

Title: Thermometer Calibration

Filename: 2140v7.lwp

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<u>Rev. No.</u>	<u>Date Revised</u>	<u>Revision Summary</u>
1.	11-29-93	New SOP
2.	05-09-94	Sec. 5.4 and 5.5, result and corrective action forms, signature by TD, archive records w/GLP
3.	09-08-95	Sec 2.0, immersion depth
4.	02-16-99	Converted to LWP format
5.	03-08-00	Sec 4.1: deleted. Sec. 4.4: added (calibration stickers). Sec. 5.2: changed to include labeling for tighter tolerance. Worksheets moved to Appendix I. Appendix II added.
6.	11-28-00	Details about Total Immersion in Sec. 2
7.	11-13-03	Sec. 2.0: Changed ice-water to ice/salt solution, added freezers. Sec. 3.6: Added. Sec. 4.3: Wording change to incorporate use of salt and replaced beaker with dewar flask. Sec's 4.4, 4.5: Added calibration of IR Thermometer and renumbered subsequent section. Sec. 5.1: Added freezers.

	<u>Prepared or Reviewed by</u>	<u>Date</u>	<u>Approved by</u>	<u>Date</u>
1.	Tony Dennis	11/17/03	[Signature]	11-19-03
2.	Tony Dennis	11/29/04	[Signature]	11-30-04
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6.				

1.0 SCOPE AND APPLICATION

This SOP is used to check the calibration of thermometers semiannually against a National Institute for Standards and Technology (NIST) traceable thermometer.

2.0 SUMMARY

Each thermometer is compared to a NIST-traceable thermometer at two temperatures. All thermometers are checked at room temperature. Thermometers used in refrigerators and freezers are also checked using ice/salt water solution; other thermometers are also checked at elevated temperature. The thermometer must be within tolerance, which varies with the application.

Each thermometer should be checked according to its calibrated immersion depth. The immersion depth is generally noted as a horizontal line across the thermometer. Some thermometers are calibrated for total immersion. These generally lack the horizontal line, and are labeled "Imm.". All mercury or alcohol filled glass thermometers should be used in the near vertical position.

Total immersion thermometers should be immersed vertically to the line which is the temperature being recorded, not totally immersed or horizontal. In other words if you are measuring the temperature of 67 °C, the "total immersion" thermometer should be immersed vertically to the 67 °C mark.

3.0 APPARATUS AND MATERIALS

- 3.1 NIST-traceable thermometer (Ertco 58924 or equivalent).
- 3.2 Hot-water bath.
- 3.3 Beaker, 250 mL.
- 3.4 Magnetic stirrer.
- 3.5 Stirring bars.
- 3.6 Dewar flask.
- 3.7 Rock Salt

4.0 PROCEDURE

4.1 Ambient temperature.

- 4.1.1 Fill a 250 mL beaker with tap water and allow to equilibrate to room temperature for one hour.
- 4.1.2 Insert both the NIST-traceable thermometer and the test thermometers into the beaker and allow the readings to stabilize.
- 4.1.3 Record the temperature readings of both thermometers (see Appendix I for worksheet).

4.2 Elevated temperature.

- 4.2.1 Turn on the hot water bath and allow to equilibrate for one hour.
- 4.2.2 Insert both the NIST-traceable thermometer and the test thermometer into the bath and allow the readings to stabilize.
- 4.2.3 Record the temperature readings of both thermometers.

4.3 Sub-ambient temperature

- 4.3.1 Add ice to a dewar flask to appx halfway to the surface.
- 4.3.2 Add water to appx ½ to 1 inch below the rim of the flask.
- 4.3.3 Add salt and stir until temperature is below 0 °C.
- 4.3.4 Allow the system to equilibrate.
- 4.3.5 Insert both the NIST-traceable thermometer and the test thermometer into the flask and allow the readings to stabilize.
- 4.3.6 Record the temperature readings of both thermometers.
- 4.3.7 If the ice melts, pour out some water, add more ice and salt, and allow to re-stabilize.

4.4 Infrared thermometer elevated temperature calibration.

- 4.4.1 Fill a large styrofoam cup up to ½ to 1 inch below the rim with hot tap water.
- 4.4.2 Insert the NIST-traceable thermometer into the water, stir, and allow the readings to stabilize.
- 4.4.3 Continue stirring and record the temperature readings of both thermometers. Hold the IR thermometer within 3 inches of the surface of the water and outside the rim of the cup, away from the steam.

4.5 Infrared thermometer sub-ambient temperature calibration.

- 4.5.1 Add ice to a large styrofoam cup to appx halfway to the surace.
- 4.5.2 Add cold tap water to appx ½ to 1 inch below the rim of the cup.
- 4.5.3 Insert the NIST-traceable thermometer into the water, stir, and allow the readings to stabilize.
- 4.5.4 Continue stirring and record the temperature readings of both thermometers. Hold the IR thermometer within 3 inches of the surface of the water.

- 4.6 Following calibration, a calibration sticker will be attached to each thermometer including the thermometer identification number, the date of calibration, the initials of the person performing the calibration, and the date the next calibration is due (see Appendix II).

5.0 REQUIREMENTS

- 5.1 Thermometers must be checked every six months. Thermometers used only for refrigerators and freezers need to be checked at ambient and sub-ambient temperatures.
- 5.2 Thermometers used for applications where the measured temperature is the analytical result (e.g. flash point, melting point) must be accurate within $\pm 1^{\circ}\text{C}$. These thermometers will be labeled: "Tolerance $\pm 1^{\circ}\text{C}$ ".
- 5.3 Thermometers used for less critical applications (e.g. oven or refrigerator monitoring) must be accurate within $\pm 2^{\circ}\text{C}$.

- 5.4 Thermometers not meeting the above requirements must not be used for these applications. The thermometers can be reassigned to less stringent uses (refrigerators, if they meet the specifications for that use) or they must be disposed of. Such corrective action should be documented on the attached form and signed by a member of the Quality Assurance Unit (QAU).
- 5.5 All results are recorded on a form similar to the one attached. After the calibration is checked, a member of the Quality Assurance Unit (QAU) will sign the form. A copy of the most recent results will be kept in a notebook which is kept with the QA files. The original shall be stored in the GLP archives.
- 5.6 For comparing Fahrenheit thermometers to the Celsius reference thermometer, use the following equations or the attached table:

$$F = (C * 1.8) + 32$$

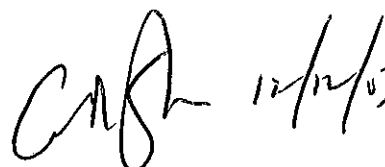
$$C = (F - 32) / 1.8$$

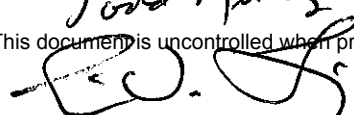
TABLE I

Degrees		Degrees		Degrees	
F	C	F	C	F	C
10	-12.2	98	36.7	186	85.6
12	-11.1	100	37.8	188	86.7
14	-10.0	102	38.9	190	87.8
16	-8.9	104	40.0	192	88.9
18	-7.8	106	41.1	194	90.0
20	-6.7	108	42.2	196	91.1
22	-5.6	110	43.3	198	92.2
24	-4.4	112	44.4	200	93.3
26	-3.3	114	45.6	202	94.4
28	-2.2	116	46.7	204	95.6
30	-1.1	118	47.8	206	96.7
32	0.0	120	48.9	208	97.8
34	1.1	122	50.0	210	98.9
36	2.2	124	51.1	212	100.0
38	3.3	126	52.2	214	101.1
40	4.4	128	53.3	216	102.2
42	5.6	130	54.4	218	103.3
44	6.7	132	55.6	220	104.4
46	7.8	134	56.7	222	105.6
48	8.9	136	57.8	224	106.7
50	10.0	138	58.9	226	107.8
52	11.1	140	60.0	228	108.9
54	12.2	142	61.1	230	110.0
56	13.3	144	62.2	232	111.1
58	14.4	146	63.3	234	112.2
60	15.6	148	64.4	236	113.3
62	16.7	150	65.6	238	114.4
64	17.8	152	66.7	240	115.6
66	18.9	154	67.8	242	116.7
68	20.0	156	68.9	244	117.8
70	21.1	158	70.0	246	118.9
72	22.2	160	71.1	248	120.0
74	23.3	162	72.2	250	121.1
76	24.4	164	73.3	252	122.2
78	25.6	166	74.4	254	123.3
80	26.7	168	75.6	256	124.4
82	27.8	170	76.7	258	125.6
84	28.9	172	77.8	260	126.7
86	30.0	174	78.9	262	127.8
88	31.1	176	80.0	264	128.9
90	32.2	178	81.1	266	130.0
92	33.3	180	82.2	268	131.1
94	34.4	182	83.3	270	132.2
96	35.6	184	84.4	272	133.3

The following people have read this SOP and are currently using these procedures in the laboratory:

Signature	Date
T Dennis	11-19-03
Louis Albanese	11-26-03
Leo Metzger	11-26-03
Kevin Smith	11-26-03
Shirley J. [unclear]	11-26-03
Ruben Huester	11-26-03
Patricia J. Metzger	11-26-03
Joseph B. Adams	11-26-03
Babette Horan	12/1/03
Matt [unclear]	12/2/03
Mary Hammors	12-3-03
Jane York	12-5-03
[unclear]	12-5-03
Robert Stead	12-5-03
[unclear]	12-5-03
Charles Jacks	12-10-03
[unclear]	12-10-03
M. J. Sherd	12-11-03
Domen M. Macias	12-11-03
A. [unclear]	12-11-03
Todd Murray	12-11-03

 12/12/03
 Maclon Wright 12-15-03
 [unclear] 10/25/04
 Eloutfander 11/23/04
 Kevin [unclear] 02/17/05
 Janet L. Hawey 10-5-05
 Marant 8-21-06
 Rey Ghodini 06-14-07
 S. Adler 06-14-07
 [unclear] 06/14/07
 [unclear] 09/25/07
 Alan [unclear] 1/04/08
 [unclear] 1/04/08
 [unclear] 01/16/08
 [unclear] 05/21/08


 12.11.03

APPENDIX I
THERMOMETER CALIBRATION WORKSHEETS

Thermometer Calibration

Page 1

Analyst: _____

Date _____

QAU: _____

Date _____

Critical Thermometers

ID #	Usage	Specifications:		High:	$\frac{+1}{C}$	$\frac{+2}{F}$
		Low:				
Ertco 58924	NIST Traceable Thermometer					
	Melting Point					
	Flash Point					

Other Thermometers

ID #	Usage	Specifications:		High:	$\frac{+2}{C}$	$\frac{+4}{F}$
		Low:				
Ertco 58924	NIST Traceable Thermometer					

APPENDIX II
SAMPLE THERMOMETER CALIBRATION STICKER

Cal: 06/27/03 By: TD
Due: 12/2003 Therm: 87