range (9.6), Operating current (9.7); Transmitter (Pulse repetition rate (9.9), pulse shape, rise time and peak voltage (9.10); Performance characteristics (minimum and maximum measurable thickness (9.12), accuracy and resolution (9.13), calibration setting storage (9.16)); Display (recall of records to display (9.19)).	1 year

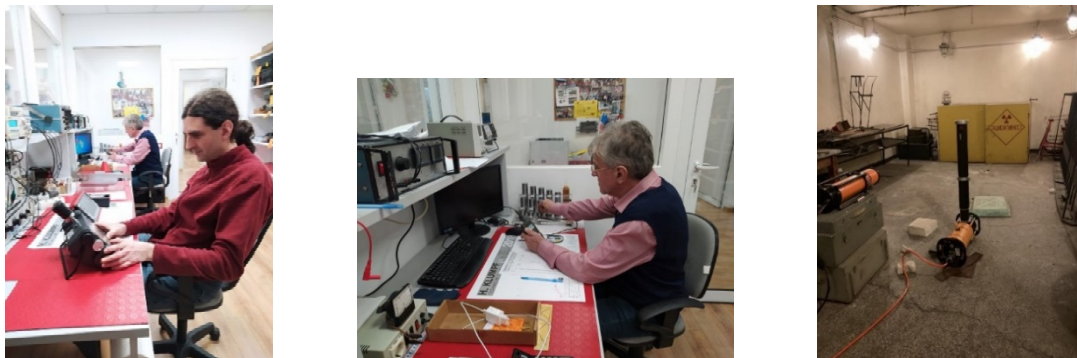
### **6.3. Presentation of results of verified functional suitability characteristics of non-destructive test equipment**

Verification is evidenced by the marking and/or issuance of a verification certificate of equipment. The document providing results of verification must show precisely and clearly the characteristics verified. Where the verification characteristics are defined in a standard or in a technical specification of the equipment, Testing Report must clearly state according to which paragraph of the standard the verification was carried out.

The certificate of conformity of NDT equipment, after verification of the later, shall not refer to the standard or technical specification if there are any of the paragraphs of the standard or technical specification on which the test has not been carried out. Reference should be made of the document and the paragraphs according to which the verification was carried out. It is the responsibility of IB to see to these requirements in documents received from the verification.

## **7. Organizations for verification non-destructive testing equipment in Bulgaria**

In Bulgaria, two IBs provide the verification of NDT equipment services, as illustrated on photographs in Fig.1 and Fig. 2. The scope of accreditation for the equipment verifications and calibrations performed can be found at the EA "BAS" website.



**Fig. 1. Inspection Body in OMEL NDT, accredited by EA “BAS” to perform functional fitness verification of NDT equipment**



**Fig. 2. Inspection Body and Calibration Laboratory in MULTITEST LTD, accredited by EA “BAS” to perform functional fitness verification of NDT equipment and calibration of test equipment.**

## Conclusion

As a result of the review of literature sources on conducting testing and measurement with equipment and the analysis made, Table 3 summarizes the following conclusions regarding the terms and definitions applied.

**Table. 3. Conclusions with regard to the terms and definitions applied for performance of testing and measurement using equipment**

<b>Terms and definitions</b>	<b>Test</b>	<b>Measurement</b>
Result	“characteristic” is distinguishing feature, which helps to distinguish between elements of a given set of phenomena, bodies or substances	“quantity” is a property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed as a number or a reference (for example by reference standard)
Definition	“test” is a technical operation that consists of determination of one or more characteristics of a given product, process or service according to a specified procedure	“measurement” is a process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity (for example for the length can be attributed to quantity meter)
Result obtained	The test result depends on the method and particular procedure used to determine the test characteristic, and sometimes and no uncertainty statement is largely required (relative or equivalent size)	The measurement result does not depend on the method used for measurement and the uncertainty is stated
Equipment	test equipment is practically equipment for measuring the quantitative value of a quantity(ies) used to determine the tested characteristic (test is indirect except for the readout equipment)	measuring equipment determines the quantitative value assigned to a measured quantity(ies) (the measurement can be direct using readout equipment or indirect)
Calibration	comparison of an instrument with, or the adjustment of an instrument to, known reference(s).	In a first step, it establishes a relationship between the quantity values and their uncertainty of measurement, obtained through the standards and the corresponding indications of the equipment with the added uncertainty of measurement. In a second step, this information is used to establish a dependency to obtain a measurement result from an indication.
Adjustment	Terms calibration and adjustment are synonymous for equipment used to test	a 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. After an adjustment of a measuring system, the measuring system must usually be recalibrated.

Verification	a provision of objective evidence that a given test/measurement equipment (process, test/measurement procedure, material, etc.) fulfils specified requirements	
Validation	a verification where requirements are specified adequate for an intended use of the unit	
Characteristics for verification	<p>Characteristics of verification of test equipment/measurement can be determined from:</p> <ul style="list-style-type: none"> <li>– Technical specification of equipment (verification);</li> <li>– validated characteristics specified in standards and regulations on verification of equipment;</li> <li>– other characteristics defined by IB in a validated written procedure for equipment verification (validation).</li> </ul> <p>In all cases, characteristics are specified by IB using the equipment in its documentation.</p>	
Types of verifications/calibrations	<ul style="list-style-type: none"> <li>– Verification by a manufacturer of a sample of the equipment model produced to validated characteristics;</li> <li>– Initial functional fitness verification of test equipment is conducted by the manufacturer before every piece of equipment delivery according to standard or regulation;</li> <li>– Verification of equipment before putting into use;</li> <li>– Regular verification at a certain time interval after the introduction into use of the equipment can be carried out by the manufacturer, the owner of the equipment or a testing laboratory.</li> <li>– Post-repair verification of equipment is carried out as in the case of equipment verification before putting into use.</li> <li>– Intermediate verification of equipment is done according to set characteristics before conducting each testing or at a certain period according to the procedure of IB or standard on verification. The intermediate verification shall be carried out by the test unit operator and shall demonstrate that the equipment is fit for its intended use. This verification is different from regular checks.</li> </ul>	<ul style="list-style-type: none"> <li>– Verification by a manufacturer of a sample of the equipment model produced to validated characteristics;</li> <li>– Initial functional fitness verification of measuring equipment is conducted by the manufacturer before every piece of equipment delivery according to standard or regulation;</li> <li>– Calibration of equipment before putting into use;</li> <li>– Regularly calibration at a certain time interval after the introduction into use of the equipment can be carried out by the manufacturer, the owner of the equipment or a testing laboratory.</li> <li>– Post-repair or post-adjustment calibration of equipment is carried out as in the case of equipment calibration before putting into use.</li> <li>– Intermediate verification of equipment is done at a certain period between two regular calibrations. The intermediate verification shall be carried out by the instrument operator and shall demonstrate that the result is usable for the specified measurement purposes.</li> </ul>
Organization carrying out verification/calibration of equipment	<ul style="list-style-type: none"> <li>– National Metrological Institute (NMI), Laboratory or IB, verification service of which is suitable for the intended use;</li> <li>– According to ILAC–P10, it is possible to perform in-house regular verification of equipment used for tests.</li> </ul> <p><i>Note:</i> National accreditation bodies are</p>	<ul style="list-style-type: none"> <li>– National Metrological Institute (NMI) or Laboratory, calibration service of which is suitable for the intended use;</li> <li>– According to ILAC – P 10, it is possible to perform in-house regular calibration of equipment used for measurements.</li> </ul> <p><i>Note:</i> National accreditation bodies are</p>

	required to have a policy to ensure that such in-house verification services (or external from a non-accredited Laboratory or IB) are carried out in compliance with the respective criteria for metrological traceability set in ISO/IEC 17025.	required to have a policy to ensure that such in-house calibration services (or external from a non-accredited Laboratory or IB) are carried out in compliance with the respective criteria for metrological traceability set in ISO/IEC 17025.
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## References

1. ISO/IEC 17020 (ISO/IEC WD 17020, stage 20.20). Conformity assessment – Requirements for the operation of various types of bodies performing inspection.
2. ISO/IEC 17025. General requirements for the competence of testing and calibration laboratories.
3. ISO/IEC GUIDE 99. International vocabulary of metrology – Basic and general concepts and associated terms (VIM).
4. ISO 3534-2. Statistics – Vocabulary and symbols – Part 2: Applied statistics.
5. ISO/TS 18173. Non-destructive testing – General terms and definitions.
6. ILAC – P 15. Application of ISO/IEC 17020:2012 for the Accreditation of Inspection Bodies.
7. ILAC – P 10. ILAC Policy on Metrological Traceability of Measurement Results.
8. ILAC – G 24. Guidelines for the determination of recalibration intervals of measuring equipment.
9. EN 61010-1. Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.
10. EN ISO 22232-1. Non-destructive testing – Characterization and verification of ultrasonic test equipment – Part 1: Instruments.
11. EN ISO 18563-1. Non-destructive testing – Characterization and verification of ultrasonic phased array equipment – Part 1: Instruments.
12. EN 15317 (prEN ISO 16831, stage 10.99). Non-destructive testing – Ultrasonic testing – Characterization and verification of ultrasonic thickness measuring equipment.
13. EN ISO 9934-3. Non-destructive testing – Magnetic particle testing – Part 3: Equipment
14. EN ISO 3059. Non-destructive testing – Penetrant testing and magnetic particle testing – Viewing conditions.
15. EN ISO 15548-1. Non-destructive testing – Equipment for eddy current examination – Part 1: Instrument characteristics and verification.
16. EN 12543-2. Non-destructive testing – Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing – Part 2: Pinhole camera radiographic method.
17. EN ISO 16526-1. Non-destructive testing – Measurement and evaluation of the X-ray tube voltage – Part 1: Voltage divider method
18. EN 25580. Non-destructive testing – Industrial radiographic illuminators – Minimum requirements.
19. EN 13477-1. Non-destructive testing – Acoustic emission – Equipment characterisation – Part 1: Equipment description.
20. EN 13477-2. Non-destructive testing – Acoustic emission testing – Equipment characterisation – Part 2: Verification of operating characteristics.
21. ISO 12713. Non-destructive testing – Acoustic emission inspection – Primary calibration of transducers;
22. ISO 12714. Non-destructive testing – Acoustic emission inspection – Secondary calibration of acoustic emission sensors.