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The content presented in this section is based on the following provisions found within the Food Code:

- 1-201.10(B)(94) Statement of Application and Listing of Terms
- 4-203.11 Temperature Measuring Devices, Food
- 4-203.12 Temperature Measuring Devices, Ambient Air and Water
- 4-302.12 Food Temperature Measuring Devices
- 4-502.11(B) Good Repair and Calibration

The Food Code is available at: <http://www.cfsan.fda.gov/~dms/fc05-toc.html>

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## Thermometers

- Thermometers must be:
  - In degrees Centigrade (°C) *or*
  - both in Celcius (°C) and degrees Fahrenheit (°F)
- Thermometers only in °F must be accurate to  $\pm 2^{\circ}\text{F}$ .
- Thermometers dually scaled must be accurate to  $\pm 1^{\circ}\text{C}$ .
- Examples of thermometers:
  - Instant-read, thermocouple/thermistor, infrared, and time-temperature indicator

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### DIGITAL FOOD THERMOMETERS

**Thermocouples.** Of all food thermometers, thermocouples read and display the final temperature the fastest - within 2 to 5 seconds. The temperature appears on a digital display. A thermocouple measures temperature at the junction of two fine wires located in the tip of the probe. Thermocouples used in scientific laboratories have very thin probes, similar to hypodermic needles, while others may have a thickness of 1/16-inch. Because thermocouple thermometers respond so rapidly, the temperature can be quickly checked in a number of locations to ensure that the food is thoroughly cooked. This is especially useful for cooking large foods, such as roasts or turkeys, when checking the temperature in more than one place is advised. The thin probe of the thermocouple also enables it to accurately read the temperature of thin foods such as hamburger patties, pork chops, and chicken breasts. Thermocouples are not designed to remain in the food while it is cooking. They should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking.

**Thermistors.** Thermistor-style food thermometers use a resistor (a ceramic semiconductor bonded in the tip with temperature-sensitive epoxy) to measure temperature. The thickness of the probe is approximately 1/8-inch, and it takes roughly 10 seconds to register the temperature on the digital display. Since the semiconductor is in the tip, thermistors can measure temperature in thin foods, as well as thick foods. Because the center of a food is usually cooler than the outer surface, the tip should be placed in the center of the thickest part of the food. Thermistors are not designed to remain in the food while it's cooking. They should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking.

**Oven cord thermometers.** Oven cord thermometers allow the cook to check the temperature of food in the oven without opening the oven door. A base unit with a digital screen is attached to a thermistor-type food thermometer probe by a long metal cord. The probe is inserted into the food, and the cord extends from the oven to the base unit. The base can be placed on the counter or attached to the stovetop or oven door by a magnet. The thermometer is programmed for the desired temperature, and it beeps when the temperature is reached. While designed for use in ovens, these thermometers can also be used to check foods cooking on the stove.

**Thermometer fork combination.** This utensil combines a cooking fork with a food thermometer. A temperature-sensing device is embedded in one of the tines of the fork. There are several different brands and styles of thermometer forks on the market; some using thermocouples and some using thermistors. The

food temperature is indicated on a digital display or by indicator lights on the handle within 2 to 10 seconds (depending on the type). These lights will tell if the food has reached rare, medium, well done, etc. Particularly useful for grilling, the thermometer fork will accurately measure the internal temperature of even the thinnest foods. The thermometer fork should be used to check the temperature of a food toward the end of the estimated cooking time. Thermometer forks are not designed remain in a food while in the oven or on the grill. Thermometer forks cannot be calibrated.

## **DIAL FOOD THERMOMETERS**

**Bimetallic-coil thermometers.** These thermometers contain a coil in the probe made of two different metals that are bonded together. The two metals have different rates of expansion. The coil, which is connected to the temperature indicator, expands when heated. This food thermometer senses temperature from its tip and up the stem for 2- to 2-1/2 inches. The resulting temperature is an average of the temperatures along the sensing area. These food thermometers have a dial display and are available as "oven-safe" and "instant-read."

**"Oven-safe" bimetallic-coil thermometers.** This food thermometer is designed to remain in the food while it is cooking in the oven, and is generally used for large items such as a roast or turkey. This food thermometer is convenient because it constantly shows the temperature of the food while it is cooking. However, if not left in the food while cooking, these thermometers can take as long as 1 to 2 minutes to register the correct temperature. The bimetal food thermometer can accurately measure the temperature of relatively thick foods (such as beef roasts) or deep foods (foods in a stockpot). Because the temperature-sensing coil on the stem is 2- to 2-1/2 inches long and the stem is relatively thick, it is not appropriate to measure the temperature of any food less than 3 inches thick. There is concern that because heat conducts along the stem's metal surface faster than through the food, the area of the food in contact with the thermometer tip will be hotter than the area a short distance to the side (the "potato nail effect"). To remedy this, the temperature should be taken in a second, and even third, area to verify the temperature of the food. Each time the thermometer is inserted into the food, let the thermometer equilibrate (come to temperature) at least 1 minute before reading the temperature. Some models can be calibrated. Check the manufacturer's instructions.

**Instant-read bimetallic-coil thermometers.** This food thermometer measures the temperature of a food in about 15 to 20% seconds. It is not designed to remain in the food while it is cooking in the oven, but should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking. For accurate temperature measurement, the probe of the bimetallic-coil thermometer must be inserted the full length of the sensing area (usually 2 to 3 inches). If measuring the temperature of a thin food, such as a hamburger patty or boneless chicken breast, the probe should be inserted through the side of the food so that the entire sensing area is positioned through the center of the food. Some models can be calibrated. Check the manufacturer's instructions.

**Single-use temperature indicators.** One of the most recent developments in the retail food market is the emergence of disposable temperature indicators. Several brands are available, and all make quick work of determining if a food has reached its final temperature. These temperature sensors are designed for specific temperature ranges, for example, 160°F-170°F. These sensors should only be used only with foods for which they are intended. Read the package directions to ensure that the temperature the sensor will reach is consistent with the recommended internal cooking temperature. The sensors on disposable thermometers are made from special temperature-sensitive materials. The sensor is inserted into a food. When the food reaches the proper temperature, the sensor changes color. They are designed to be used only once. However, if the desired temperature has not been reached, they can be reinserted until the temperature is reached. These sensors cannot be left in a food while it is cooking. They should be used near the end of the estimated cooking time. To prevent overcooking, check the temperature before the food is expected to finish cooking. Disposable temperature indicators are made from materials approved by the FDA for contact with food.

**Pop-up timers.** Commonly used in turkeys and roasting chickens since 1965, the "pop-up" temperature device is constructed from a food-approved nylon. The inside contains a stainless steel spring and firing

material. The firing material is made of an organic salt compound or an alloy of metals commonly used in other thermo-sensing devices. The tip of the stem is imbedded in the firing material until it melts, releasing the stem, which is then "popped up" by means of the spring. This indicates that the food has reached the final temperature for safety and doneness. Pop-up timers are reliable within 1°F to 2°F if accurately placed in a food; however, checking the temperature of other parts of the food with a conventional food thermometer is recommended.

#### **OTHER TYPES OF FOOD THERMOMETERS**

**Liquid-filled thermometers.** Also called "spirit-filled" or "liquid in glass" thermometers, these thermometers are the oldest kind of food thermometer used in home kitchens. They have either metal or glass stems. As the internal temperature of the food increases, the colored liquid inside the stem expands and rises to indicate the temperature on a scale. Heat conduction in the metal stems can cause false high readings. They are designed to remain in the food while it is cooking. They should be inserted at least 2 inches deep in the thickest part of the food; therefore, they are not appropriate for thin foods. Some liquid-filled thermometers can be calibrated by carefully moving the glass stem within the holder.

**Candy/jelly/deep fry thermometers.** These thermometers will measure temperatures ranging from 100°F to 400°F. They are used to measure the extra-high temperatures required of candy and jelly making, as well as frying with hot oil.

#### **APPLIANCE THERMOMETERS**

**Refrigerator/freezer thermometers.** For safety, it is important to verify the temperature of refrigerators and freezers. Refrigerators should maintain at a temperature no higher than 40°F. Frozen food will hold its top quality for the longest possible time when the freezer maintains 0°F. An appliance thermometer can be kept in the refrigerator and freezer to monitor temperature. This can be critical in the event of a power outage. When power returns after an outage, the food is safe if the refrigerator is 40°F or colder and the freezer is still colder than 40°F. These bimetallic-coil thermometers are specially designed to provide accuracy at cold temperatures.

**Oven thermometers.** An oven thermometer can be left in the oven to verify that the oven is heating to the desired temperatures. These bimetallic-coil thermometers can measure temperatures from 100°F to 600°F.

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The speaker notes for Slide 81 describe the thermometers shown in this slide.

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## Checking Your Thermometer

Check the accuracy of all food thermometers:

- at least once a day
- every time it is dropped
- After being exposed to extreme temperatures

Methods to check the accuracy:

- Boiling water method
- Ice-point method

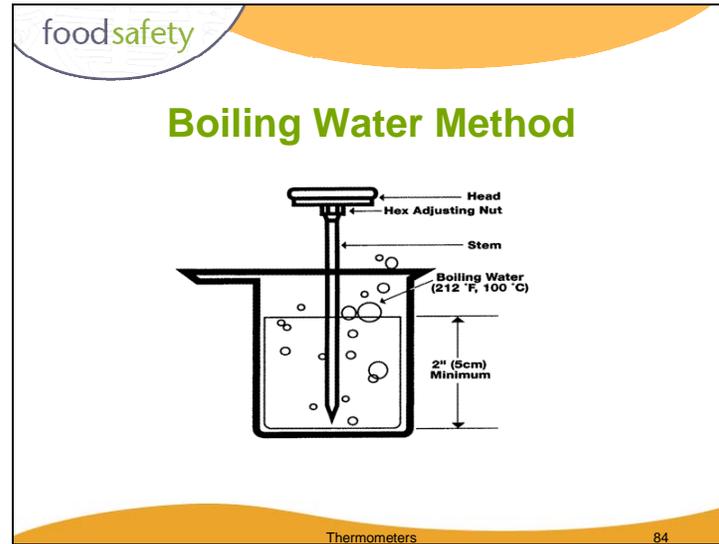
If not correct, calibrate.



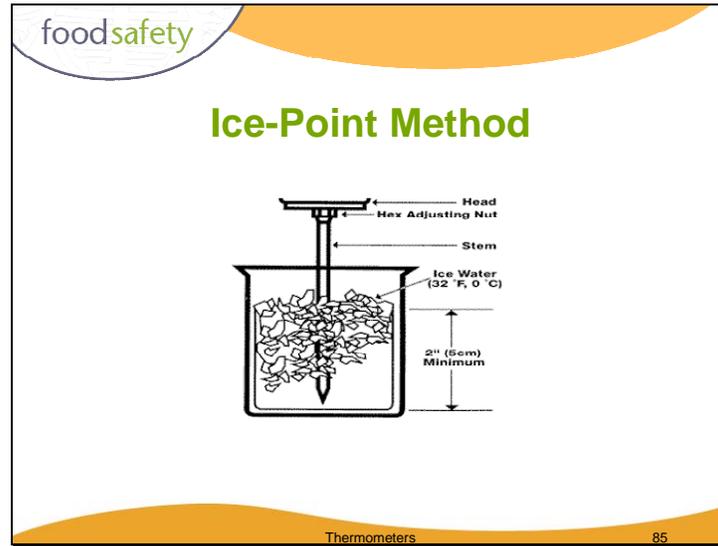
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There are two ways to check the accuracy of a food thermometer: ice water and boiling water. Many food thermometers have a calibration nut under the dial that can be adjusted. Check the package for instructions.

Even if the food thermometer cannot be calibrated, it should still be checked for accuracy using either method. Any inaccuracies can be taken into consideration when using the food thermometer, or the food thermometer can be replaced. For example, water boils at 212°F. If the food thermometer reads 214°F in boiling water, then it is reading 2°F too high. Therefore, 2°F must be subtracted from the temperature displayed when taking a reading in food to find out the food's true temperature. For another example, ground beef patties must reach 160°F for safety. In this instance, if the thermometer is reading 2°F too high, 2°F would be added to the desired temperature, meaning the hamburger patties must be cooked to 162°F.



**Boiling water.** To use the boiling water method, bring a pot of clean tap water to a full rolling boil. Immerse the stem of a food thermometer in boiling water a minimum of 2 inches and wait at least 30 seconds. (For ease in handling, place the stem of the food thermometer through the clip section of the stem sheath and, holding the sheath horizontally, lower it into the boiling water.) Without removing the stem from the pan, hold the adjusting nut under the head of the food thermometer with a suitable tool and turn the head so the thermometer reads 212°F or 100°C. For true accuracy, distilled water must be used and the atmospheric pressure must be one atmosphere (29.921 inches of mercury). A consumer using tap water in unknown atmospheric conditions would probably not measure water boiling at 212°F. Most likely it would boil at least 2°F, and perhaps as much as 5°F, lower. Remember that water boils at a lower temperature in a high altitude area.



**Ice-point method.** To use the ice water method, fill a large glass with finely crushed ice. Add clean tap water to the top of the ice and stir well. Immerse the food thermometer stem a minimum of 2 inches into the mixture, touching neither the sides nor the bottom of the glass. Wait a minimum of 30 seconds before adjusting. (For ease in handling, place the stem of the food thermometer through the clip section of the stem sheath and, holding the sheath horizontally, lower it into the water.) Without removing the stem from the ice, hold the adjusting nut under the head of the thermometer with a suitable tool and turn the head so the pointer reads 32°F or 0°C.



***“Looking does not guarantee  
proper cooking.”***

Measure the temperatures of food  
during storage, cooking, and holding

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## Measuring Food Temperatures

- Use an approved thermometer
- Locate the sensing portion of the thermometer.
- Clean and sanitize the probe before use.
- Insert the sensing portion of the thermometer into the thickest part or into the center of the food.

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### Using a food thermometer

Most available food thermometers will give an accurate reading within 2°F to 4°F. The reading will only be correct, however, if the thermometer is placed in the proper location in the food. If not inserted correctly, or placed in the wrong area, the reading on the food thermometer will not accurately reflect the internal temperature of the food. In general, the food thermometer should be placed in the thickest part of the food, away from bone, fat, or gristle. Before using a food thermometer, read the manufacturer's instructions. The instructions should tell how far the thermometer must be inserted in a food to give an accurate reading. If instructions are not available, check the stem of the food thermometer for an indentation, or "dimple." This shows one end of the location of the sensing device. Dial thermometers must penetrate about 2 to 3 inches into the food. Most digital thermometers will read the temperature in a small area of the tip.

### Where to place the food thermometer

**Meat.** When taking the temperature of beef, pork, or lamb roasts, the food thermometer should be placed midway in the roast, avoiding the bone. When cooking hamburgers, steaks, or chops, insert a thermistor or thermocouple in the thickest part of the meat, away from bone, fat, or gristle. If using a dial bimetal thermometer, see "Thin foods" below. When cooking irregularly shaped food, such as a beef roast, check the temperature in several places.

**Poultry.** When cooking whole poultry, the food thermometer should be inserted into the thickest part of the thigh (avoiding the bone). If the poultry is stuffed, the center of the stuffing should be checked after the thigh reads 180°F (stuffing must reach 165°F). If cooking poultry parts, insert food thermometer into the thickest area, avoiding the bone. The food thermometer may be inserted sideways if necessary. When the food is irregularly shaped, the temperature should be checked in several places.

**Thin foods.** When measuring the temperature of a thin food, such as a hamburger patty, pork chop, or chicken breast, use a thermistor or thermocouple food thermometer if possible. However, if an "instant-read" dial bimetallic-coil food thermometer is used, the probe must be inserted into the side of the food so that entire sensing area (usually 2-3 inches) is positioned through the center of the food. To avoid burning fingers, it may be helpful to remove the food from the heat source (if cooking on a grill or in a frying pan) and insert the food thermometer sideways after placing the item on a clean spatula or plate.

**Combination dishes.** For casseroles and other combination dishes, place the food thermometer into the thickest portion of the food or the center of the dish. Egg dishes and dishes containing ground meat and poultry should be checked in several places.

**Thermometer care**

As with any cooking utensil, food thermometers should be washed with hot soapy water. Most thermometers should not be immersed in water. Wash carefully by hand. Use caution when using a food thermometer. Some models have plastic faces, which can melt if placed too close to heat or dropped in hot liquid. Thermometer probes are sharp and should be stored with the probe in the stem sheath. Some glass thermometers are sensitive to rough handling and should be stored in their packaging for extra protection or in a location where they will not be jostled.

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## Cleaning and Sanitizing Thermometers

- The probe or stem of a thermometer must be cleaned and sanitized before it is used.
- If only measuring the temperature of ready-to-eat food, the probe or stem only needs to be cleaned between uses.



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The stem of a thermometer is a food-contact surface. Therefore, it needs to be properly washed, rinsed, and sanitized between uses. The stem can be sanitized by immersing in a properly prepared sanitizing solution or by wiping the clean step with an alcohol swab.