USDA Food Safety and Inspection Service

Technical Information From FSIS

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Kitchen Thermometers

One of the critical factors in controlling bacteria in food is controlling temperature: *pathogenic microorganisms grow very slowly at low temperatures, multiply rapidly in mid-range temperatures, and are killed at high temperatures. For safety, foods must be held at proper cold temperatures in refrigerators or freezers and they must be cooked thoroughly. It is essential to use a thermometer when cooking meat and poultry to prevent undercooking and, consequently, prevent foodborne illness.*

Why Use a Thermometer?

Using a thermometer is the only reliable way to ensure safety and to determine the "doneness" of most foods. To be safe, a product must be cooked to an internal temperature high enough to destroy any harmful bacteria that may have been in the food.

Doneness refers to a food being cooked to the desired state, and indicates the sensory aspects of foods such as texture, appearance, and juiciness. Unlike the temperatures required for safety, these sensory aspects are subjective.

Color Is Not a Reliable Indicator

Many food handlers believe that visible indicators, such as color changes in the food, can be relied on to determine that foods have been cooked to an endpoint that ensures bacterial destruction. However, recent research has shown that color and texture indicators are not reliable. For example, ground beef may turn brown before it has reached a temperature at which bacteria are destroyed. A consumer preparing hamburger patties and depending on visual signs to determine safety by using the brown color as an indicator is taking a chance that pathogenic microorganisms may survive. A hamburger cooked to 160 ˚F, regardless of color, is safe.

Safety Versus Doneness

The temperature at which different pathogenic bacteria are destroyed varies, as does the "doneness" temperature for different meat and poultry products. A roast or steak that has never been pierced in any way during slaughter, processing, or preparation and has reached an internal temperature of 145 ˚F is safe to eat. A consumer looking for a visual sign of doneness might continue cooking it until it was over-cooked and dry. A consumer using a thermometer can feel reassured the food has reached a safe temperature.

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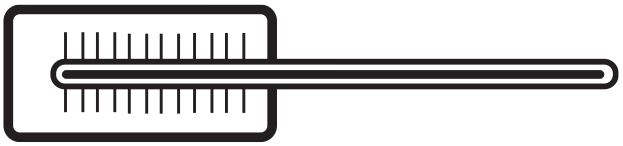
Likewise, poultry should reach at least 160 ˚F throughout for safety, but at this temperature the meat has not reached a traditional "done" texture and color (the red color of poultry does not change to the expected cooked color of white until temperatures are well above160 ˚F), and many consumers prefer to cook it longer to higher temperatures.

A thermometer should also be used to ensure that cooked foods are held at a safe temperature (below 40 ˚F or above 140 ˚F) until served.

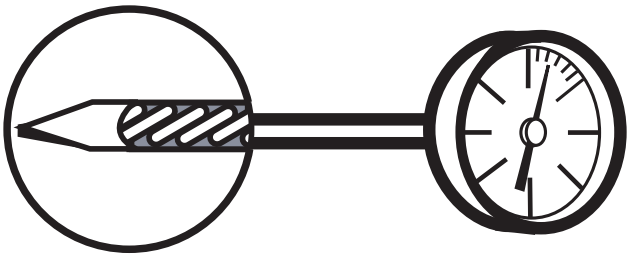
Types of Thermometers

Food thermometers come in several types and styles, and range in level of technology and price.

Liquid-filled Thermometers, also called "spirit-filled" or "liquid in glass" thermometers, are the oldest type of thermometers used in home kitchens. These thermometers are designed to be placed in a food before the food goes in the oven. As the internal temperature of the food increases, the colored liquid inside the thermometer expands and rises to indicate the temperature on a scale. Some liquid-filled thermometers can be calibrated by carefully moving the glass stem within the holder.



Bimetallic-coil Thermometers contain a coil in the probe made of two different metals with different rates of expansion that are bonded together. This coil, which is connected to the temperature indicator, expands when heated. This thermometer senses temperature from its tip up the stem for 2 to 2 1/2 inches. The resulting temperature is an average of the food-contact temperatures along the sensing section (in other words, if the temperature at the tip of the probe is 170 ˚F, and the temperature 2 inches above the tip is 180 ˚F, the thermometer will register about 175 ˚F). These thermometers come in both oven-safe and "instant-read" forms and are read from a dial. Many of the dial thermometers can be calibrated.



Oven-safe Bimetallic-coil Thermometers: This type of thermometer is familiar to most consumers. This is the traditional "meat" thermometer designed to be placed in a food before it goes into the oven. It is generally used for large items such as a roast or turkey.

These thermometers show the temperature with a dial. They can take as long as 1 to 2 minutes to register the correct temperature. The bimetal stem thermometer can accurately measure the temperature of relatively thick or deep foods such as beef roasts and foods in a stockpot. However, since the temperature-sensing coil on the probe is between 2 and 2 1/2 inches long, and this probe is relatively thick, this instrument is not appropriate to measure the temperature of any food less than 3 inches thick. This thermometer is convenient because a quick glance (either through the oven window or by opening the oven door just a crack) will show how the food is progressing. There is concern, however, that because heat conducts along the stem's metal surface faster than through the food, the food in contact with the thermometer tip will be hotter than the food a short distance to the side. This is the "potato nail effect." To remedy this, the temperature should be taken in a second and even third place to verify the temperature of the food. Each time the thermometer is inserted into a food let the temperature equilibrate, or come to temperature, at least 1 minute before reading the temperature.

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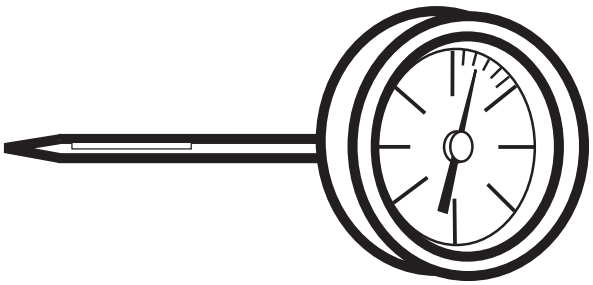
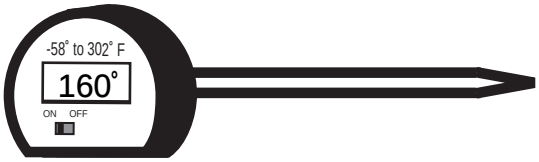


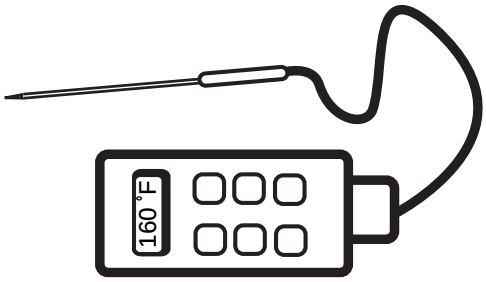
Bimetallic-coil "Instant Read" Thermometers: These thermometers are designed to quickly measure the temperature and cannot be left in the oven while the food is cooking. About 15 to 20 seconds are required for the temperature to be accurately displayed on a dial. The thermometer is inserted in the food only while assessing the temperature. Once the temperature is determined, the thermometer must be removed. It is important to wash the probe with hot, soapy water after each insertion to prevent cross-contamination.

For accurate temperature measurement the probe of the bimetallic-coil thermometer must be inserted the full length of the sensing device (usually 2-3 inches). If measuring the temperature of a thin food, such as a hamburger patty or boneless chicken breast, the probe should be inserted sideways with the sensing device in the very center of the patty. Bimetallic-coil thermometers measure temperature by averaging the temperatures along the metallic coil area. Inserting the thermometer through the center takes advantage of this by averaging the temperature of the center of the food.

Thermistors: Thermistor-style thermometers use a resistor (a ceramic semiconductor bonded in the tip with temperature-sensitive epoxy) to measure temperature. The probe diameter is approximately 1/8" thick and takes roughly 10 seconds to register a temperature on a digital display. Since the semiconductor is in the tip, thermistors can measure temperature in thin foods. As with the bimetal instant read thermometers, thermistors should be placed in foods towards the end of cooking time to check for final cooking temperatures. Because the center of a food is usually cooler than the outer surface, place the tip (where the semiconductor is located) in the center of the thickest part of the food.



Thermocouple: Thermocouple thermometers are the fastest reading of all thermometers. They can show a final temperature in seconds on a digital display. They have very small tips and can accurately measure the temperature of very thin foods, depending on the size of the probes. (Thermocouples used in scientific laboratories use probes similar to hypodermic needles, while other probes may have a thickness of 1/16 of an inch.) Thermocouples measure temperature at the junction of two fine wires located in the tips of the probes. Since thermocouple thermometers respond so rapidly, the temperature can be easily read in a number of locations to ensure that the food is thoroughly cooked. This type of thermometer is used primarily in retail or foodservice kitchens, but consumer models are now being marketed. Thermocouples can be calibrated for accuracy.



It is important to wash the probe after each use with hot, soapy water before reinserting it into a food.

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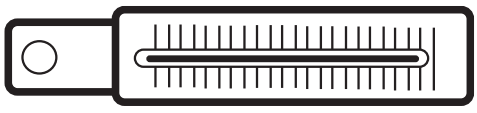
Candy/Jelly/Deep Fry Thermometers: These thermometers will measure a temperature ranging from 100 °F to 400 °F. They are used to measure the extra-high temperatures required of candy and jelly making, as well as frying with hot oil.



Refrigerator/Freezer Thermometers: For safety, it is important to verify the temperature of refrigerators and freezers. Refrigerators should maintain a temperature no higher than 40 ˚F. 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 the temperature. This can be critical in the event of a power outage. When the power goes back on, if the refrigerator is still 40 ˚F and the freezer is still colder than 40 ˚F, the food is safe. 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.

Other Temperature Indicators

Pop-up Timers: Commonly used in turkeys and roasting chickens, the “pop-up” temperature device is constructed from a food-approved nylon. Inside is a firing material, and a stainless steel spring. The firing material may be an organic salt compound or an alloy of metals commonly used in other thermo-sensing devices. The tip of the stem is imbedded in this hardened 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 thermometers have been produced since 1965 and are reliable to within 1-2 ˚F if accurately placed in the product. It is also suggested that the temperature be checked with a conventional thermometer in several places. These can also be found for sale as single-use items.

T-Stick Disposable Thermometers: A disposable, single use, cardboard thermometer which indicates 160 ˚F (+/- 1 ˚F). At 160 ˚F or higher, a white material inside the plastic coated tip becomes clear. As a result, the tip changes from a white to black indicating a safe temperature has been reached. The T-Stick is made from materials accepted by the FDA for contact with food.

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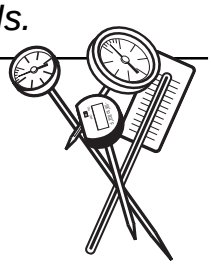
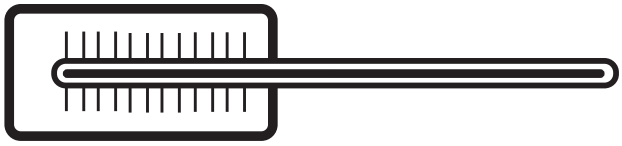
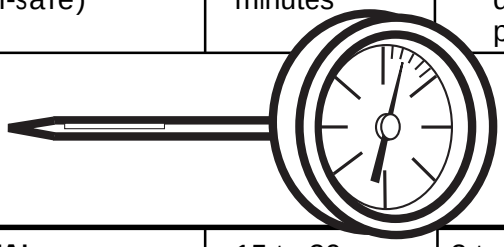
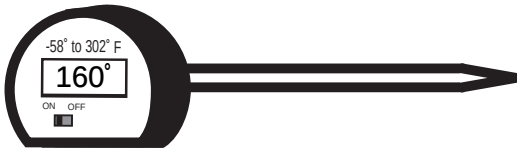
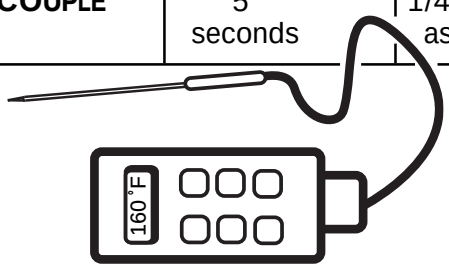


TYPES OF THERMOMETERS	SPEED	PLACEMENT	USAGE CONSIDERATIONS
LIQUID-FILLED	1 to 2 minutes	At least 2 inches deep in the thickest part of the food	• Used in roasts, casseroles, and soups • Can be placed in a food while it is cooking • Cannot measure thin foods • Calibration cannot be adjusted • Possible breakage while in food • Heat conduction of metal shield can cause false high reading
			
BIMETAL (oven-safe)	1 to 2 minutes	2 to 2 1/2 inches deep in the thickest part of the food.	• Can be used in roasts casseroles, and soups • Can be placed in a food while it is cooking • Not appropriate for thin foods • Heat conduction of metal stem can cause false high reading
			
BIMETAL (instant-read)	15 to 20 seconds	2 to 2 1/2 inches deep in the thickest part of the food	• Can be used in roasts, casseroles, and soups • Use to check the internal temperature of a food at the end of cooking time • Can be calibrated • Cannot measure thin foods unless inserted sideways • Cannot be used in an oven while food is cooking • Temperature is averaged along 2-3” of probe • Readily available in stores
			
THERMISTOR (digital)	10 seconds	At least 1/2 inch deep in a food	• Gives faster reading • Can measure temperature in thin foods • Digital face easy to read • Cannot be used in an oven while food is cooking • Available in “kitchen” stores
			
THERMOCOUPLE (digital)	5 seconds	1/4 deep, or deeper, as needed	• Fastest • Can quickly measure even the thinnest foods • Digital face easy to read • Can be calibrated • More costly, may be difficult for consumers to find in stores
			

Doneness and Safety

Most pathogenic bacteria are destroyed between 140 ˚F and 160 ˚F. However, for best quality, meat and poultry require various temperatures for "doneness."

RECOMMENDED INTERNAL TEMPERATURES*

Product	Degrees Fahrenheit
Eggs & Egg Dishes	
Eggs	160˚
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Ground Meat and Poultry Mixtures	
Turkey, chicken (including patties)	165˚
Veal, beef, lamb, pork (including patties)	160˚
Fresh Beef	
Medium rare	145˚
Medium	160˚
Well done	170˚
Fresh Lamb	
Medium rare	145˚
Medium	160˚
Well done	170˚
Fresh Pork	
Medium	160˚
Well done	170˚
Poultry	
Chicken, whole	180˚
Turkey, whole	180˚
Poultry breasts, roasts	170˚
Poultry thighs, wings	180˚
Stuffing	165˚
Duck and goose	180˚
Ham	
Fresh (raw)	160˚
Pre-cooked (to reheat)	140˚

*These temperatures are recommended for consumer cooking. They are not intended for processing, institutional, or foodservice preparation.

Using the Thermometer

Most thermometers available will give an accurate reading within 2 to 4 ˚F. The reading will only be helpful, however, if the thermometer is placed in the proper location in the product. If not inserted correctly, or if the thermometer is placed in the wrong area, the reading will not accurately reflect the internal temperature of the product. In general, the thermometer should be placed in the thickest part of the food, away from bone, fat, or gristle.

Check the Manufacturer's Instructions First

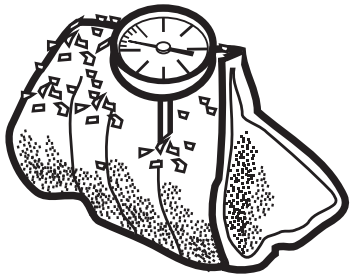
Before using a food thermometer, read the manufacturer's instructions. The instructions should tell how far the thermometer must be inserted in a food to give an accurate reading. Most thermometers also come with instructions on how to recalibrate the thermometer (see below for more information about calibrating a thermometer). If instructions are not available, check the stem of the thermometer for an indentation, or "dimple," that shows one end of the location of the sensing device. Most digital thermometers will read the temperature in a small area of the tip. Dial types must penetrate about two to three inches into the food.

Where to Place the Thermometer

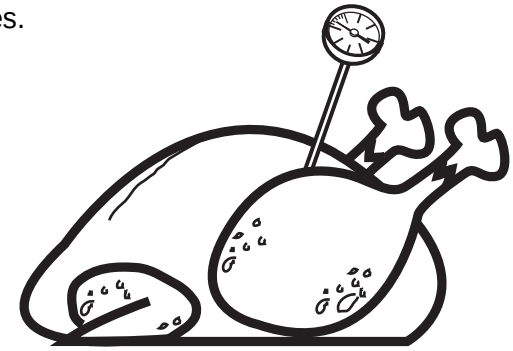
MEAT

When taking the temperature of beef, pork, or lamb roasts, the 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, away from bone, fat, or gristle. If using a dial bimetal thermometer, see thin foods below.

When the food being cooked is irregularly shaped, such as may be the case with a beef roast, check the temperature in several places.

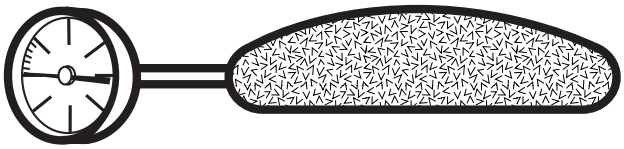


POULTRY
When cooking whole poultry, the thermometer should be inserted into the thickest part of the thigh. If stuffed, the center of the stuffing should be checked after the thigh reads 180 ˚F (stuffing must reach 165 ˚F). If cooking poultry parts, insert thermometer into the thickest area, avoiding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

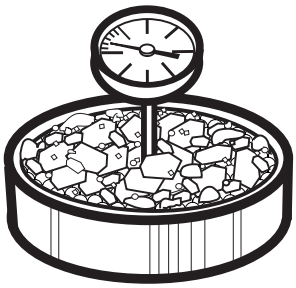


THIN FOODS
When measuring the temperature of a thin food, such as a hamburger patty or chops, a thermistor or thermocouple thermometer should be used, if possible.

A dial bimetallic-coil thermometer averages the internal temperature along the length of the sensor within its probe. Thin foods usually cannot accommodate the 2-inch probe if it is inserted from top to bottom and, thus, it will not give an accurate reading. For thin foods, the bimetal thermometer may be inserted sideways so that it will average the temperature in 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 thermometer sideways after placing the item on a clean spatula or plate.



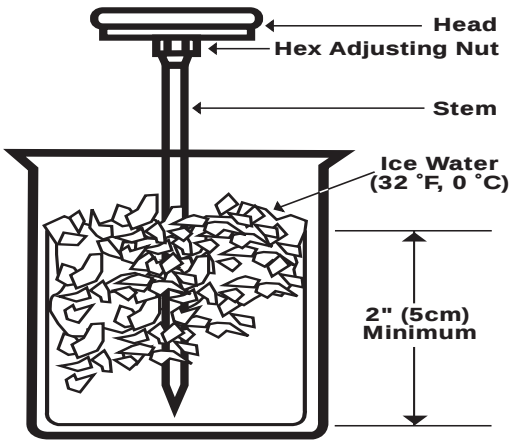
COMBINATION DISHES
For casseroles and other combination dishes, place the thermometer into the thickest portion of the food or the center of the dish. Egg dishes, and dishes made using ground meat and poultry, should be checked in several places.



Calibrating a Thermometer

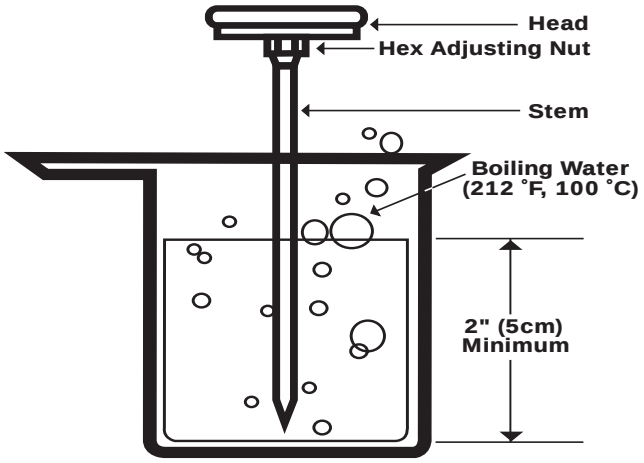
There are two ways to check the accuracy of a food thermometer. One method uses ice water, the other uses boiling water. Many thermometers have a calibration nut under the dial that can be adjusted. Check the package for instructions.

ICE WATER
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 thermometer stem a minimum of 2 inches into the mixture, touching neither the sides nor the bottom of the glass. (For ease in handling, the stem of the thermometer can be placed through the clip section of the stem sheath and, holding the sheath horizontally, lowered 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 head so pointer reads 32 ˚F. Allow a minimum of 30 seconds before adjusting.



BOILING WATER

To use the boiling water method, bring a deep pan of clean tap water to a full rolling boil. Immerse the stem of a thermometer in boiling water a minimum of 2 inches and wait at least 30 seconds. (For ease in handling, the stem of the thermometer can be placed through the clip section of the stem sheath and, holding the sheath horizontally, lowered into the boiling water.) Without removing the stem from the pan, hold the adjusting nut under the head of the thermometer with a suitable tool and turn head so the thermometer reads 212 ˚F.



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. And, remember that water boils at a lower temperature in a high altitude area.

Check with your local Cooperative Extension Service or Health Department for the exact temperature of boiling water in your area.

Even if the thermometer cannot be calibrated, it should still be checked for accuracy using either method. Any inaccuracies can be taken into consideration when using, or the thermometer can be replaced. For example, if the thermometer reads 214 ˚F in boiling water, subtract 2 degrees from the temperature registered when taking a reading in food.

For further food safety information:

Call the USDA's nationwide, toll-free Meat and Poultry Hotline at :

1-800-535-4555

TTY: 1-800-256-7072

Specialists are available Monday through Friday, from 10 a.m. to 4 p.m., Eastern Time.

In addition, timely recorded food safety messages are available 24 hours a day, 7 days a week.

Visit the FSIS Web site at:

http://www.usda.gov/fsis