



**INDIANA DEPARTMENT OF TRANSPORTATION  
DIVISION OF MATERIALS AND TESTS**

**VERIFYING THERMOMETERS  
ITM No. 909-15**

**1.0 SCOPE.**

- 1.1 This test method covers the procedure for a verification of scale accuracy of liquid-in-glass total and partial immersion thermometers, dial type thermometers, handheld digital thermometers, infrared digital thermometers.
- 1.2 This ITM may involve hazardous materials, operations, equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

**2.0 REFERENCES.**

**2.1 ASTM Standards.**

- E1 Specification for ASTM Thermometers

**3.0 TERMINOLOGY.** Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

**4.0 APPARATUS.**

- 4.1 Certified thermometer, National Institute of Standards and Technology (NIST) traceable, and of equal or better precision than the thermometer being verified.
- 4.2 Water/oil bath, capable of maintaining a constant temperature for the time sufficient for verification.

**5.0 SIGNIFICANCE AND USE.** This ITM is used by laboratory personnel to verify the scale accuracy of liquid-in-glass total and partial immersion thermometers, dial type thermometers, and handheld digital thermometers.

**6.0 PROCEDURE.**

**6.1 Liquid-in-Glass Total and Partial Immersion Thermometers.**

- 6.1.1 Record the manufacturer, serial number, type, model number, graduation, and date of calibration for the certified thermometer

- 6.1.2 Record the manufacturer, serial number, type, model number, and graduation of the thermometer being verified
- 6.1.3 Visually inspect the shaft of the thermometer being verified for air bubbles, separation of the liquid, foreign matter, glass faults, or any other apparent defects
- 6.1.4 Immerse the thermometer being verified into a water/oil bath to the indicated immersion line for partial immersion thermometers or to the point being verified for total immersion thermometers. A water bath is used for verifications less than 200°F, and an oil bath is used for verifications equal to or greater than 200°F.
- 6.1.5 Immerse the certified thermometer into the bath as specified in 6.1.4
- 6.1.6 Allow the readings on both thermometers to stabilize, and record the temperatures of the thermometers

## **6.2 Dial Type Thermometers.**

- 6.2.1 Record the manufacturer, serial number, type, model number, graduation, and date of calibration for the certified thermometer
- 6.2.2 Record the manufacturer, serial number, type, model number, and graduation of the thermometer being verified
- 6.2.3 Immerse the dial thermometer into a container of boiling water to a depth of approximately one-half of the depth of the container
- 6.2.4 Immerse the certified thermometer into the container as specified in 6.2.3
- 6.2.5 Allow the readings on both thermometers to stabilize and record the temperatures of the thermometers

## **6.3 Handheld Digital Thermometer.**

- 6.3.1 Record the manufacturer, serial number, type, model number, graduation, and date of calibration for the certified thermometer
- 6.3.2 Record the manufacturer, serial number, type, model number, and graduation of the thermometer being verified
- 6.3.3 Immerse the thermocouple assembly into a container of boiling water to a depth of approximately one-half of the depth of the container
- 6.3.4 Immerse the certified thermometer into the container as specified in 6.3.3

- 6.3.5 Allow the readings on both thermometers to stabilize and record the temperature of the thermometers

#### 6.4 Infrared Digital Thermometer

- 6.4.1 Record the manufacturer, serial number, type, model number, graduation, and date of calibration for the certified thermometer
- 6.4.2 Record the manufacturer, serial number, type, model number, and graduation of the thermometer being verified
- 6.4.3 Immerse the certified thermometer into a 1000 mL glass beaker of boiling water to a depth of approximately one-half of the depth of the container and allow the thermometer to stabilize. Record the temperature of the thermometer.
- 6.4.4 Hold the infrared digital thermometer approximately 3 in. from the top of the boiling water and point the thermometer to the center of the beaker. Record the temperature of the thermometer.
- 6.4.5 Repeat 6.4.4 to obtain nine additional temperature readings. After each reading, allow the infrared digital thermometer to recycle to an off setting before obtaining the next reading.
- 6.4.6 Calculate the average of the 10 temperature readings and record the average.

#### 7.0 TOLERANCES.

- 7.1 Thermometers not indicating the same reading as the certified thermometer may be used if the difference in the readings is within the tolerances of 7.2, 7.3, 7.4, and 7.5 for the type of thermometer verified. The difference in readings shall be visibly noted on the thermometer and the difference applied during use is visibly noted and the offset is applied during use. Thermometers not within the tolerances of 7.2, 7.3, 7.4, and 7.5 shall not be used.
- 7.2 Liquid-in-glass thermometers shall agree with the certified thermometer to within the scale error max of Table 1.
- 7.3 Dial type thermometers shall be within 5.0°F.
- 7.4 Handheld digital thermometers shall be within 2°F.
- 7.5 Infrared digital thermometers shall be within 4°F.

**8.0 REPORT.** The verification of scale accuracy is reported on the form in Appendix A.

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Celsius Range	Scale Error max	Fahrenheit Range	Scale Error max	Celsius Range	Scale Error max	Fahrenheit Range	Scale Error max
Graduated in 0.01 °C				Graduated in 0.1 °C		Graduated in 0.2 °F	
18.9 to 25.1	0.1			0 to 30	0.1		
23.9 to 30.1	0.1			19 to 27	0.1	66 to 80	0.2
Graduated in 0.02 °C		Graduated in 0.05 °F		20 to 50	0.1		
4 to 6	0.04			25 to 50	0.1	77 to 131	0.2
19 to 35	0.10	66 to 95	0.20	34 to 42	0.1	94 to 108	0.2
Graduated in 0.05 °C		Graduated in 0.1 °F		38 to 82	0.1	100 to 180	0.2
-55.4 to -52.6	0.1	-67.5 to 62.5	0.2	40 to 70	0.1		
-41.4 to 38.6	0.1	-42.5 to 37.5	0.2	49 to 57	0.1	120 to 134	0.2
-27.4 to 24.6	0.1	-17.5 to -12.5	0.2	50 to 80	0.1	122 to 176	0.2
-21.4 to 18.6	0.1			57 to 65	0.1	134 to 148	0.2
-19.4 to 16.6	0.1	-2.5 to +2.5	0.2	60 to 90	0.1		
-1.4 to +1.4	0.1	29.5 to 34.5	0.2	75 to 105	0.1	167 to 221	0.2
		54 to 101	0.2	79 to 87	0.1	174 to 188	0.2
18.6 to 21.4	0.1	66.5 to 71.5	0.2	80 to 110	0.1		
	0.1	69 to 116	0.2	95 to 103	0.1	204 to 218	0.2
23.6 to 26.4	0.1	74.5 to 79.5	0.2	100 to 130	0.2		
28.6 to 31.4	0.1	83.5 to 88.5	0.2	120 to 150	0.2		
36.6 To 39.4	0.1	97.5 to 102.5	0.2	130 to 140	0.2		
38.5 to 41.5	0.1			Graduated in 0.2 °C		Graduated in 0.5 °F	
48.6 to 51.4	0.1	119.5 to 124.5	0.2			-65 to +5	1
52.6 to 55.4	0.1	127.5 to 132.5	0.2	-50 to +5	0.2	-55 to +40	0.4
58.6 to 61.4	0.1	137.5 to 142.5	0.2	-38 to +42	0.2	-36.5 to +107.5	0.5
80.6 to 83.4	0.1	177.5 to 182.5	0.2			-35 to +35	0.5
91.6 to 94.4	0.1	197.5 to 202.5	0.2	0.2-20 to +102	0.1	-5 to +215	0.25
		207.5 to 212.5	0.2	-2 to +52	0.2		
98.6 to 101.4	0.1			-2 to +68	0.2		
133.6 to 136.4	0.15	272.5 to 277.5	0.3	-2 to +80	0.2	30 to 180	0.4
				18 to 28	0.1		
Graduated in 0.1 °C		Graduated in 0.2 °F		20 to 70	0.2		
-51.6 to -34	0.1	-61 to -29	0.2	20 to 100.6	0.2	68 to 213	0.5
-45 to -35	0.4			24 to 78	0.2		
-38.3 to -30	0.2	-37 to -22	0.4	25 to 105	0.2	77 to 221	0.5
-38 to +2	0.1	-36 to +35	0.2	32 to 127	0.2	90 to 260	0.5
-35 to -25	0.4			39 to 54	0.1		
-25 to -15	0.2			48 to 102	0.2		
-15 to -5	0.2			72 to 126	0.2		
-20 to +10	0.1			90 to 170	0.4	194 to 338	1
-10 to +5	0.1			95 to 105	0.1		
				98 to 152	0.3		
-8 to +32	0.1	18 to 89		95 to 155	0.2	203 to 311	0.5

TABLE 1

Celsius Range	Scale Error max	Fahrenheit Range	Scale Error max	Celsius Range	Scale Error max	Fahrenheit Range	Scale Error max
Graduated in 0.2 °C		Graduated in 0.5 °F		Graduated in 1 °C		Graduated in 2 °F	
		245 to 265	0.5	-80 to +20	B	-112 to +70	C
123 to 177	0.3			-38 to +50	0.5	-36 to +120	1
		270 to 290	0.5	-15 to +105	1	0 to 220	2
		295 to 315	0.5	-20 to +150	0.5	0 to 302	1
145 to 205	0.2	293 to 401	0.5	-5 to +300	1	20 to 580	2
145 to 205	0.4			-5 to 400	D	20 to 760	E
148 to 202	0.4			-2 to +300	F	30 to 580	G
		320 to 340	0.5	-2 to +400	H	30 to 760	I
170 to 250	A			10 to 200	1	50 to 392	2
173 to 227	0.4			15 to 70	1		
		345 to 365	0.5	25 to 80	1		
198 to 252	0.6			40 to 150	1	100 to 300	2
		395 to 415	0.5	77 to 260	1	170 to 500	1
		445 to 465	0.5	95 to 175	1	200 to 350	2
223 to 277	0.8			150 to 205	1		
248 to 302	1			Graduated in 2 °C		Graduated in 5 °F	
Graduated in 0.5 °C		Graduated in 1 °F		-6 to +400	J	20 to 760	K
-80 to +20	1			90 to 370	L	200 to 700	M
-37 to +21	0.2	-35 to +70	0.5	A 0.4 °C to 225 °C; 0.6 °C above 225 °C B 1 °C to -33 °C; 2 °C below -33 °C C 2 °F to -28 °F; 4 °F below -28 °F D 1 °C to 301 °C; 1.5 °C to 301 °C E 2 °F to 574 °F; 3 °F above 574 °F F 0.5 °C to 150 °C; 1 °C above 150 °C G 1 °F to 300 °F; 2 °F above 300 °F H 1 °C to 300 °C; 1.5 °C above 300 °C I 2 °F to 570 °F; 3 °F above 570 °F J 2 °C to 260 °C; 4 °C above 260 °C K 5 °F to 500 °F; 7 °F above 500 °F L 1 °C to 260 °C; 2 °C above 260 °C M 2.5 °F to 500 °F; 3.5 °F above 500 °F			
-34 to +49	0.5	-30 to +120	0.5				
-20 to +50	0.5	-4 to +122	1				
-18 to +49	0.5	0 to 120	0.5				
-18 to +82	0.5	0 to 180	0.5				
-7 to 105	0.5	20 to 220	1				
-5 to +110	0.5	20 to 230	1				
-1 to 175	0.5	30 to 350	1				
		60 to 160	2				
16 to 82	0.5	60 to 180	0.5				
		75 to 175	2				
30 to 200	0.3	85 to 392	0.5				
95 to 255	1						
147 to 182	0.5						
155 to 170	0.5						
		300 to 400	2				
195 to 305	0.5	383 to 581	1				
195 to 305	1						
295 to 405	0.5	563 to 761	1				

TABLE 1 (cont.)

**THERMOMETER VERIFICATION**  
**ITM 909**

**CERTIFIED THERMOMETER IDENTIFICATION**

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Type: \_\_\_\_\_ Serial No.: \_\_\_\_\_

Date of Calibration: \_\_\_\_\_ Graduations: \_\_\_\_\_

**VERIFICATION OF THERMOMETER**

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Type: \_\_\_\_\_ Serial No.: \_\_\_\_\_

Graduations: \_\_\_\_\_

Is thermometer free of any apparent defects? (Yes or No) \_\_\_\_\_

<b>Certified Thermometer Reading</b>	<b>Thermometer Being Verified Reading</b>	<b>Correction Applied</b>

Remarks: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Verified by: \_\_\_\_\_

Date: \_\_\_\_\_

Next Due Date: \_\_\_\_\_