

National Manual of Assets and Facilities Management

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Equipment Calibration Procedure

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Equipment Calibrations Procedure

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1.0 PURPOSE

The purpose of this document is to provide guidelines and best practices in relation to the requirements, control, management and calibration of Measuring and Testing Equipment (MTE). These recommendations will assist the Entity in the management of the tools and equipment for which they are responsible. The guidance given shall be applicable to the legislation and requirements of the Kingdom of Saudi Arabia.

2.0 SCOPE

The scope of this document is to advise the Entity client of the motivations, importance and requirements relating to MTE that may fall directly or indirectly under their responsibility. The scope also includes a Best Practice Procedure to inform the Entity client on the processes and practices that they should be requiring or expecting from their maintenance contractor.

This Procedure does not cover fixed devices, such as sensors attached to a building Management System. The maintenance of these types of assets is discussed in the National Manual of Assets and Facilities Management (NMA&FM) Volume 6, Chapter 6 Building Management Systems Maintenance Plans and Chapter 7 Instrumentation Systems Maintenance Plans.

3.0 DEFINITIONS

Term	Definition
Accuracy Ratio	The ratio of the accuracy tolerance of the unit under calibration to the accuracy tolerance of the calibration standard used
Asset	An item or thing that has potential, or actual value to an organization
Asset Management	The coordinated activity of an organization to realize value from assets
Asset Management System	A dedicated software application used to record and track an asset throughout its life cycle from procurement to disposal
Asset Register	A list of the assets owned by an Entity. It contains relevant details about each asset including the location, description, value, and age
Best Practice	In relation to any undertaking and any circumstances, the exercise of that degree of skill, diligence, prudence, and foresight which would reasonably and ordinarily be expected from a skilled and experienced operator engaged in the same type of undertaking under the same or similar circumstances
Calibration Baseline	A multi-point reference line, which is accurately established early in the life of the project or has been previously established for the purpose of checking the accuracy of tapes, Electronic Distance Measuring equipment and other survey equipment
Entity	A Saudi Government organization which is responsible for the delivery of government funded infrastructure construction projects.
Equipment Register	A subset of the Master Equipment and Tool Control Register
Facility	A specific building or a group of buildings either on the same site or several sites which are used to provide an overall function (e.g., a school, research establishment, hospital complex, training complex, or university campus)
Frequency	Refers to a cyclic time period (e.g., weekly, monthly, quarterly)
Master Equipment and Tool Control Register	A database where each item is identified by a unique code number and relevant information
Measurement and Test Equipment	Equipment used across a wide variety of fields to measure various components of the materials they are working with and analyzing
Precision	The ability to obtain a value or measurement several times in a row to achieve a specification
Quality Management System	The act of overseeing all activities and tasks needed to maintain a desired level of excellence
Quality Assurance	Method to assess whether quality standards are being met
Quality Control	Quality standards to be attained



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Term	Definition
Threshold	The value which collected data is compared to
Tolerance	An acceptable value determined and accepted from an actual value and measurement
Acronyms	
AMS	Asset Management System
BOD	Basis of Design
ISO	International Organization for Standardization
KSA	Kingdom of Saudi Arabia
MTE	Measurement and Test Equipment
NMA&FM	National Manual of Assets and Facilities Management
OEM	Original Equipment Manufacturer
SASO	Saudi Standards, Metrology and Quality Organization

Table 1: Definitions and Acronyms

4.0 REFERENCES

- ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories
- ISO 9001 Quality Management System
- ISO 13485 Medical Device Manufacture Quality Management
- British Institute of Facilities Management (BIFM) – Sourcing Strategies Document
- National Manual of Assets and Facilities Management Volume 6: Building Management Systems Maintenance Plans
- National Manual of Assets and Facilities Management Volume 6: Instrumentation Systems Maintenance Plans
- National Manual of Assets and Facilities Management Volume 9: Contracts Management
- National Manual of Assets and Facilities Management Volume 11: Quality Execution Procedure
- National Manual of Assets and Facilities Management Volume 11 Quality Assurance Audits
- National Institute of Standards and Technology
- Saudi Arabia Standards Organization (SASO) – National Measurement and Calibration Center (NMCC) rules and regulations



5.0 RESPONSIBILITIES

Role	Description
Entity	A Saudi Government organization which is responsible for the delivery of government funded infrastructure and construction projects, and who monitor and ensure compliance of systems.
Facility manager	Responsible to appoint individuals to monitor, communicate, schedule, and review the tooling and equipment needs of a facility and management of the schedule for the calibration of equipment in accordance with legislation and OEM guidelines.
Maintenance Contractor	Individuals that are responsible for the provision of equipment calibration services, relevant certification, and validity date range.

Table 2: Responsibilities

6.0 PROCESS

6.1 Introduction

The responsibility for tool and equipment calibration remains with the end user of that equipment. The Entity shall ensure the end user is adhering to the standards and regulations set out by the Kingdom of Saudi Arabia (KSA). The Quality Management System for the testing and calibration of maintenance equipment is strictly configured to assure the Basis of Design (BOD) and that its stipulated tolerances are adhered to.

The maintenance and calibration of tools and equipment shall only be delivered by certified laboratories (A detailed list of laboratories can be accessed in the website of Saudi Accreditation Center (SAC) or in accordance with the references provided in Section 4 of this document or, where appropriate, similar organizations. When the equipment is returned, the contractor should ensure that it has passed the calibration or testing parameters and is accompanied with the approved certificates according to the type of calibration and/or testing carried out. Similarly, the recommended schedule for testing and calibrating is also clearly defined by the Original Equipment Manufacturer (OEM), which provides guidance on the requirements and suitable certification.

Processes, parameters, and frequency associated with the testing and calibration of maintenance equipment can vary depending on their design and complexity. The assurance provided by any testing or calibration process is a vital element in Quality Control and therefore, will have a direct and positive impact on asset reliability, availability, performance, and adherence to the BOD limits. In many instances, the requirement for calibration is legally binding.

The responsibility of the end user is to manage the equipment subject to testing and calibration in a manner that assures safety, availability, and suitability of testing and calibration methodology by assigning to the appropriate laboratory. Included in this duty of care is the protection from misuse and substandard storage.

NOTE: The certification of Assets, Systems, and their equipment is subject to legislation. For KSA, it is governed by the SASO “*Law of Calibration and Measurement*” and is subject to penalties in cases of non-compliance.

6.2 Tooling Calibration Recommended Standards

Testing and calibration shall be monitored, controlled and documented by legislation such that all systems assure integrity. The process of calibration services for all critical and non-critical instruments shall appropriately adhere to the statutory inspections by The Law of Calibration and Measurement Resolution by Saudi Standards, Metrology and Quality Organization (SASO).

Testing and/or calibration shall also be driven by the need for performance or reliable data maintenance following Original Equipment Manufacturer (OEM) guidelines and best practice. Examples of this are:

- Assembling close tolerance machines (i.e. standby generator engines, electrical generators, pumps, hydraulic components and so on) require very specific engineering tolerances to be able



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- to function. In the best interest of assuring proper function and life cycle value of a component, it is recommended to follow OEM guidelines and best practice to check the dimensions and torque specifications during the assembly phase to ensure BOD tolerances are adhered to.
- Testing a battery or other similar electrical power supply for correct voltage; many systems rely on specific power supply quality to be able to function correctly and therefore the calibration of electrical systems testing equipment shall be maintained.
 - Root cause analysis also depends on the integrity of accurate measuring equipment.
 - All methods, procedures and supporting documentation, such as instructions, standards, manuals and reference data relevant to the laboratory activities, shall be kept up to date and shall be made readily available to personnel.

6.3 Calibration Accuracy

Calibration is a comparison between the standard (a known measurement) and the level of measurement accuracy of an instrument. Typically, the accuracy of the standard should be ten times the accuracy of the measuring device (10:1) in use. However, an Accuracy Ratio of 3:1 is acceptable by most standards organizations. This Accuracy Ratio should be applicable to the equipment. Factors affecting accuracy may include:

- Qualified and trained lab technicians who are competent to perform the calibration activities.
- The environmental conditions and controls of a laboratory monitored and regulated properly. These conditions shall be suitable for the laboratory activities and shall not adversely affect the validity of results. Laboratory conditions that can negatively affect the validity of results can include, but are not limited to:
 - o Contamination such as dust or moisture
 - o Electromagnetic disturbances and radiation
 - o Temperature and humidity
 - o Sound and vibration
- Record keeping and documentation must be accurate, validated and controlled to ensure data is not misplaced or wrongly distributed. These documents must be accessible if requested in the event of an incident where calibration of a tool or system has affected the Entity in a negative manner.

The laboratory performing the calibrations is required to keep the following:

- A validated procedure
- A specification of requirements
- A document of the results

6.4 Applications and Requirements

Measuring and Test Equipment exist and are calibrated to assure a range of measurable parameters including but not limited to:

- Physical – Dimensions, displacement, depth, strength, weight
- Mechanical – Temperature, pressure, flow, velocity, viscosity
- Electrical – Voltage, current, resistance
- Other – Particulates, concentration, frequency

In order to establish the types and quantities of measuring and test equipment required to satisfy the legislative profile in any given section of the Asset Register. It will be necessary to establish the range of assets and systems which are subject to test and calibration. The list shall be prioritized to reflect those assets which require certification.



6.4.1 Statutory Inspections

Assets with functional classifications are subject to statutory inspections as required by legislation applicable to KSA. For these types of assets, the measuring and testing equipment used to certify integrity shall be subject to calibration regardless of owner. The list below demonstrates the wide range of assets and systems subject to statutory inspections:

- Airport Infrastructure, Navigational Aids and Energy consumption if applicable,
- Buildings
- Bridges
- Baggage System, if applicable
- Safety Circuit
- Fire Detection and Suppression
- Monitoring Device
- Smoke Ventilation

The majority of these inspections will be carried out by specialists and fully certified providers of testing and calibration processes. Before awarding any contracts to these inspections, the Entity or contractor should ensure the provider of testing and measuring is in possession of valid calibration certificates to verify they are suitably competent. Without this proof, the specialist cannot confirm that they are competent in the execution of testing and measuring.

6.4.2 Non-Statutory Inspections

Measuring and testing inspections are required for statutory reasons. The use of these types of specialist tools and equipment shall be required by the maintenance contractor and some of their specialist subcontractors. An elevated level of knowledge and skill is required for both the use of and care for these types of tools and conducting of the measurement tasks. Appreciation and skill in recognizing the need for repair, replacement or calibration of these types of tools is required, but are not limited to the following:

- Vernier Gauges
- Micrometers
- Bore Gauges
- Go/No Go Gauges
- Surface Tables
- Height Vernier
- Feeler Gauges
- Torque Wrenches
- Belt Tension Gauges
- Weigh Scales
- Ammeters
- Temperature measurement devices
- Non-destructive Testing of Equipment (normally a specialist application)

The frequency of calibration can be influenced by such factors as:

- Frequency of use
- Criticality of asset or equipment being measured
- Environment in which it is used and stored
- Age and general condition, especially after being damaged

The calibration interval should be based on the instrument's stability, purpose, degree of usage, environment, past calibration history of similar instruments, and manufacturer's recommendations. According to ISO 9000 standards, the recommended frequency for the calibration of measurement and test equipment used exclusively for non-statutory tasks is provided in the table below. These recommended frequencies shall apply unless the OEM recommendations are more frequent, in which case this shall take precedence. In addition, calibration is recommended if it is suspected or known that the tool has been



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damaged or is providing readings that are thought to be inaccurate or are not verified when compared to the measurements given by an alternative tool.

Use Frequency	Calibration Periodic Interval
Daily	3 months
Every other Day	6 months
Once Weekly	12 months
Once Monthly	24 months
Once Yearly	36 months

Table 3 – Calibration Frequency

Reference to the British Institute of Facilities Management (BIFM) – Sourcing Strategies document is recommended when procuring the services of a maintenance contractor. It is recommended that the maintenance contractor refers their sub-contractors to the aforementioned guide. The provider of the calibration service should provide proof of their competency in accordance with ISO/IEC 17025 general requirements for the competence of testing and calibration laboratories. This ensures that the laboratories are authorized to carry out the calibration and that any certificates provided will be legally binding.

For management of uncontrolled (outside of Asset Management System) tools, refer to the National Manual of Assets and Facilities Management Volume 8 – Equipment and Tool Control Procedure

6.5 Equipment Calibration Procedure

Figure 1 below is a high-level flowchart that illustrates the Equipment Calibration Procedure.



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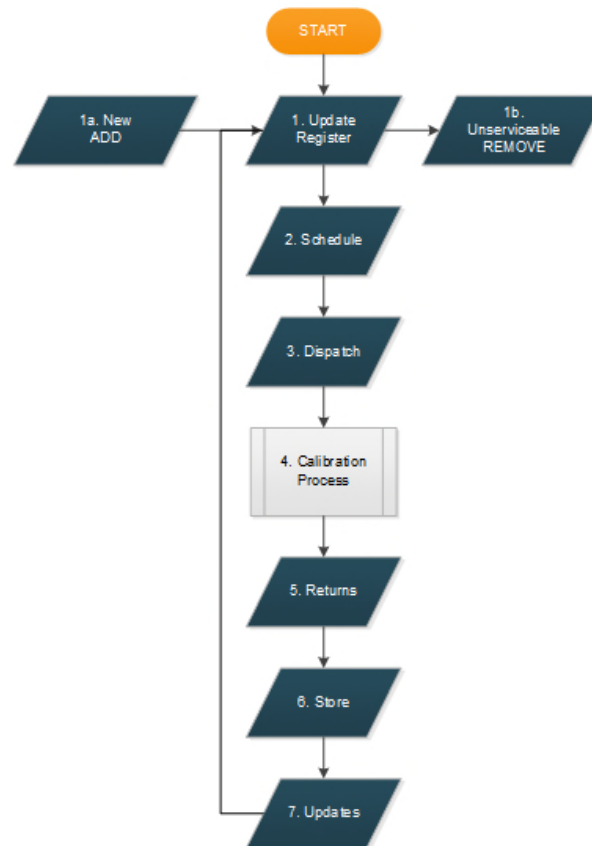


Figure 1: Equipment Calibration Procedure Flow Chart

6.5.1 Equipment Register Management

This procedure requires the compilation and management of an Equipment Register. This can be a subset of a Master Equipment and Tool Control Register and should provide a clear record of which equipment or tools are subject to calibration.

For MTE that is managed by the Entity client or a contractor, the following points are recommended advice:

- A person responsible for the storage management is identified
- An Equipment Register is maintained
- A unique identification Tool Number is created and used
- This Tool Number system should be able to identify a singular tool within a set of tools
- This identification system should include the owner and location
- The primary method of identification shall be etching or metal stamping
- A color scheme for critical and non-critical tools may be adopted

6.5.2 Scheduling

To ensure the absence of any equipment does not affect the asset or facility maintenance or inspection schedule, the process of dispatching equipment must be appropriately programmed to avoid any disruptions in normal operations. Where resources allow, good practice strategies shall keep backup tooling and testing equipment to cover for such normal operations, especially the high criticality items in Healthcare Facilities, Schools and Universities, Housing, Municipal and Parks and Recreation Facilities.



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Once a list of equipment has been defined and the calibration requirements established via the OEM recommendations and local requirements, a suitable schedule should be dispatched to the calibration company. This schedule should take into consideration the demand for fully certified equipment to carry out inspections and testing.

6.5.3 Dispatching

The dispatch register should be updated to track the equipment once it has been dispatched for calibration. Clear instructions should be provided, detailing where and for how long equipment is due to be away from its place of need.

Not all equipment will pass the initial calibration test. Rather, some equipment will require remedial work to rectify an error that prevents the equipment from passing its calibration test. Therefore, it is necessary to have a contingency plan in place to account for such instances. This contingency plan would require the contractor of the laboratory to inform the Facility Manager that the equipment has failed its calibration test.

It is imperative to ensure that the laboratory contractor understands the requirements and the urgency of need of the equipment to successfully pass its calibration test. The response time must be strictly adhered to and any deviations must be communicated to the contractor and Entity representatives immediately.

6.5.4 Returned

Once tooling and equipment are returned from the calibration laboratory, the Facility Manager shall ensure the following measures are in place that confirm the function, software, and calibration status are to a satisfactory standard before the equipment is returned to service:

- The certificates of the contractors or calibration service providers are verified.
- Check that Identification number, date of calibration, and location are consistent.
- Test the equipment to ensure that the operation of the equipment is within the manufacturers specifications

6.5.5 Storage and Handling

The care for precision measuring and testing equipment should be at a higher standard than that for less precise tools. Every effort should be made to protect the condition of the equipment by storing it in safe dry storage areas, preferably in moisture-free and shock proof protected containers. If not in regular use, they should be inspected at regular intervals (e.g., on a monthly basis) to monitor their condition. The inspection should be a recognized work activity and recorded in the Asset Management System (AMS).

As per the ISO/ICE 17025:2017 Section 7.4, the laboratory shall have a procedure for the transportation, receipt, handling, protection, storage, retention, and disposal or return of test or calibration items. This shall also include all provisions necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer. Precautions shall be taken to prevent deterioration, contamination, loss or damage to the item during handling, transporting, storing/waiting, and preparation for testing or calibration. Handling instructions provided with the item shall be followed.

6.5.6 Updates

It is essential to establish an internal audit to ensure the process of measuring, testing, and calibration of equipment is properly adhered to and that the register is properly managed and controlled. For further details on this topic, refer to ISO 9001 Guidelines for Implementing a Quality Management System.

All certificates must be maintained in a safe, accessible and central location that is controlled by an Entity representative such as a Facility Manager. It is crucial that certificates are properly managed, as they may need to be produced for legal reasons and failure to furnish such certificates could result in severe legal and cost implications.



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NOTE: It should be understood that this document discusses mandatory requirements in order to ensure the accuracy and precision of the tools and instruments used in the operations and maintenance of facilities. It should be noted that a thorough inventory of assets is necessary to understand the scope of the processes required to effectively and efficiently maintain calibrated tooling and equipment. As per the references mentioned in Section 4, it is essential to follow the recommended instructions to maintain the integrity of equipment calibration procedures.