Sections Included in this Document and Change History

1. Purpose

This procedure specifies the schedule and requirements for maintenance, performance, calibration, and verification of laboratory testing equipment. Meeting the criteria in this procedure demonstrates control of the maintenance and calibration parameters needed to achieve the accuracy of instruments used for analytical testing.

2. Scope

These procedures apply to the analytical testing equipment used by the Food and Drug Administration/Office of Regulatory Affairs (FDA/ORA) laboratories.

3. Responsibilities

A. The FDA/ORA laboratory Directors are responsible for:

- ensuring that the laboratory is equipped with the needed instruments and equipment that, at a minimum, meets the specifications of the analytical methods employed.

B. The Supervisors are responsible for:

- ensuring that equipment maintenance and calibration are conducted,
- providing support for arranging non-routine instrument repair and ordering of replacement instrument parts, and
- designating equipment monitors where needed to perform periodic equipment checks.

C. The Quality Management System Manager is responsible for:

- maintaining the equipment maintenance records.

D. Staff is responsible for:

- verifying equipment conforms to specifications prior to use, and completing the documentation of this verification, and
- adhering to written equipment operation procedures.

5. References

International Organization for Standardization and International Electrotechnical Commission. *International Standard (ISO/IEC) 17025 General requirements for the competence of testing and calibration laboratories* (Section 5.5 Equipment). Geneva, Switzerland: ISO Committee on Conformity Assessment.

AOAC *International guidelines for laboratories performing microbiological and chemical analyses of foods and pharmaceuticals.*

6. Procedure

A. Equipment Identification and Records

1. All equipment in the FDA equipment inventory system is labeled with a unique identification number (e.g. FDA bar code number). Generally, equipment not bar coded under the FDA-wide inventory system is identified under the laboratory's own unique numbering system.

2. Each laboratory maintains an inventory of its major equipment used to perform regulatory testing. This inventory contains the following information:

   - Item and its software,
   - Manufacturer and model,
   - Serial number or other unique identification, and
   - Location.

3. The label or tag found on or near the equipment contains the following information:

   - FDA bar code or unique identification number,

- Date of last calibration, and
- Date of the next calibration.

4. Equipment that is scheduled to be calibrated daily or with each use, is tagged as above, except that instead of the calibration dates, it is annotated as such (e.g. calibrated daily or calibrated with each use).

5. Small items with insufficient space to record the information on the label (e.g. thermometers) need only be identified with their unique identification number.

6. Further guidance on instrument and equipment documents and records is provided in Volume II, Section 2, ORA-LAB.5.5.1 Instrument and Equipment Documentation and Records.

B. Equipment Qualification

1. When new instruments are installed, laboratories may elect to purchase Installation Qualification (IQ) and Operation Qualification (OQ) from the manufacturer or installer. This information is kept with the equipment records.

2. Alternatively, for new instruments the laboratory may determine independently that quality assurance specifications have been met. Equipment is not used until this has been completed and users have been trained in its operation.

C. Equipment Maintenance and Performance Checks

1. Laboratory equipment maintenance and performance checks are conducted on a scheduled basis. A schedule, identifying and eliminating potential sources of problems, is established for the servicing of laboratory equipment.

2. Such maintenance and performance checks are documented to demonstrate that the program is being followed according to schedule.

3. Manufacturer's instructions are used for guidance in performing equipment maintenance. In the absence of manufacturer's instructions, instructions are provided in the instrument operation procedure.

4. The maintenance and performance checks records may be maintained in a logbook or log sheet.

5. Table 1 provides information on minimum maintenance requirements for equipment according to Association of Analytical Chemists (AOAC). FDA/ORA laboratories are responsible for developing comparable maintenance schedules for equipment not listed in Table 1.

6. Preventative maintenance procedures, other than basic cleaning, for each equipment item performed internally, are developed unless they are already described elsewhere (e.g. the instrument manual).

7. General service equipment is typically maintained only with cleaning and safety checks.

8. Use of outside contractors to perform repairs or maintenance is at the discretion of local laboratory management.

D. Equipment Calibration or Verification

1. A calibration or verification procedure is prepared by the testing laboratory for all critical laboratory equipment where laboratory personnel perform the testing. If the procedure is described in an operations manuals or a test procedure, this can be referenced in lieu of preparing a separate work instruction.

2. Records of calibration or verification are maintained. See Volume II, Section 2, ORA-LAB.5.5.1 Instrument and Equipment Documentation and Records

3. Minimum calibration or verification schedules according to AOAC for the most common types of FDA/ORA laboratory equipment is found in Table 2. For remaining analytical equipment not listed, the laboratory that has the equipment develops a comparable schedule.

   Generally, laboratory equipment are categorized as follows:

   - General service equipment such as blenders, ovens, hotplates,

furnaces, stirrers;

- Volumetric equipment such as class A glassware, mechanical and automatic pipettes and burets; Note: A manufacturer's certificate of graduation accuracy for class A glassware may be accepted. Other volumetric equipment, including mechanical and automatic pipettes and burets, are calibrated by the laboratory's procedure.

- Measuring instruments such as balances, chromatographs, spectrometers, thermometers; and

- Physical standards such as reference weights and reference standards.

4. Laboratories may do less than illustrated in the tables provided a strong justification exists. The exception is documented in writing and approved by the laboratory director.

5. Some instrumentation, such as chromatographic systems, may not be calibrated by a unique national or international standard. Latitude is provided to address such systems at the method application level as long as traceability is maintained with specified method performance criteria, which includes a certified reference or in-house reference material, and system suitability checks.

6. Data acquired on instruments which fail a parameter are suspect between the failing assessment date and the last successful calibration or verification date. The problems and investigation is conducted as part of the laboratory's corrective action process. See Volume II, Section 1, ORA-LAB.4.10 Corrective Action

E. Out of Service Equipment

1. Equipment that is not in use, and therefore has not been calibrated or verified, should be clearly tagged out of service.

2. Out of service equipment must be calibrated or verified prior to use.

3. Equipment that is not operating properly is clearly marked to show that it is out of service.

4. When an instrument is discovered to be improperly operating, it is tagged and taken out of service.

5. Equipment is not returned to service until performance checks and verification have been performed and documented. An exception may be made if the equipment failure is not directly related to its analytical function, such as a problem with peripheral equipment. For example, if a printer or computer attached to a chromatographic system is out of order, performance checks and verification for the chromatograph may not be needed following repair.

6. When, for whatever reason, i.e. repair or calibration, equipment goes outside the direct control of the laboratory, the laboratory shall ensure that the function and calibration status of the equipment and its software are checked and shown to be satisfactory before the equipment is returned to service.

    a. For equipment returned after repair, the performance checks and calibration identified in Table 1and 2 are conducted prior to use and documented to be within specifications.

    b. For equipment returned after calibration, the calibration certificates are reviewed for the following to ensure the calibration status:
    i. a statement of conformity to relevant specification after calibration/verification, Note: such as the manufactures specifications
    ii. item name, type, or description,
    iii. identification number,
    iv. location,
    v. calibration interval,
    vi. calibration procedure used,
    vii. calibration source (both the standard used and the lab providing the service),
    viii.date of calibration,
    ix. corrections, conditions of use (including environmental conditions) necessary to achieve the required performance,
    x. specific results of each calibration, prior to adjustment or repair, if the item was found out of tolerance,

xi. details of any maintenance such as servicing, adjustments, repairs or modifications carried out,
xii. any limitations on use,
xii. identification of person(s) performing the calibration,
xiv.where the accuracy of an item is described in a calibration report or certificate, there must be a means of traceability between that item and the report or certificate,
xvi. accreditation logo.

NOTE: The records may be maintained by approved calibration suppliers as part of their services but must remain accessible upon request. Electronic records may be used in lieu of paper calibration certificates.

c. Additionally, any equipment returned after calibration must be checked for functionality by performing a check of the operation of the equipment. For example, a pipette check would be to demonstrate that the pipette draws up a volume of water. This check must be documented.

F. Handling, Use, Storage and Transport of Equipment

1. The Work Instruction defines the handling and use of the equipment. Each instrument or piece of equipment has step-by-step instructions for its start-up, operation and shutdown described in manufacturer's manuals or per laboratory procedure. Equipment is operated by authorized personnel; authorized personnel are identified per laboratory.

2. The location of equipment in active use is specified in the FDA/ORA Equipment Performance System (EPS) or the laboratory equipment inventory. Equipment not in use is tagged per instructions in 6. Procedures, Part E, Out of Service Equipment.

3. Surplus equipment instructions are found in the Staff Manual Guide; surplus equipment is documented on FDA form HHS-22.

4. Transport or move sensitive equipment according to manufacturer's instructions. Transportation or moving equipment may be performed

by the manufacturer or other service provider. Equipment is not returned to service until performance checks and verification have been performed and documented.

5. For mobile laboratories, equipment functionality is established prior to use by work instructions. Part F.4 (above) does not apply to equipment in mobile laboratories

6. ORA laboratories are secure. Only authorized personnel are permitted in the laboratory; non-authorized personnel are escorted. Computer software is write protected and, in most cases, password protected to prevent unauthorized program adjustments. These measures safeguard the equipment, sample security and computer software.

7. Definitions

Calibration – Calibration is the set of operations, under specified conditions, establishing the relationship between values of quantities by a measuring instrument or measuring system, or values represented by a material measure or reference material, and the corresponding values realized by standards.

Certified reference material (CRM) – A CRM is a reference material, whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or documentation issued by a certifying body.

General service equipment – General service equipment is laboratory equipment that is not used for measuring but that can affect the results of an analysis. Examples include grinders, blenders, ovens, furnaces, hotplates, stirrers, non-volumetric glassware used for approximate volume measurements (e.g. measuring cylinders), laboratory heating, and ventilation systems.

Installation qualification (IQ) – This is the identification of all system elements, electrical or otherwise. This identification and the subsequent documentation for each installed item details normal operating instructions, routine user maintenance, preventive maintenance and cleaning procedures.

Measuring instruments – This includes balances, chromatographs, spectrometers, thermometers, timers, viscometers, electrochemical meters.

Operational qualification (OQ) - OQ is generally described as commissioning. It includes calibration and critical instrument test parameters defined for the use and purpose of the instrument, and may include the definition of upper and lower tolerances.

Performance qualification (PQ) - PQ relates to the daily use of the instrument and is designed to measure routine performance. Details of work instructions and specifications are included.

Physical standards – Physical standards includes reference weights and reference thermometers.

Reference Standard – A reference standard usually has the highest metrological quality found at a given location in a given organization, from which measurements made there are derived. Generally, this refers to recognized national or international traceable standards such as National Institute of Standards and Technology (NIST) thermometers and weights.

Traceability – Traceability is the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties (VIM: 1999-6.10).

Verification Confirmation - Verification confirmation is through the provision of objective evidence that specified requirements have been fulfilled. (ISO 9000: 2000 3.8.4)

NOTE: : In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision to restore in service, perform adjustments or repair, downgrade or declare the equipment obsolete. In all cases, written traceability of the verification performed is kept on the measuring instrument's individual record.

8. Records

Equipment maintenance and performance checks records
Calibration records
Installation and operation qualification records obtained from equipment manufacturer or installer
Equipment inventory

9. Supporting Documents

FDA Staff Manual Guide, procedure for surplus equipment

Laboratory Thermometer Calibration Work Instruction

Laboratory Pipette Calibration Work Instruction

10. Attachments

Attachment A: Table 1, AOAC Equipment Maintenance and Performance Requirements
Attachment B: Table 2, AOAC Equipment Calibration and Verification Requirements

Document History					
Version No.	**Status** (I, R, C)	**Date Approved**	**Location of Change History**	**Name & Title**	
				Author	**Approving Official**
1.2	R	6/22/05	Attachment A - #3.added to Fume Hoods; #2 frequency for Spects changed to Daily Attachment B – Annual frequency for freezers, refrigerators, waterbaths, ovens, incubators, furnaces, autoclaves, thermometers checks added; row deleted on safety cabinets & vol. delivery devices;#2 added to freeze dryers, vacuum ovens	LMEB	LMEB
1.3	R	11/16/05	In Document	LMEB	LMEB
1.4	R	11/15/07	In Document	LMEB	LMEB
1.5	R	10/30/08	In Document	LMEB	LMEB
1.6	R	06/07/10	In Document	LMEB	LMEB

Approving Official's signature: _____ Date: _____

Table 1. Equipment Maintenance and Performance Requirements

NOTE 1: Documentation is required for annual maintenance. NOTE 2: Daily refers to measurements when in use.

Equipment	Requirement	Minimum Frequency
Autoclaves	1. Clean 2. Temperature and Time 3. Sterile control all media 4. Spore vials or strips 5. Service	1. After spills 2. Daily 3. Each load 4. Weekly 5. As per manufacturer or laboratory procedure
Balances	1. Clean 2. Mass measurement 3. Service Note: Balances used for USP analysis meets compendial specifications.	1. After each use 2. Daily with internal calibration or with a reference weight 3. Annually
Centrifuges	1.Clean 2. Sanitize (for micro use) 3. Service	1. After spills or breakages 2. Each month 3. As per laboratory procedure
Chromatographs	1. Refer to instrument manufacturer's instructions	1. As recommended by manufacturer or per laboratory procedure
Freezers	1. Clean, sanitize and reorganize 2. Temperature	1. As scheduled by lab 2. Daily
Fume hoods	1. Clean 2. Air flow monitor 3. Service (to include airflow)	1. After spills 2. Quarterly 3. Annually
ID Systems (eg. Vitek, VIDAS)	1. ± Reaction each lot	1. ± Culture reference
Incubators	1. Clean, sanitize 2. Temperature	1. As scheduled by lab 2. Daily am and pm
Media, prepared	1. Sterility, growth promotion, pH, appearance, expected reaction	1. Each batch
Microscopes	1. Clean objectives and eyepieces 2. Service	1. After each use 2. Annually
Ovens, Furnaces	1. Clean 2. Temperature	1. As scheduled by lab 2. Daily
Pipettes, petri dishes, plasticware (micro.)	Sterility	Each lot (manufacturer's certification fulfills requirement)
Rapid test kits (micro.)	Test in-house kit +/- controls.	Each lot and test run
Serological test	+ control and saline negative control	Each test run

Equipment	**Requirement**	**Minimum Frequency**
Refrigerators	1. Clean and sanitize 2. Temperature	1. As scheduled by lab 2. Daily
Still/De-ionized Water Systems	Clean DI System: Replace cartridge Service	As recommended by manufacturer
Safety Cabinets and Laminar flow hoods	1. Clean, sanitize 2. Test for air purity by exposing open culture plate 3. Service: check filter integrity, air flow velocity and direction 4. Monitor air flow	1. Each use 2. Each sample set-up 3. Annually 4. Quarterly
Spectrophotometers and Spectrometers (AA, UV/Vis fluorometric, ICP, Mass etc.)	1. Clean 2. System response (blank, standard, control, etc.)	1. After each use 2. Daily
Test reagents (micro)	1. +/- reaction	1. Each lot
Vial fillers (micro)	1. Clean	1. As scheduled by lab
Water, DI or Distilled	1. Conductivity 2. Aerobic Plate Count, Toxicity, Heavy Metals	1. Weekly 2. At installation, after repair, or system failure
Water baths	1. Clean 2. Temperature	1. As scheduled 2. Daily
pH meter	1. Clean electrodes	Each use

Table 2. Equipment Calibration or Verification Requirements

NOTE 1: Documentation is required for annual calibration or verification. NOTE 2: Daily refers to measurements when in use.

CALIBRATION OF EQUIPMENT

Equipment	Requirement	Minimum Frequency
Balances	1. Recognized mass standard	1. Annually
Freezers and Refrigerators	1. Stability and uniformity of temperature 2. Accuracy of temperature sensing unit	1. At installation & annually 2. At installation & annually
Dispensing equipment for microbiological media	1. Volume	1. At installation & daily
Glassware, Non-Class A, Volumetric: pipets, burets and volumetric flasks	1. Accuracy and precision using mass of water	1. Upon receipt
Hydrometer, Reference	1. One point calibration to standard of known specific gravity	1. Every two years
Hydrometer, Working	1. One point calibration to reference hydrometer	1. Annually
Incubators	1. Accuracy of temperature sensing system, uniformity and stability of temperature	1. At installation & 2. Annually
Microscopes	1. Calibrate stage micrometer	1. At installation
Ovens, Furnaces, Autoclaves, and Waterbaths	1. Accuracy of temperature sensing system, uniformity and stability of temperature	1. At installation & 2. Annually
Thermometer, Reference	1. Critical points on scale	1. Annually
Thermocouple, Reference	1. Calibration std. verification	1. Annually
pH meters, ion selective and conductivity equipment	1. pH reading with standard buffers or other known and standardized ionic solutions	1. Each use
Volumetric delivery devices; mechanical pipets and burets	1. Accuracy and precision	1. Every 6 months
Timers	1. National time standard	1. Annually
Weights, reference	1. Re-certification for accuracy from recognized national or international calibration units	1. Every 5 years
Weights, working	1. Verify against reference weights	1. Annually
Pipettes	1. Volume	1. Each lot (manufacturer's certification fulfills requirement)

VERIFICATION OF EQUIPMENT

Equipment	Requirement	Minimum Frequency
Spectrophotometers and Spectrometers (AA, UV/Vis fluorometric, ICP, Mass etc.)	1. Overall systems check: Wavelength (accuracy, precision, stability), source stability, detector performance (resolution, selectivity, stability, linearity, accuracy, precision), signal-to-noise (mass, ppm, wavelength, frequency, absorbance, transmittance, bandwidth, intensity), as applicable	1. Annually
Chromatographs	1. Overall system checks, column performance (resolution, capacity, retention), detector performance (output, response, noise, drift, selectivity, linearity), automatic sampler (accuracy and precision of time routines, reproducibility of injections), as applicable	1. Annually
Thermocouple, Working	Calibration versus reference thermocouple	Annually
Thermometer, Working	Specific points against reference thermometer	Annually
Freeze dryers, Vacuum ovens	1. Ability to achieve and sustain vacuum 2. Gauges calibrated and verified	1. Annually 2. Annually
Water activity meter	1. Water activity of known solutions	1. Each use