

# **\*TB 9-6685-322-50**

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## **DEPARTMENT OF THE ARMY TECHNICAL BULLETIN**

# **CALIBRATION PROCEDURE FOR SELF-INDICATING THERMOMETERS (-38°C TO + 250°C) AND (-38°F TO + 482°F) (GENERAL)**

Headquarters Department of the Army, Washington, DC  
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\*This bulletin supersedes TB 9-6685-322-50, 14 November 1980, including all changes.

**SECTION I  
IDENTIFICATION AND DESCRIPTION**

**1. Test Instrument Identification.** This bulletin provides instructions for the calibration of Self-Indicating Thermometers (-38°C to +250°C) and (-38°F to +482°F) (General). The manufacturers' instruction manuals and NBS Monograph 150 were, used as the prime data source In compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

**a. Model Variations.** Thermometer types vary in range, accuracy, and immersion depth. This Is a general procedure for thermometers covering the ranges of -38°F to +482°F and -38°C to +250°C.

**b. Time and Technique.** The time required for this calibration is approximately 2 hours, using the physical technique.

**2. Forms, Records, and Reports**

**a.** Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

**b.** Adjustments to be reported are designated (R) at the end of the sentence .in which they appear. When adjustments are In tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

**3. Calibration Description.** TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Temperature	Range: -38°C to +250° C Accuracy: Depends on range and type (see table 4)
Temperature	Range: -38°F to +482°F Accuracy: Depends on range and type (see table 4)

**SECTION II  
EQUIPMENT REQUIREMENTS**

**4. Equipment Required.** Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is Issued with the secondary reference calibration standards set NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The Items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

Table 2. Minimum Specifications of Equipment Required

Item	Common name (official nomenclature)	Minimum use specifications	Manufacturer and model (part number)
A1	HIGH TEMPERATURE BATH (THERMOMETER CALIBRATOR)	Range: Ambient to 250 oC	Hallikainen, Model 1128CS2 (7907725)
A2	LOW TEMPERATURE BATH (CALIBRATION BATH ASSEMBLY)	Range: -39 °C to ambient	Hallikainen, Model 1283A5S2 (7907733) or Neslab, Model LT-50DD (7916963)
A3	STANDARD THERMOMETER	Range: -38 to 100 °C Accuracy: ± 0.5 °C Range: 100 to 200 °C Accuracy: ± 0.1 °C Range: 200 to 250 °C Accuracy: ± 0.3 °C	Scientific Glass, Model T-3780 (7910479)

**5. Accessories Required.** The accessories listed in table 3 are issued with the secondary reference calibration standards set and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

Table 3. Accessories Required

Item	Common name	Description (part number)
B1	CALIBRATION THERMOMETER KIT CONSISTING OF:	7911944
	TELESCOPE ADAPTER	Aluminum plate 2 1/2 x 1 1/2 x 3.8 in. (7911953)
	EXTENSION CLAMP	A.H. Thomas, No. 3204P (7911948)
	CLAMP HOLDER	A.H. Thomas, No. 3214-25 (7911951)
	ADJUSTABLE PLATE	Aluminum plate 2 x 1 x 1/4 in. (7911952)
	RIGHT ANGLE PRISM	Edmund Scientific Co., No. 3169 (7911949)
	PRISM HOLDER	Fabricated from aluminum to hold and align prisms (7911945)
	ROD COLLAR	Gaertner, No. M330 (7911946)
	SUPPORT STAND	A.H. Thomas, No. 3294-P (7911950)
	PRISM HOLDING TAB	Aluminum 1/23 in. thick x 5/16 in. wide and 1 13/16 in. long
	TELEMICROSCOPE	Gaertner, No. M101A7 (7911947)
B2	CONTAINER	Approximately 4 in. in diameter and at least 8 in. in height, able to withstand -3°C to +250°C

### SECTION III CALIBRATION PROCESS

#### 6. Preliminary Instructions

**a.** The Instructions outlined in this section are preparatory to the calibrate process. Personnel should become familiar with the entire bulletin before beginning the calibration.

**b.** Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced to item numbers prefixed with A, see table 2, and for prefix B, see table 3.

**NOTE**

This procedure is to be used for the initial calibration of all thermometers listed in table 4. Thereafter, the thermometer will be checked at the ice point only. Changes in the correction at the ice point will be applied to all corrections. That is, if the ice point correction increases, then the increase will be added to all corrections. If the ice point correction decreases, then the decrease will be subtracted from all corrections. If the shift in the ice point exceeds the rejection tolerance specified in table 4, the thermometer will be replaced. Thermometers which do not have ice points will be tested at some other point. Testing at some temperature other than the ice point requires a controlled temperature calibration bath and a temperature standard.

**7. Equipment Setup**

- a.** Remove TI from protective case.
- b.** Inspect TI for foreign matter and evidence of deterioration.

**NOTE**

Paragraph **7c** below is applicable only to liquid-in-glass thermometers.

**c.** Hold TI in vertical position and observe that bulb and column are free from gas bubbles and stem is free from globules of liquid. If not, perform (1), (2), or (3) below as applicable.

(1) Eliminate gas bubbles in TI bulb by cooling with dry ice or equivalent coolant until liquid is drawn into bulb. Tap TI gently against pad of paper or against palm of hand. Bubbles should rise to surface and disperse.

(2) Eliminate gas bubbles from stem of TI by slowly and carefully heating bulb until bubbles are joined. Carefully tap TI against pad of paper or against palm of hand.

**CAUTION**

To avoid damage to TI, exercise extreme care when applying heat.

(3) Eliminate globules of liquid inside TI stem by carefully and slowly heating TI bulb until liquid column merges with globules.

**NOTE**

If globules tend to unite and reappear after bulb cools, obstructions or oxidation of mercury may be present and TI must be rejected.

**NOTE**

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met before continuing with the calibration. Adjustments required to calibrate the TI are in this procedure. Additional maintenance information is in the manufacturer's manuals and NBS Monograph 150.

**NOTE**

In performing paragraph **8** below, total immersion type thermometers will be inserted to a depth sufficient to cover the 32 °F (0 °C) graduation. In paragraphs **9** and **10** below, the mercury column of total immersion thermometer must be as near the liquid surface as possible. Partial-immersion type thermometers will be inserted to the depth of the immersion line etched on the stem.

**NOTE**

Before calibrating thermometer 7915890, make ZERO and SPAN adjustment in accordance with the manufacturer's manual.

**NOTE**

Paragraph **10** provides an alternate technique that may be used to calibrate thermometers that are difficult to read through the prism used in figure 1. Paragraph **9** is suitable for thermometers that do not present a reading difficulty.

**8. Ice Point**

**a. Performance Check**

- (1) Place container (B2) on work area.
- (2) Select clear ice made from pure water, rinse with cold pure water, and shave or crush into small pieces.
- (3) Put ice into container to a depth of approximately 4 inches.

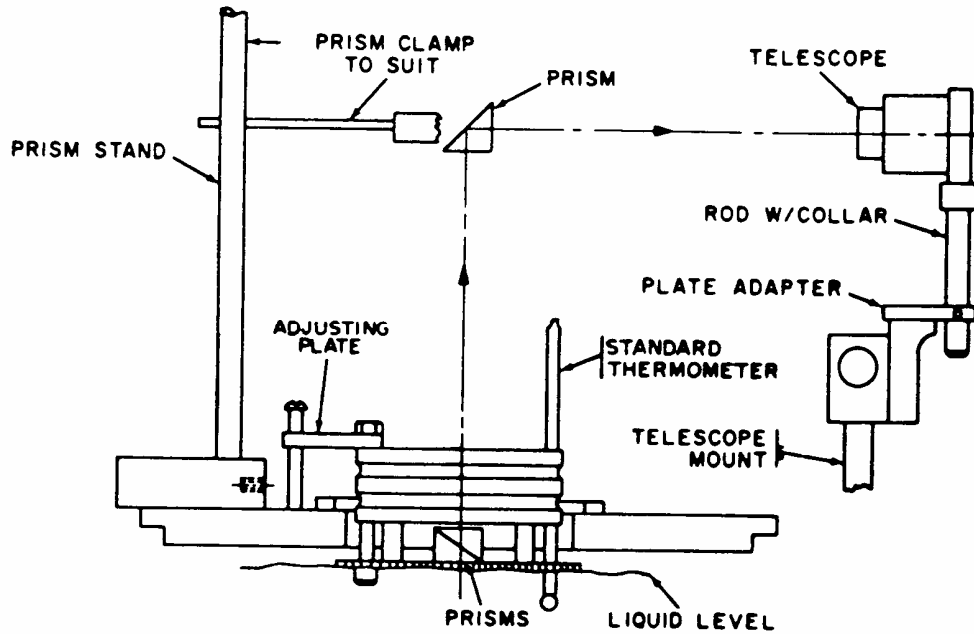


Figure 1. Temperature calibration - equipment setup.

- (4) Add pure water to ice in container until a slush is formed.
- (5) Insert TI into ice to proper depth, carefully packing ice around stem.

$$\begin{aligned} \text{°F} &= \text{°C} \times 9/5 + 32 \\ \text{°C} &= 5/9(\text{°F} - 32) \end{aligned}$$

- (6) After 3 minutes, lift TI slightly above ice and tap stem gently.

(7) Record TI temperature indication. If TI does not indicate 0 °C (32 °F) within the scale deviation limits specified in column four, table 4, perform **b** below. Table 4 provides rejection tolerance and acceptable scale deviations.

- (8) Remove TI from container and empty water and ice from container.

**b.** Adjustments. Prepare a correction chart for TI specifying the scale correction at the ice point.

Table 4. Temperature Accuracy

Test Instrument		Standard thermometer indication (°c) (rejection tolerance) (column 3)		Acceptable test instrument deviations (without corrections or adjustments) (column 4)		
Identifying number (column 1)	Indication (column 2)		Min	Max	°F	°C
	°F	°C				
7913471 and ASTM 615 (± 2°F)	125	---	49.7	53.7	± 0.5	---
	150		64.4	66.6		
	200		92.2	94.4		
	250		120.0	122.2		

Table 4. Temperature Accuracy - Continued

Test Instrument		Standard thermometer indication (°C) (rejection tolerance) (column 3)		Acceptable test instrument deviations (without corrections or adjustments) (column 4)		
Identifying number (column 1)	Indication (column 2)		Min	Max	°F	°C
	°F	°C				
7913470 and 8032312 (± 3°F)	-20	---	-27.2	-30.5	± 0.7	---
	32		-1.7	1.7		
	80		25.0	28.3		
	100		36.1	39.5		
7910596 and <sup>1</sup> Taylor, Model 1328 (± 2°F) and Psychon Model 566-2	32	---	-1.1	1.1	± 0.5	---
	50		8.9	11.1		
	80		25.6	27.7		
	110		42.2	44.5		
MIS-10320 (± 2°F)	32	---	-1.1	1.1	± 0.7	---
	70		20.0	22.2		
	110		42.2	44.5		
7907119 (± 3°C)	---	0	-3	3	---	± 1.5
		100	97	103		
		200	197	203		
		250	247	253		
ASTM 42C (± 1.5°C)	---	125	123.5	126.5	---	± 0.5
		150	148.5	151.5		
		200	198.5	201.5		
		250	248.5	251.5		
7909077 (± 2°F)	30	---	-33.3	-35.5	± 0.5	---
	32		-1.1	1.1		
	80		25.6	27.7		
	100		36.7	38.9		
Fisher Scientific Model 14-985C	---	0	-3	3	---	1.0
		50	47	53		
		100	97	103		
		140	137	143		
7915890	-22	-30	N/A	N/A	± 0.3 <sup>2</sup>	± 0.15 <sup>2</sup>
	32	0			± 0.3 <sup>2</sup>	± 0.15 <sup>2</sup>
	122	50			± 0.45 <sup>2</sup>	± 0.25 <sup>2</sup>
	212	100			± 0.65 <sup>2</sup>	± 0.35 <sup>2</sup>
	302	150			± 0.80 <sup>2</sup>	± 0.45 <sup>2</sup>
	392	200			± 1.0 <sup>2</sup>	± 0.55 <sup>2</sup>
Telethermometer Model 42SF or SC	---	-20	---	---	---	± 0.5 <sup>2</sup>
		0				± 0.5 <sup>2</sup>
		100				± 0.5 <sup>2</sup>
		120				± 1.0 <sup>2</sup>
	140				± 1.5 <sup>2</sup>	
Other thermometers within the temperature range	Other precision thermometers not listed in this table may be calibrated using this procedure to the accuracy of the TI plus the accuracy of the standard thermometer. The rejection tolerance should be based on the tolerance listed in this table for a thermometer in the same temperature range, or the tolerance listed in NBS Monograph 150 for the specified range.					

<sup>1</sup>Thermometers are part of hygrometer sling psychrometer set.

<sup>2</sup>If out of tolerance, perform adjustments in accordance with manufacturer's manual (R).

**9. Temperature Calibration**

**a. Performance Check**

**NOTE**

Perform (1) through (6) below for initial calibration only. For subsequent calibrations perform (7) below only.

- (1) Assemble thermometer calibration kit as shown in figure 1.
- (2) Place TI and appropriate standard thermometer (A3) into appropriate temperature bath (A1 and A2).
- (3) Adjust temperature bath for appropriate TI listed in table 4.
- (4) After temperature has stabilized, compare TI indication with standard thermometer indication and record standard thermometer indication.

**NOTE**

At higher temperatures oil film may blur the lower prism. This film may be removed long enough to take reading by removing the prism from setup, wipe clean and replace.

**CAUTION**

Do not attempt to remove prism from setup with bare hands.

- (5) Repeat (2) and (4) above for a total of three times.
- (6) Average the three indications recorded in (4) above. If average indication is not within limits specified in column four, table 4, perform **b** below.
- (7) If ice point correction recorded in **8a(7)** above has changed from initial calibration correction chart, apply the ice point correction to each scale point listed on the correction chart.

Initial Calibration	
Indication (°F)	Correction (°F)
-20	+ .6
32	+ .4
80	+ .2
100	.0

At the end of the calibration interval, the thermometer is checked at the ice point with the following result:

$$\text{New Correction} = +.3$$



The change in the ice point correction is -.1. This decrease is applied to the correction chart from the initial calibration to produce the following.

New Correction Chart Based on Ice Point	
Indication (°F)	Correction (°F)
-20	+.5
32	+.3
80	+.1
100	-.1

**b. Adjustments**

(1) If TI indications exceed the tolerance limitation (rejection tolerance) listed in table 4, the TI will be rejected.

(2) If the TI indications exceed the scale deviations allowed in table 4, but do not exceed the rejection tolerance, prepare a correction chart using values in column 4 specifying the scale corrections at each test point.

**10. Alternate Temperature Calibration**

**a. Performance Check**

(1) Place TI and appropriate standard thermometer (A3) into appropriate temperature bath (A1 or A2).

(2) Adjust temperature bath for appropriate TI indication listed in table 4.

(3) After temperature has stabilized read TI and standard thermometer at a point slightly above, but as near the top of the bath as possible.

Stem correction =  $Kn (T - t)$

$K = 0.00016$

T = TI indication in °C.

t = Average temperature of liquid column of n degrees.

n = Number of degrees on TI scale from top of liquid level to temperature indication.

(4) Compute immergent stem correction for the TI and standard as follows:

(5) Compare TI corrected temperature with standard thermometer corrected temperature and record standard thermometer temperature.

(6) Repeat (1) and (3) through (5) above for a total of three times.

(7) Average the three temperatures recorded in (5) above. If the average temperature is not within the limits specified In table 4, perform **9b** above.

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- b. Adjustments.** No adjustments can be made.

**11. Final Procedure**

- a.** Deenergize and disconnect all equipment.
- b.** Annotate and affix DA label/form in accordance with TB 750-25.

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By Order of the Secretary of the Army:

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