Retort thermometers are the reference instrument used for monitoring the retort temperature during the cook process. It is imperative that they be accurate, dependable, and easily seen by the operator. The Food and Drug Administration (FDA) regulation 21 CFR 113 requires that retort thermometers be tested for accuracy against a known accurate standard thermometer upon installation and at least once a year thereafter.

21 CFR 113.40(a): “Equipment and procedures for pressure processing in steam in still retorts -- (1) Indicating mercury-in-glass thermometer. Each retort shall be equipped with at least one mercury-in-glass thermometer whose divisions are easily readable to 1 degree F and whose temperature range does not exceed 17 degree F per inch of graduated scale. Thermometers shall be tested for accuracy against a known accurate standard thermometer upon installation and at least once a year thereafter, or more frequently if necessary, to ensure their accuracy.”

Testing Retort Thermometers Against a Known Accurate Standard Thermometer

Described below are two options for the instrument used as the known accurate standard thermometer:

1. Using a retort thermometer as the known accurate standard
2. Using a certified NIST traceable etched stem thermometer as the known accurate standard

Using a Retort Thermometer as the Known Accurate Standard

Select or purchase one retort thermometer to be used only as a standard for the purpose of testing all of your other retort thermometers. Retort thermometers are available from many instrument companies. Only sturdy, high quality thermometers should be used as standards. It is advisable to order thermometers at least 60 days before the season to allow for delivery time.

The retort thermometer that you plan to use as a standard may be brought to the Seafood Products Association (SPA) Laboratory where we can test its accuracy against our certified National Institute of Standards and Technology (NIST) traceable standard etched stem thermometer and make any necessary adjustments. We will assign a number to your thermometer and issue a letter confirming its accuracy. Along with the thermometer that you plan to use as a standard, it is recommended that you bring an additional one that is of the same make, model and size to the SPA. Compare these two thermometers prior to testing others to assure that there were no changes in transporting or shipping the standard.
Using a Certified NIST Traceable Etched Stem Thermometer as the Known Accurate Standard

You may also acquire your own certified NIST traceable etched stem thermometer to use as the standard for onsite testing of retort thermometers. SPA recommends an etched stem thermometer to use as the known accurate standard thermometer because the scale is fixed (etched) directly onto the thermometer, which prevents measurement error due to scale movement. As additional assurance of accuracy, it is recommended you retain a second certified NIST traceable etched stem thermometer for cross reference. Compare these two thermometers and ensure that they are in agreement before testing against retort thermometers. It is very unlikely (pretty much impossible) that an etched stem thermometer will change from its original calibration, and even more unlikely that two certified etched stem thermometers would be out of calibration at the same time.

Calibration of the certified NIST traceable etched stem thermometer at SPA is not necessary. However, you will need a certificate of calibration from the manufacturer, and you will need to ensure the ongoing accuracy of the standard thermometers using the following procedures.

According to NIST, it is sufficient if you re-calibrate once a year, the accurate standard thermometer with a \textit{single previously calibrated temperature} shown on your calibration certificate.

While many manufacturers recommend calibration of thermometers at a maximum frequency of 3 years, a certified etched stem reference standard that is annually recalibrated at a single point (ice point), either in its main scale, or as an auxiliary scale requires only one complete calibration in its lifetime.

The need for re-calibration of a "properly manufactured" liquid-in-glass thermometer is due to the gradual relaxation of residual mechanical strains in the glass that have a significant effect on the volume of the bulb. The re-calibration of a single point provides a reliable indication of the effect of any change in volume and provides a means for the accurate adjustment of the remainder of the scale. The most convenient reference temperature to achieve is the ice point. This can be done using ice slurry as described in the NIST special publication 1088 and this publication can be accessed at \url{http://www.nist.gov/cgi-bin/get_pdf.cgi?pub_id=900914}.

- OR -

You can also check the accuracy of the known standard thermometer against another etched stem thermometer that is calibrated against an NIST certified master instrument in accordance with the procedures outlined by ASTM E77-98 and NIST special publication 250-33.

References:

1. NIST (formerly NBS) Special Publication (SP) 250-23
2. ASTM E77-98
3. ISO 9000
4. NIST Special Publication (SP) 1088
 TESTING AND ADJUSTING RETORT THERMOMETERS

SPA recommends that standard thermometer be hand carried to your cannery when possible. We have found that shipping by mail or other commercial methods often results in breakage or separation of mercury column. If shipping is your only option, the thermometer needs to be heavily padded when packed and marked fragile.

All other retort thermometers should be tested at the plant against this standard. Testing at the plant eliminates the need for transporting and the potential for breakage or lost accuracy. The FDA regulation requires that records of thermometer accuracy tests that specify date, method, standard used, and person performing the test should be maintained. Each thermometer should have a tag, seal or other means of identity that includes the date it was last tested for accuracy.

The above recommendations are based on the scale graduations and degree of accuracy (precision) that can be visibly observed by an operator. Also, these recommendations are based on both the precision and accuracy of the instrument.

You can use the SPA retort thermometer calibration form, which provides information on both precision and accuracy of the known standard used to check the retort thermometers as a reference.

SPA recommends that retort thermometers be within ½ degree F of the known accurate standard that is calibrated against an NIST traceable instrument. This is based on the typical operating process that includes at least a 1 degree F safety margin over the scheduled process. If retort thermometers are tested and found greater than ½ degree F off, we recommend documenting the inaccuracy indicating what the retort thermometer reads compared to the standard. The information should be provided to your process authority (SPA) for evaluation.

Also, prior to using the retort, the thermometer should be adjusted to agree with the standard at both the vent and process temperatures to ensure accuracy through the range of critical temperatures during a typical cook.

The following are instructions on how to use your known accurate standard thermometer to test your retort thermometers.

Currently, 21 CFR 113.40(a) specifies the use of mercury-in-glass thermometers as the reference temperature instrument (retort thermometer). However, rules have been proposed that allow for the use of alternative temperature indicating devices under certain conditions.
Equipment Needed

1. Known Accurate Standard Thermometer. The standard thermometer can be a retort thermometer that has been calibrated for use as the standard, or an NIST traceable etched stem thermometer as described previously.

2. Cross made of ¾ inch pipe fittings for holding 3 thermometers (see illustration below). The couplings which hold the thermometers should have 1/16 inch drilled holes as bleeders.

3. A supply of ¾ inch pipe fittings, plugs, and reducers, so that the equipment can be installed on any type of retort. Compression fittings may be necessary if using etched stem thermometers as the standard.

4. One coupling for each angle thermometer.

5. One 15 inch crescent and two 15 inch Stillson pipe wrenches.


7. Warding file to file scale plate slots.

8. Tin snips to cut scale plates when too long.

9. Small screw driver with clip for holding screws - to be used on screws in thermometer scales.

10. Rags and steel wool for cleaning thermometer glass and scales.

11. Hand drill.

12. A No. 47 drill for drilling out holes when screws break off.

13. Tap and holder - 4/40 for tapping holes after drilling.


15. Extra screws for cases.

16. Flashlight.

17. Pliers.

18. Gloves.
cont. Testing Retort Thermometers

Equipment Needed (cont.)

Standard Thermometer

Figure 1

1/16 inch bleeder in each coupling

Compression Fittings for Etched Steam Thermometer

Figure 2
Set Up and Test Procedure

1. Remove a retort thermometer and install the testing equipment in its place.

2. Remove the thermometers to be tested. Use the crescent wrench for removing thermometers because it is less likely to slip, and there is less danger of damaging the surfaces or breaking the stems.

3. Remove the faces from the thermometers and place two of them in the test equipment as shown in the illustration. The standard thermometer should be in the middle. Check for loose stems by attempting to move them up and down. (If loose, destroy or send back to manufacturer for repair or replacement.)

4. Bring the retort to the required temperature, making certain to vent sufficiently to eliminate all air.

5. Open the valve on the test equipment and allow the thermometers to come to equilibrium, which will require at least 15 minutes. If the temperature fluctuates it may be steadied by throttling the control valve. Examine mercury column carefully to detect any separation. (Separated mercury columns may sometimes be remedied by cooling the bulb overnight with dry ice.)

6. Take at least 3 temperature readings over a period of several minutes to make certain the thermometers are at equilibrium.

7. Loosen the screws on the temperature scale of the thermometers being tested and bring it into agreement with the standard thermometer by moving it up or down. If it cannot be moved enough to make the adjustment, remove the scale from the thermometer and file the screw slots longer, or plane off the end of the scale, slightly, whichever may be necessary.

8. Tighten the scale adjustment screws and take another reading to make certain the thermometers are properly standardized.

9. Close the valve, remove the plant thermometers, and replace them with two more. Open the valve and repeat process above.

10. Number each thermometer for future identification. Mark broken thermometers in such a way that they will not be used before repair or replacement.

11. Affix a sticker to the retort thermometer with the date of calibration, date the next calibration is due, and initials of the person testing the thermometer.

12. Clean the case glasses and replace the thermometer faces.