

Calibration of Measuring and Testing Equipment

Calibration Scheduling, Methods and Outcomes

Development

To define detail, scope and purpose.

Development

This information can be used to develop food safety and quality programs that meet the requirements of modern Regulatory, Customer and Industry Standards:

- We take the time to explain the expectations and requirements of food safety and quality compliance as these relate to your food safety and quality programs.
- You may choose to use our Premium Resources to build, enhance or upgrade your food safety and quality program.
- We encourage you to share this webpage with any food compliance associates and peers you believe may benefit from our commitment to providing our users with user-friendly information and resources to achieve a superior Food Compliance Culture.
- We welcome your suggestions for additions of general or specific content through the haccp.com Contact Page.

Key Definitions for Calibration of Measuring and Testing Equipment

- Calibration: The operation that compares the reading of a device against a traceable reference of known accuracy under specified conditions, and records the deviation and its uncertainty. Adjustment of the device, where required, is a separate step.
- Calibration Adjustment: A physical or electronic adjustment made to a device so that its readings fall within tolerance. It is usually performed after calibration shows a deviation, and should be followed by a re-test.
- Calibration Check: A comparison of a device against a reference to confirm that it is within tolerance, without adjusting it. It is sometimes called a verification check.
- CCP: Critical Control Point. A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level (see HACCP).
- Emissivity: A measure, on a scale from 0 to 1, of how effectively a surface emits infrared energy. It affects the readings of infrared thermometers.
- HACCP: Hazard Analysis and Critical Control Points. A systematic, preventive approach to food safety.
- Ice Point: The temperature at which pure water and ice are in equilibrium, which is 0°C (32°F) at standard atmospheric pressure. It is a common reference for checking thermometers.
- Infrared (IR): Electromagnetic radiation with wavelengths longer than visible light. It cannot be seen by the human eye, but it can be sensed as heat.
- Measurement Uncertainty: A value that expresses the doubt about a measurement result. It is normally stated on a calibration certificate.
- pH: A measure of the acidity or alkalinity of a solution, commonly expressed on a scale from 0 to 14, where 7 is neutral, values below 7 are acidic, and values above 7 are alkaline. It is the negative logarithm of the hydrogen ion concentration in moles per litre.
- Reference Standard: A device or material of known, certified accuracy, traceable to national or international standards, used to calibrate or check other devices.
- Standard Weight Reference: Also known as a test weight. A certified, traceable mass used to confirm the accuracy of a scale or other weighing device.
- Thermal Equilibrium: The state in which a device and its surroundings have stabilised at the same temperature, so that readings are no longer changing.
- Tolerance: The maximum deviation from the reference value that is permitted for a device to be considered fit for use.

- **Traceability:** The ability to relate a measurement result, through an unbroken chain of calibrations with stated uncertainties, to national or international standards.

Calibration of Measuring and Testing Equipment Development

When considering the development, documentation, and implementation of Calibration of Measuring and Testing Equipment within food safety and quality management systems, the following information should be considered to ensure effective outcomes:

Inaccurate equipment used to measure or test products or processes can compromise regulatory compliance and the safety and quality of food products. Calibration programs are implemented to ensure that measuring and testing equipment is accurate and capable of meeting its intended requirements.

Calibration is a technique used to confirm that the operational parameters of measuring and testing equipment are accurate. It is usually completed in two steps:

- **Testing:** The reading of the equipment or device is compared with a defined standard or reference device, and the deviation is recorded. A procedure for the methods used should be documented.
- **Adjustment and re-test:** The deviation can be used to adjust the equipment or device where adjustment is possible. A re-test is then completed to confirm the accuracy of the adjustment. Where a device cannot be adjusted, it may be used with a documented correction, or replaced. The accuracy of the calibrated equipment must be relevant to the risk-based context in which it is used, and should be within the accuracy nominated by relevant regulatory or industry standards.

What does Calibration Involve?

Calibration of Measuring and Testing Equipment involves comparing the readings of a device with those of a reference device, or a specially constructed and certified piece of calibration equipment. Readings are taken at several points across the operating range in which the device will be used (for example, at the ice point and at a hot holding temperature for a thermometer), and the difference from the reference value is recorded. The results allow the accuracy of the device to be assessed and documented as part of the food safety and quality system.

Depending on the type of equipment or device, calibration may be completed internally by the food business, or externally by an appropriate service provider. Calibration is commonly considered a component of the maintenance program.

Measuring and testing equipment that may require scheduled calibration includes:

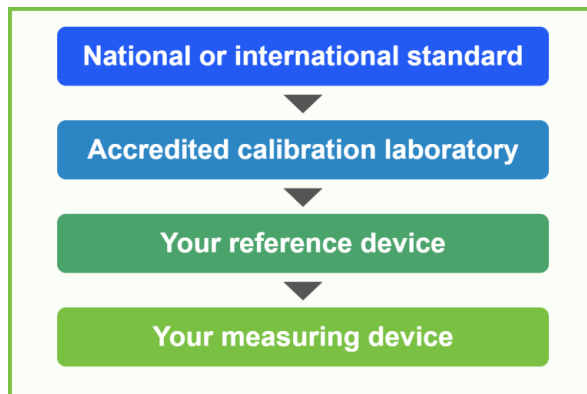
- Ovens, smokers, and retorts;
- Temperature probes, including thermometers, thermocouples, and thermistors;
- Infrared temperature devices, including radiation pyrometers;
- Data loggers and chart recorders;
- Scales and checkweighers;
- pH meters;
- Water activity meters;
- Refractometers;
- Conductivity meters and chlorine or other concentration measuring equipment;
- Chemical dispensing units, including spraying and dosing units for chemicals used in primary production;
- Optical and colour measuring equipment;

Additional devices include:

- Pressure gauges and sensors;
- Heat sensors and thermostats;
- Penetrometers;
- Laboratory incubators;
- Timers;

- Label printers and label verification systems;
- Metal detectors and X-ray inspection systems;
- Magnets (which are checked for pull strength rather than calibrated).

Reference Standards and Traceability



Traceability links each measuring device to national or international standards through an unbroken chain of calibrations.

The value of a calibration depends on the reference used. A reference standard should be certified, appropriate for the range and accuracy required, and traceable to national or international standards through an unbroken chain of calibrations. Each step in the chain contributes a stated measurement uncertainty.

Calibration certificates provided by external service providers should be reviewed on receipt. A certificate should typically show:

- The identification of the device calibrated and of the reference standards used;
- The date of calibration and the calibration method;
- The results obtained, including deviations from the reference values;
- The measurement uncertainty;
- A statement of traceability to national or international standards;
- The identification of the person or organisation that completed the calibration.

Where a calibration is critical to food safety or regulatory compliance, it is good practice to use a laboratory accredited to ISO/IEC 17025, and to confirm that the calibration in question is within the laboratory's scope of accreditation. The terminology used on this page is consistent with the International Vocabulary of Metrology (JCGM 200).

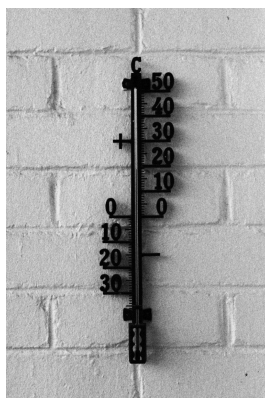
Calibration Frequency and Risk Assessment

The frequency of calibration should be based on risk. Factors that may be considered include:

- The criticality of the device, for example where it is used to monitor a CCP or to meet a legal requirement;
- Manufacturer's recommendations;
- Regulatory, customer, and certification standard requirements;
- The history of the device, including previous out-of-tolerance results and drift;
- The conditions of use, such as temperature extremes, moisture, vibration, or heavy usage;
- The consequence of an inaccurate result for food safety and quality.

Calibration frequencies should be documented in the calibration schedule, and reviewed when results, incidents, or changes in use indicate that a different frequency is appropriate.

Temperature Monitoring Equipment Calibration



Temperature measuring devices should be checked against a reference across the range in which they are used.

Calibration has the obvious benefit of determining whether temperature measuring devices are registering a true temperature reading. For a food safety system to remain verified, it should use temperature measuring devices that can accurately measure the temperature of foods requiring temperature control to within $\pm 1^{\circ}\text{C}$ ($\pm 1.8^{\circ}\text{F}$), or within the accuracy specified by relevant regulatory or customer requirements. Where thermometers are calibrated internally, it is important to ensure that the reference thermometer to which other temperature measuring devices are compared is accurate and is calibrated regularly to recognised standards.

Refrigeration Maintenance and Calibration

Whether monitored by external or internal parties, refrigeration plays a crucial part in any food safety program. The following protocols should be considered regarding the maintenance of refrigerated systems:

- Refrigerated units should not be overfilled with product. Overfilling reduces airflow between products and increases the chance of a breakdown, preventing the unit from bringing product temperatures down or holding them at optimum levels;
- Preventative maintenance and required repairs should be undertaken as scheduled, and all work must be documented as part of the food safety program;
- Any required repairs or related incidents must be reported to appropriate staff so that corrective action can be taken and recorded;
- Refrigeration service schedules should be carried out in line with legislation and industry-specific guidelines;
- Where temperature control is a major CCP for the business, refrigeration maintenance deserves closer attention than in businesses that rely less on refrigerated equipment;
- Fan, extraction, and condenser units should be cleaned regularly to remove dust and grease build-up;
- Door seals must be maintained so that they do not reduce the capacity of the equipment to hold appropriate temperatures, and so that they do not provide a breeding ground for bacterial pathogens;
- The calibration of all fitted temperature measuring devices should be carried out at least annually.

Types of Calibration

Calibration activities can generally be classed as either absolute or local, according to their methods. These terms are used here for continuity; absolute calibration is a traceable calibration with a stated uncertainty, and local calibration is a comparative check completed within the business.

Absolute Calibration

Absolute calibration is when readings are systematically measured against an instrument that has been calibrated by controlled methods and against recognised standards. Governmental authorities and national measurement institutes around the world maintain the scientific standards used to calibrate calibration equipment. Absolute calibration is usually completed in a manner that is traceable to those standards, and its results are reported with a stated measurement uncertainty.

Local Calibration

Where it is not possible to perform an absolute calibration, a local calibration, also known as a comparative test, can be performed to ascertain the working accuracy of a measuring or testing device. The reliability of such testing depends on the calibration of the equipment used for comparison and on the control of variables that may alter readings.

Laboratory Testing Equipment and Materials

Requirements for laboratory testing equipment and materials should include:

- Suitable size, construction, condition, and location of equipment used for testing and for controlling the environmental conditions under which testing is conducted;
- Inspection, cleaning, sanitation, and maintenance requirements for testing equipment;
- Calibration schedules, procedures, and records for relevant equipment;
- Provisions to ensure that equipment and materials used in testing do not interfere with the testing procedures or outcomes;
- Identification, traceability, description, and intended use information for reagents used for testing conducted at the site.

Laboratories that perform testing or calibration for others are commonly expected to operate in line with ISO/IEC 17025.

Temperature Calibration



An ice and water slush provides a reliable reference of 0°C (32°F) for checking thermometers.

Thermometers are among the most commonly calibrated measuring and testing devices in the food industry. The following are examples of how to complete local calibrations (comparative checks) for contact temperature measuring devices.

Ice point check. Fill an insulated container with crushed ice made from potable water, and add enough clean water to create a slush with ice throughout. Stir the mixture and immerse the thermometer to the depth recommended by the manufacturer, without letting the stem or sensing element touch the bottom or sides of the container. Allow the thermometer display to stabilise for at least a minute, and then read the temperature. The reading should be 0°C (32°F) within the tolerance set for the device.

Boiling point check. Water boils at 100°C (212°F) only at sea level. The boiling point falls as altitude increases, by roughly 1°C (1.8°F) for every 300 m, and varies with atmospheric pressure, so the local boiling point must be determined before this method is used, for example by using a calibrated reference thermometer. Use a vessel that is deep enough to remain unaffected by air cooling, with water at a rolling boil. Place the thermometer probe in the centre of the boiling water without touching the bottom or sides of the container, and allow the display to stabilise for at least a minute before reading. Take all necessary safety precautions to prevent scalding. The ice point check is generally the more reliable method, and boiling point checks are suitable only for devices rated for that temperature.

The reading, the deviation from the expected value, the tolerance, the date, and the person completing the check should be recorded. A device that is outside tolerance should be adjusted, repaired, or removed from use.

Contact Thermometers

For maximum accuracy, temperature measurements have historically been made with devices that contact the food directly. Contact thermometers come in a variety of shapes and sizes and employ various technologies. They all have a contact surface, or probe, that senses the heat of the food it touches. The sensor may be a liquid that expands and contracts; a bimetal, or combination of two different metals that expand or contract at different rates; a thermocouple that generates a small voltage; or a thermistor that varies its electrical resistance, all in proportion to the applied heat. The sensor reacts and the temperature is indicated on a dial, gauge, or display.

The compact size of most of these devices allows them to be carried in a pocket and used readily on a variety of food items. Contact thermometers have drawbacks, the largest of which is a delay in reaction time, and a probe that is not inserted to the correct depth may give an inaccurate reading.

Another consideration is the need to avoid cross-contamination. When taking multiple measurements, probes must be cleaned and sanitised between uses, and users must avoid transferring microorganisms from hands and other surfaces to the food being checked. Infrared thermometers avoid contact with the food, but they have their own limitations, which are described below.

Infrared Thermometers

Infrared radiation consists of electromagnetic wavelengths longer than visible light but shorter than microwaves. Infrared thermometers use this radiation to measure surface temperature without contact. To take a reading, the user aims the thermometer at the target, presses a button, and reads the temperature display.

The device has an optical lens that collects the infrared energy radiated from the object and focuses it on a detector. The detector converts the energy into an electrical signal that is amplified and displayed as a temperature reading. The thermometer measures the magnitude of the radiated energy and, using that data and the temperature of the detector, calculates the temperature of the surface that emitted the energy.

Because air is essentially transparent at infrared frequencies, an infrared thermometer can measure food surface temperature without touching the food. This reduces the risk of cross-contamination and avoids the thermal lag of a contact probe that must heat up or cool down after touching food. Infrared thermometers register a surface temperature quickly, which allows many food temperatures to be scanned over a short time as part of general food safety system surveillance.

Accurate temperature measurement is particularly important in the temperature range in which pathogenic bacteria can multiply rapidly, often referred to as the danger zone. The danger zone is commonly described as the range between about 5°C (41°F) and 60°C (140°F), although the exact limits vary between jurisdictions, and local legislation should be followed. If foods requiring temperature control, such as dairy products, seafood, meats, and eggs, remain within this range for more than a short time, bacteria can multiply and produce toxins that may cause foodborne illness. For more information, see Food-Borne Illness Prevention.

A non-contact thermometer can help staff check temperatures quickly, for example when scanning hot and cold holding areas to confirm that foods are at appropriate temperatures. Quick scans can identify potential problems early, and questionable readings can be followed up with a contact thermometer.

Infrared Thermometer Limitations

Infrared energy is emitted from the surface of the food, and the surface temperature is not always the same as the core temperature. Placing too much reliance on a surface reading is dangerous when the core of the food may remain in the danger zone, as is familiar to anyone who has defrosted or cooked a dense meal in a microwave oven.

Other factors that can affect the accuracy of infrared readings include:

- Emissivity: Shiny or reflective surfaces, such as foil or polished stainless steel, emit less infrared energy than matt surfaces, and can give readings that are too low unless the emissivity setting is adjusted or the surface is prepared;
- Distance-to-spot ratio: The area measured increases with distance, and the target must fill the field of view to give an accurate reading;
- Steam, vapour, condensation, and frost between the food and the thermometer optics;

- Food packaging materials, which may be opaque to infrared energy and will usually give the temperature of the packaging;
- Low temperatures: Where food is close to freezing, the weak infrared energy from a cold surface can be difficult to distinguish from the background, particularly in uncontrolled environments;
- Ambient temperature changes: A thermometer taken from one environment to another should be allowed to reach thermal equilibrium before use, because a changing optics temperature can produce errors.

Because of these limitations, regulators commonly do not accept infrared thermometers for enforcement or for demonstrating core temperature compliance. Used as intended by the manufacturer, they are effective screening tools. A reading from an infrared thermometer can be followed by measurement with a contact thermometer whenever questionable readings are obtained, and typical applications include checking surface temperatures of unpackaged, accessible food in hot or cold buffets where multiple consecutive readings are needed.

Thermometer User Information

Users of infrared thermometers play a critical role in the proper and effective operation of the device, so they must be adequately informed about its capabilities and limitations. Information is usually included with each thermometer to help educate users, including:

- Proper application and operation;
- Screening and surface measurement;
- How to switch between temperature scales such as Celsius and Fahrenheit;
- Operating temperature range;
- Ambient temperature range for use;
- Field of view, minimum spot area, and operating distance;
- Angle of measurement.

Further information that users should be aware of includes:

- Battery life, voltage, and type;
- Thermal shock and minimum stabilisation time;
- Adjustability of emissivity;
- Effects of packaging on readings;
- Use on surfaces other than food;
- Accuracy specifications, resolution, and repeatability;
- Cleaning instructions;
- Storage temperature and other storage conditions;
- Response time.

Coolroom and Freezer Calibration



Display and control thermometers on cool rooms and freezers should be compared with a reference device.

The calibration of fixed devices located in cool rooms and freezers may be completed using the following method, in the nominated sequence:

- Using an accurate reference device or reference thermometer, measure the temperature near the internal probe located inside the cool room or freezer. Where product temperature is the concern, place the reference probe in a container of water or glycol solution so that it responds slowly like product, and allow the reading to stabilise.
- Compare the recorded temperature with the temperature shown on the display of the fitted device. The display is usually found on the outside of the cool room or freezer.
- If the readings are not within $\pm 1^{\circ}\text{C}$ ($\pm 1.8^{\circ}\text{F}$) of each other, or within the tolerance specified by the business, the unit may need to be adjusted or serviced in line with the manufacturer's specifications.
- Record the readings, the deviation, the reference device used, and any action taken.

Although this is a simple method of rating the accuracy of temperature measuring devices, scientifically based principles regarding the correct use of thermometers and other temperature measuring devices must be followed to gain the most accurate results.

Calibration of Heating Units



Heating and cooking equipment should be checked against a calibrated reference probe.

Heating units may include:

- Hotboxes;
- Ovens;
- Hot smokers;
- Bain maries;
- Fryers;
- Kettles;
- Belt grills;
- Steamers;
- Microwave units.

Calibration of these devices is important, particularly where they are used for hot holding. A common method is to compare the temperature setting or display of the unit with the reading of a calibrated reference probe placed in the working zone, and to confirm that the unit reaches and holds the required temperature. To verify the capability of the devices to hold foods at appropriate temperatures, records of calibration and servicing must be maintained.

Because of the sensitive nature of the operation of these devices, and the potential for foods to become unsafe if they are not held at correct temperatures, it is vitally important that required repairs are carried out before the equipment is used again. Providers of external calibration services should be included within the approved supplier program (see Approved Supplier Management).

Calibration of Scales



Certified, traceable test weights are used to check the accuracy of scales.

A five-point check of a scale is often used as part of calibration. This is a corner and centre loading (eccentricity) test: first zero the scale, then place a test weight in turn on each of the four corners of the platform and in the middle. The read-out should be the same as the weight at all five positions, within the tolerance set for the scale.

The acceptable tolerance is generally set by the business or customer, based on the product, the risk, and any legal requirements. It should not be set arbitrarily, and the tolerance for scales used for trade or label declarations is defined by weights and measures (legal metrology) requirements.

It is recommended that scales are calibrated by an accredited external service provider at least annually. Weights and measures legislation in many countries and regions requires that scales used for trade are externally certified by an approved or accredited provider. We recommend that you refer to your local weights and measures authority for specific requirements.

Scales can be checked internally using a certified, traceable standard weight reference. The weight chosen should normally be similar to the product weight that the scale is used to measure, and the checks should cover the working range. For example, a 100 g (or ounce) standard weight reference would be appropriate for a scale used to weigh a 110 g (or ounce) product, whereas a 1,000 g (or ounce) weight would not generally be appropriate for that scale.

Internal checks are recommended daily, or at the start of each shift, for scales used to manufacture or sell products by net or gross weight, and whenever a scale has been moved or damaged.

Calibration of a pH Meter



Calibration buffers have a known pH and should bracket the range of products being tested.

Depending on the type of pH testing device, it may recognise the pH buffer automatically or perform the calibration adjustment automatically. Alternatively, most pH meters can be adjusted manually to ensure that they measure accurately.

It is generally considered best practice for pH meters to be calibrated before each session of use. Each pH testing device is slightly different in its accuracy, and accuracy changes with the age of the electrode. Uncalibrated pH testing devices can give inaccurate results, which may create food safety hazards, particularly where acidity is used to control microbiological growth. Calibration of pH meters is commonly known as pH electrode calibration, because the parameters set depend on the electrode rather than the device.

Calibration of a pH meter calls for two or three pH calibration buffers. These are liquids with a controlled and known pH, and they should bracket the range of pH values expected in the products being tested (for example, pH 4 and 7 for acid foods, or pH 4, 7, and 10 where a wider range is measured). Good practice includes:

- Using fresh, in-date buffers, and not reusing buffer that has been used;
- Rinsing the electrode with clean water between buffers, and blotting it dry without rubbing;
- Using temperature compensation, or buffers and samples at the same temperature;
- Dipping the electrode into each buffer and adjusting the displayed pH to the known pH of the buffer;
- Checking the electrode slope, which is commonly expected to be within about 95 to 105 percent, and replacing electrodes that cannot meet this;
- Confirming the calibration with a check buffer, and storing the electrode as the manufacturer recommends.

Calibration of a Metal Detector

In the food processing industry, one of the most common foreign materials found in food is metal. Metal contaminants can be unintentionally introduced to food products and become a safety hazard to consumers. One approach to preventing metal contamination is the use of metal detectors.

Metal detectors can detect metal contaminants such as ferrous metals (iron), non-ferrous metals (such as copper, lead, and brass), and stainless steel. Sensitivity differs between these metal types, and it is also affected by the nature of the product.

Depending on the type of metal detector and the nature of operations, metal detection units are commonly checked by passing certified test pieces through the device using a validated, best practice method. Good practice includes:

- Using certified ferrous, non-ferrous, and stainless steel test pieces of the sizes defined for the product;
- Testing at the start of production, at defined intervals, at the end of production, and after changeovers or repairs;
- Passing test pieces through the most difficult position, usually the centre of the aperture, and within the product where possible;
- Confirming that the reject device operates correctly and that the system fails safe;
- Recording the sensitivity of the unit and the effectiveness of the detection system.

The frequency of such checks is determined by risk assessment. Similar principles apply to X-ray inspection systems.

Chemical Dosing

Dosing involves the mixing and application ratios and amounts of the chemicals applied. The critical factor in ensuring foods do not pose a safety risk to consumers in this context is adhering to science-based mixing and application rates. These ratios are usually defined within the chemical manufacturer's instructions for use, in conjunction with best practice, regulatory, and industry requirements.

Mixing ratios are the dilution rates for chemicals, which are generally mixed with water for application. They are formulated on scientific data to ensure that the chemical application is effective and that the risk of chemical contamination is controlled. Concentrations can be verified with test kits, conductivity meters, or titration.

Application ratios define how much of the diluted chemical is applied within a specific area, or onto a specific crop. These can be justified by the scheduled calibration of chemical application equipment, such as measuring the output of a sprayer over a known area, which may be documented on a Chemical Application Equipment Calibration Log.

Out-of-Tolerance Results and Impact Assessment

If a measuring or testing device is found to be outside the acceptable tolerance, the following steps should be considered:

- Remove the device from use, or clearly identify it as out of service;
- Investigate the product, processes, or tests that relied on the device since its last satisfactory calibration, and assess the impact on food safety and quality;
- Hold or quarantine any affected product until the assessment is complete, and take appropriate action, including recall or withdrawal where required;
- Adjust, repair, or replace the device, and re-test it against a reference before it is returned to service;
- Record the outcome and any corrective and preventative actions (see Corrective Action and Preventative Action).

A device that is found to be out of tolerance should be repaired by the manufacturer or an authorised and approved service provider where applicable. Failure to act promptly could compromise food safety or quality, or breach food law.

Calibration Records, Labels and Equipment Register

Calibration activities should be controlled through an equipment register and calibration schedule. Useful elements include:

- A unique identification for each device, with details such as make, model, and serial number;
- The location of storage and use;
- Labels or stickers affixed to measuring and testing equipment, showing that the device has been calibrated, the date of the next calibration, and commonly the calibration tolerance or outcome;
- A clear status for each device (in service, out of service, or awaiting calibration);
- Calibration records and certificates retained for the period defined by the business and by legislation or certification requirements.

Calibration of Measuring and Testing Equipment Development Key Points

- Calibration of Measuring and Testing Equipment programs must be developed to meet relevant Regulatory, Industry, and Customer standards and requirements;
- The Senior Management of your business is committed to providing adequate resources for the development of your Calibration of Measuring and Testing Equipment program;
- Should you require additional resources for the development of Calibration of Measuring and Testing Equipment program elements, please discuss this with the relevant Senior Management representative;
- A properly developed Calibration of Measuring and Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and

requirements;

- A poorly developed Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Documentation

To establish the developed detail in a viewable format to facilitate information.

Documentation

Document: A document provides guidance or direction for performing work, making decisions, or rendering judgments that affect the safety or quality of the products or services that customers receive.

Documented policies, procedures, work instructions, and schedules form the basis of any food safety and quality management system. The following documentation formats may be considered to ensure ongoing compliance with specified requirements for Calibration of Measuring and Testing Equipment:

- Calibration of Measuring and Testing Equipment policy;
- Calibration of Measuring and Testing Equipment development procedures;
- Calibration of Measuring and Testing Equipment implementation procedures and work instructions;
- Calibration of Measuring and Testing Equipment monitoring procedures;
- Calibration of Measuring and Testing Equipment corrective and preventative action procedures;
- Calibration of Measuring and Testing Equipment verification schedule;
- Calibration of Measuring and Testing Equipment verification procedures;
- Calibration of Measuring and Testing Equipment validation schedule;
- Calibration of Measuring and Testing Equipment validation procedures;
- Calibration of Measuring and Testing Equipment training procedures;
- Equipment register and calibration schedule;
- Calibration records and certificates;
- Out-of-tolerance procedure, including product impact assessment;
- Labelling and status control procedure for calibrated equipment.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Documentation requirements in relation to their items.

You may wish to visit the Calibration of Measuring and Testing Equipment Templates section of haccp.com for examples of Calibration of Measuring and Testing Equipment documentation, record, and resource formats commonly applied within food safety and quality systems.

Calibration of Measuring and Testing Equipment Documentation Key Points

- Calibration of Measuring and Testing Equipment programs must be documented to meet relevant Regulatory, Industry, and Customer standards and requirements;
- All documented Calibration of Measuring and Testing Equipment program elements must be controlled to ensure compliance;
- Key documented Calibration of Measuring and Testing Equipment program elements should be available to your business's team at all times to ensure they can carry out required tasks;
- A properly documented Calibration of Measuring and Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- A poorly documented Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Implementation

To facilitate the application of the documentation.

Implementation

Implementation: Implementation is the application of documented food safety and quality system elements into the actual business operation.

The implementation of Calibration of Measuring and Testing Equipment within any food business requires genuine commitment from senior management, staff, contractors, and visitors to ensure the nominated goals of implementation are achievable on an ongoing basis. It is a step that requires significant planning and consideration of general and specific food business circumstances, so that the outcomes of Calibration of Measuring and Testing Equipment do not negatively affect the safety and quality of the food items dispatched from the business.

Implementation of Calibration of Measuring and Testing Equipment must include a clear definition of responsibilities and authorities for all levels of participation by senior management, staff, contractors, and visitors to the site.

When implementing Calibration of Measuring and Testing Equipment within a food safety and quality system, the following requirements may be considered before completion:

- Communication and display of the Calibration of Measuring and Testing Equipment policy;
- Completion of verification and validation of Calibration of Measuring and Testing Equipment development procedures;
- Availability of Calibration of Measuring and Testing Equipment implementation procedures and work instructions;
- Availability of Calibration of Measuring and Testing Equipment monitoring procedures and record templates where applicable;
- Availability of Calibration of Measuring and Testing Equipment corrective and preventative action procedures and record templates where applicable;
- Availability of the Calibration of Measuring and Testing Equipment verification schedule and procedures;
- Availability of the Calibration of Measuring and Testing Equipment validation schedule and procedures;
- Completion of Calibration of Measuring and Testing Equipment training procedures;
- Completion of product design and development requirements related to Calibration of Measuring and Testing Equipment;
- Completion of process design and development requirements related to Calibration of Measuring and Testing Equipment;
- Completion of training for team members who have responsibilities and involvement within Calibration of Measuring and Testing Equipment;
- Completion of competency approval for team members who have responsibilities and involvement within Calibration of Measuring and Testing Equipment;
- Completion of an initial calibration of all devices in the equipment register, with labels or status identification applied.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Implementation requirements in relation to their items.

Calibration of Measuring and Testing Equipment Implementation Key Points

- Calibration of Measuring and Testing Equipment programs must be implemented to meet relevant Regulatory, Industry, and Customer standards and requirements;
- Your Calibration of Measuring and Testing Equipment program must be fully implemented in line with relevant documented Policies, Procedures, and Work Instructions;
- The implementation of Calibration of Measuring and Testing Equipment requires a commitment to the provision of resources by the Senior Management of your business;
- A properly implemented Calibration of Measuring and Testing Equipment program will provide a strong

framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;

- A poorly implemented Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Monitoring

To review, confirm and document evidence of the implementation against documented limits.

Monitor

Monitoring: Monitoring is the act of reviewing and confirming measurable parameters of a defined process or product status.

Monitoring requirements within food industry sectors are generally identified against limits of acceptability defined within HACCP plans, implementation procedures, and work instructions. Monitoring usually includes some element of record-keeping, which may be maintained manually or through digital systems. Advancements in technology have produced many systems and processes that are self-monitored or self-adjusted when variances are identified. Regardless of the system used, the goal of any monitoring activity is to provide sufficient evidence that any limit of acceptability has been met.

Traditional Calibration of Measuring and Testing Equipment monitoring requirements include manual recording and the application of corrective actions when the results of monitoring are found to be outside acceptable limits. Corrective actions should also be strongly linked to the monitoring process to ensure full traceability of the actions applied.

The following examples of monitoring activities and record formats may be applicable to Calibration of Measuring and Testing Equipment:

- Calibration schedule, including the equipment to be calibrated, identification details (make, model, and serial number), storage and use locations, frequency, responsibility, methods, and tolerances for internal calibration, frequency, responsibility, methods, and tolerances for external calibration, and relevant internal and external validations for accuracy;
- Calibration records, including reference to the calibration schedule, the outcomes of calibration for the calibrated device, the calibration date, the reference devices used, and conformance statements;
- Labels or stickers affixed to measuring and testing equipment, which indicate that the device has been calibrated and commonly show the next calibration date and tolerance;
- Routine checks, such as ice point checks of thermometers or test weight checks of scales at the start of use, with out-of-tolerance results flagged for action.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Monitoring requirements in relation to their items.

You may wish to visit the Calibration of Measuring and Testing Equipment Templates section of haccp.com for examples of Calibration of Measuring and Testing Equipment documentation, record, and resource formats commonly applied within food safety and quality systems.

Calibration of Measuring and Testing Equipment Monitoring Key Points

- Monitoring provides real-time confirmation and evidence that your risk-based food safety and quality controls are effectively implemented;
- Calibration of Measuring and Testing Equipment programs must be monitored to meet relevant Regulatory, Industry, and Customer standards and requirements;
- Monitoring of Calibration of Measuring and Testing Equipment must be carried out in line with relevant documented Policies, Procedures, and Work Instructions;
- Nominated monitoring records for Calibration of Measuring and Testing Equipment must be maintained in line with relevant documented Policies, Procedures, and Work Instructions;

- A properly monitored Calibration of Measuring and Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- A poorly monitored Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Corrective Action and Preventative Action

To apply "real time" interventions to documented monitoring limits.

Corrective Action

Corrective Action: Corrective action is mandatory action to be taken when a deviation from the quality system occurs, particularly concerning a Critical Control Point.

Preventative Action: At any step in the process where a hazard has been identified, preventative action must be put into place to prevent recurrence.

Corrective action and preventative action are implemented to ensure identified non-conformances are documented, investigated, and rectified within appropriate timeframes. Corrective action is any action applied to regain control over a product, process, policy, or procedure that has been identified as non-conforming or outside nominated limits of acceptability. Preventative action is any action applied to prevent an identified non-conformance from recurring.

The outcomes of corrective and preventative actions should result in regained process control after effective application. Specified corrective actions are commonly linked to the HACCP plan and the food business certification process.

Below are corrective action and preventative action examples that may be associated with Calibration of Measuring and Testing Equipment non-conformances:

- Review of the Calibration of Measuring and Testing Equipment policy;
- Review of the Calibration of Measuring and Testing Equipment development procedures;
- Review of the Calibration of Measuring and Testing Equipment implementation procedures and work instructions;
- Review of the Calibration of Measuring and Testing Equipment monitoring procedures;
- Review of the Calibration of Measuring and Testing Equipment corrective and preventative action procedures;
- Review of the Calibration of Measuring and Testing Equipment verification schedule and procedures;
- Review of the Calibration of Measuring and Testing Equipment validation schedule and procedures;
- Review of Calibration of Measuring and Testing Equipment training procedures;
- Retraining in Calibration of Measuring and Testing Equipment;
- Review of management review activities to include Calibration of Measuring and Testing Equipment as an agenda item;
- Initiation of product hold procedures where safety or quality may be compromised;
- Initiation of a product recall or recall procedures where investigations show that there is a substantial safety or quality risk to the released product;
- Contacting stakeholders, including customers, regarding any confirmed or potential Calibration of Measuring and Testing Equipment concerns involving their product;
- Where a device is found to be out of tolerance after calibration, assessing the impact on product handled since the last satisfactory calibration, and removing the device from use until it is adjusted, serviced, or repaired by the manufacturer or an authorised and approved service provider (see Approved Supplier Management). Failure to act promptly could compromise food safety or quality, or breach food law;
- A post-incident review after any significant out-of-tolerance result, with the findings and resulting actions recorded.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any

specific Calibration of Measuring and Testing Equipment Corrective Action requirements in relation to their items. You may wish to visit the Corrective Action and Preventative Action section of haccp.com for examples of best practice applications for this food safety and quality system element.

Calibration of Measuring and Testing Equipment Corrective Action and Preventative Action Key Points

- The implementation of Corrective Action and Preventative Action provides confidence that your food safety and quality program is effectively implemented and that food safety and quality criteria are being met;
- Where deviations or variations are observed, Corrective Action and Preventative Actions must be carried out to meet relevant Regulatory, Industry, and Customer standards and requirements;
- Corrective Action and Preventative Action of Calibration of Measuring and Testing Equipment must be carried out in line with relevant documented Policies, Procedures, and Work Instructions;
- Records of corrective action and preventative action for Calibration of Measuring and Testing Equipment must be maintained in line with relevant documented Policies, Procedures, and Work Instructions;
- Proper application of Corrective Action and Preventative Action for your Calibration of Measuring And Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- Poor application of Corrective Action and Preventative Action for your Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Verification

To review and confirm documented monitoring and corrective actions against documented parameters.

Verify

Verification: The act of reviewing, inspecting, testing, checking, auditing, or otherwise establishing and documenting whether items, processes, services, or documents conform to specified requirements.

Verification is the detailed review of all food safety and quality system elements to confirm that they are effectively developed, documented, implemented, monitored, and reviewed. All food safety and quality system elements, including documented policies, procedures, training, HACCP plans, and their operational applications, should be verified on an ongoing scheduled basis. The verification process commonly includes a defined schedule of the verification activities required, how often they are conducted, who is responsible, and detailed documented procedures for each nominated verification activity.

The general goal of an established verification process is to ensure that any systemic non-conformances are identified and rectified within an appropriate timeframe. When non-conformances are identified through the verification process, corrective actions and preventative actions should be implemented to ensure they do not affect the effectiveness of the food safety and quality system.

The following examples of verification activities may be applicable to Calibration of Measuring and Testing Equipment:

- Review of the Calibration of Measuring and Testing Equipment policy;
- Review of the Calibration of Measuring and Testing Equipment development procedures;
- Review of the Calibration of Measuring and Testing Equipment implementation procedures and work instructions;
- Review of the Calibration of Measuring and Testing Equipment monitoring procedures;
- Review of the Calibration of Measuring and Testing Equipment corrective and preventative action procedures;
- Review of Calibration of Measuring and Testing Equipment monitoring records;
- Review of the Calibration of Measuring and Testing Equipment verification schedule and procedures;
- Review of the Calibration of Measuring and Testing Equipment validation schedule and procedures;
- Review of Calibration of Measuring and Testing Equipment training procedures;

- Review of Calibration of Measuring and Testing Equipment performance since the last review and historically;
- Analytical testing of product or process to confirm the effectiveness of Calibration of Measuring and Testing Equipment where applicable;
- Periodic checks of in-house reference thermometers and test weights against an accredited external reference;
- Review of calibration certificates, including confirmation that the calibration is within the laboratory's scope of accreditation;
- Annual review of the equipment register and calibration schedule, with validation certifications requested and updated within the Calibration of Measuring and Testing Equipment system;
- Inclusion of Calibration of Measuring and Testing Equipment as an agenda item within the Management Review process.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Verification requirements in relation to their items.

You may wish to visit the Verification Activities section of haccp.com for examples of best practice applications for this food safety and quality system element.

Calibration of Measuring and Testing Equipment Verification Key Points

- Your verification program provides evidence that your food safety and quality controls have worked;
- Calibration of Measuring and Testing Equipment programs must be verified to meet relevant Regulatory, Industry, and Customer standards and requirements;
- The verification of Calibration of Measuring and Testing Equipment must be carried out in line with relevant documented Policies, Procedures, and Work Instructions;
- Nominated verification records for Calibration of Measuring and Testing Equipment must be maintained in line with relevant documented Policies, Procedures, and Work Instructions;
- A properly verified Calibration of Measuring and Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- A poorly verified Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Validation

To confirm the documented monitoring or procedural limits.

Validate

Validation: The process of gathering evidence to provide a scientific basis for the documented act of demonstrating that a procedure, process, or activity will consistently lead to the expected results. It often includes the qualification of systems and equipment.

Validation is the provision of evidence to support the limits of control or acceptability for food safety or quality parameters nominated within systemic elements. Limits of control or acceptability are commonly included within documented food safety and quality system elements such as procedures, HACCP plans, and specifications.

Common sources of validation include regulatory and legislative standards, finished product specifications and customer requirements, industry codes of practice and guidelines, verified and validated research, historical product and process control outcomes, and analytical testing.

The general goal of an established validation process is to ensure that any inappropriate limits of control or acceptability are identified and rectified within an appropriate timeframe. When non-conformances are identified through the validation process, corrective actions and preventative actions should be implemented to ensure they do not affect the effectiveness of the food safety and quality system.

Validation activities are commonly defined within the verification schedules and procedures of established food

safety and quality management systems.

The following examples may be applicable to the validation of the limits of control or acceptability for Calibration of Measuring and Testing Equipment:

- Confirmation that the tolerances set for each device are justified against regulatory, industry, customer, or finished product specification requirements, and against the process need;
- Confirmation that the reference device is considerably more accurate than the device it is used to check (commonly four times more accurate, or better);
- Confirmation that the calibration methods used are appropriate for the device and the range in which it is used;
- Confirmation of analytical testing methods being used to confirm the effectiveness of Calibration of Measuring and Testing Equipment and ensure the accuracy of outcomes.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Validation requirements in relation to their items.

You may wish to visit the Validation Activities section of haccp.com for examples of best practice applications for this food safety and quality system element.

Calibration of Measuring and Testing Equipment Validation Key Points

- Your validation program provides evidence that your food safety and quality controls will work;
- Calibration of Measuring and Testing Equipment programs must be validated to meet relevant Regulatory, Industry, and Customer standards and requirements;
- The validation of Calibration of Measuring and Testing Equipment must be carried out in line with relevant documented Policies, Procedures, and Work Instructions;
- Nominated validation records and supporting documentation for Calibration of Measuring and Testing Equipment must be maintained in line with relevant documented Policies, Procedures, and Work Instructions;
- A properly validated Calibration of Measuring and Testing Equipment program will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- A poorly validated Calibration of Measuring and Testing Equipment program will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

Training, Competency and Resources

Skills, knowledge and competency requirements to facilitate development, documentation, implementation, monitoring, corrective action, verification and validation of every Food Safety and Quality System Element.

Skills and Knowledge

Skills and Knowledge: Skills and knowledge are attributes of human interactions commonly linked to competency within any specified job-related task.

Training and competency requirements for Calibration of Measuring and Testing Equipment must be ongoing, including regularly scheduled reviews to ensure the effectiveness of training and competency outcomes.

Team members who have defined responsibilities regarding Calibration of Measuring and Testing Equipment should have knowledge including:

- Basic Calibration of Measuring and Testing Equipment requirements;
- Positive outcomes of Calibration of Measuring and Testing Equipment;
- Negative outcomes of a lack of Calibration of Measuring and Testing Equipment;
- Current Calibration of Measuring and Testing Equipment procedures, methods, and techniques;
- General operational, corporate, and social awareness regarding Calibration of Measuring and Testing Equipment;
- Regulatory, industry, and customer requirements regarding Calibration of Measuring and Testing Equipment.

Team members who have defined responsibilities regarding Calibration of Measuring and Testing Equipment should have skills including:

- Competency regarding basic Calibration of Measuring and Testing Equipment;
- Effective application of current Calibration of Measuring and Testing Equipment procedures, methods, and techniques;
- The correct use of reference devices, and the interpretation of calibration certificates;
- Recording calibration results, and escalating out-of-tolerance results;
- Safe handling during calibration, for example when using boiling water;
- The basic development, documentation, and implementation of HACCP and Prerequisite Programs (see Good Manufacturing Practices) within the food industry sector.

Team members who have defined responsibilities regarding Calibration of Measuring and Testing Equipment should have access to resources including:

- Calibration of Measuring and Testing Equipment training;
- Calibration of Measuring and Testing Equipment associations and events;
- Regulatory standards, and industry and customer information and updates regarding Calibration of Measuring and Testing Equipment;
- Incidents within the food industry sector regarding Calibration of Measuring and Testing Equipment;
- Commitment to Calibration of Measuring and Testing Equipment by senior management;
- Suitably qualified food industry professionals with verified experience in Calibration of Measuring and Testing Equipment;
- Effective communication systems, including email, internet, and phone, through which Calibration of Measuring and Testing Equipment information can be sent and received within suitable timeframes.

If your food business supplies foodstuffs manufactured to a customer's specifications, it is important to consider any specific Calibration of Measuring and Testing Equipment Training, Competency, and Resources requirements in relation to their items.

You may wish to visit the Training, Competency, and Resources section of haccp.com for examples of best practice applications for this food safety and quality system element.

Calibration of Measuring and Testing Equipment Training, Skills, and Knowledge Key Points

- Your Training, Skills, and Knowledge program ensures all participating personnel, contractors, and visitors have the required skills and knowledge to effectively meet the requirements of your food safety and quality program;
- Training, Skills and Knowledge programs for Calibration of Measuring and Testing Equipment must be carried out to meet relevant Regulatory, Industry, and Customer standards and requirements;
- Training, Skills and Knowledge programs for Calibration of Measuring and Testing Equipment must be carried out in line with relevant documented Policies, Procedures, and Work Instructions;
- Training, Skills and Knowledge records for Calibration of Measuring and Testing Equipment must be maintained in line with relevant documented Policies, Procedures, and Work Instructions;
- Properly applied Training, Skills, and Knowledge programs for Calibration of Measuring and Testing Equipment will provide a strong framework for your business to maintain compliance with relevant Regulatory, Industry, and Customer standards and requirements;
- Poorly applied Training, Skills, and Knowledge programs for Calibration of Measuring and Testing Equipment will not fully support your business and may contribute to significant non-compliance against Regulatory, Industry, and Customer standards and requirements.

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