INCH-POUND

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(See 6.7)

MILITARY SPECIFICATION

THERMOCOUPLE AND RESISTANCE TEMPERATURE DETECTOR ASSEMBLIES, GENERAL SPECIFICATION FOR (NAVAL SHIPBOARD)

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers environmentally hardened resistance thermometers and thermocouple sensors that transform the surrounding thermal energy in a manner that can be electrically measured and converted to a temperature using a signal conditioner/temperature monitor. Types of configurations covered in this specification are those which place the resistance thermometer or thermocouple sensor directly into the medium (bare bulb), into a thermowell, or embedded into a bearing.

1.2 Classification. Resistance thermometers and thermocouple sensors shall be classified according to the following variables:

Type (see 1.2.1)	Configuration (see 1.2.2)	Designation number (see 1.2.3)

1.2.1 Type. The type of resistance thermometer or thermocouple sensor shall be designated by one of the following three-letter symbols.

Type	Symbols
Type K thermocouple sensor	KTC
Resistance thermometer with nickel element	NRT
Resistance thermometer with platinum element	PRT

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

AMSC N/A FSC 6685

1.2.2 Configuration. Type of configuration for which the resistance thermometer or thermocouple sensor is intended shall be designated by one of the following two-letter symbols.

Type of configuration	Symbols
Thermowell	TW
Bare bulb	BB
Embedded	EM

1.2.3 Designation number. The designation number used to specify the sheath length and other applicable parameters within each type of configuration shall be denoted by one or two numerals or by one or two numerals preceded by a letter found in one of the following:

Type of configuration	Table number
TW	II
BB	III
EM	IV.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-F-320	Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes
QQ-B-637	Brass, Naval: Rod, Wire, Shapes, Forgings, and Flat Products with Finished Edges (Bar, Flat Wire, and Strip)
QQ-S-763	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
QQ-T-390	Tin Alloy Ingots and Castings and Lead Alloy Ingots and Castings (Antifriction Metal) for Bearing Applications

MILITARY

MIL-M-14	Molding Plastics and Molded Plastic Parts, Thermosetting
MIL-S-901	Shock Tests, HI (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for
MIL-W-5846	Wire, Electric, Chromel and Alumel, Thermocouple
MIL-A-8625	Anodic Coating, for Aluminum and Aluminum Alloys
MIL-T-10727	Tin Plating; Electrodeposited or Hot Dipped, for Ferrous and Nonferrous Metals
MIL-P-15024	Plates, Tags, and Bands for Identification of Equipment
MIL-P-15024/5	Plates, Identification
MIL-W-16878	Wire, Electrical, Insulated, General Specification for
MIL-W-16878/25	Wire, Electrical, Polytetrafluoroethylene (PTFE) Insulated, 260 °C, 600 Volts, Extruded Insulation
MIL-E-17555	Electronic and Electrical Equipment Accessories, and Provisioned Items (Repair Parts): Packaging of
MIL-L-19140	Lumber and Plywood, Fire-Retardant Treated
MIL-S-22473	Sealing, Locking, and Retaining Compounds: (Single Component)
MIL-T-24270	Thermowells for Thermometers and Electrical Temperature Sensors, General Specification for
MIL-T-28800	Test Equipment for Use with Electrical and Electronic Equipment, General Specification for
MIL-T-55164	Terminal Boards, Molded, Barrier, Screw and Stud Types, and Associated Accessories, General Specification for
MIL-W-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-W-81381/12	Wire, Electric, Fluorocarbon/Polyimide Insulated, Medium Weight, Nickel Coated Copper Conductor, 600 Volts, 200 °C, Nominal 8.4 or 15.4 MIL WALL

STANDARDS

FEDERAL

FED-STD-H28	Screw-Thread Standards for Federal Services

MILITARY

MIL-STD-108	Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment
MIL-STD-271	Requirements for Nondestructive Testing Methods
MIL-STD-278	Welding and Casting Standard
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-735	Test Methods and Test Equipment for Thermometers Used in Machinery and Piping Systems
MS 3102	Connector, Receptacle, Electric, Box Mounting, Solder Contacts, AN
MS 3106	Connector, Plug, Electric, Straight, Solder Contacts, AN Type

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation (see 6.2).

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

0900-LP-001-7000	Fabrication and Inspection of Brazed Piping Systems

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

NATIONAL BUREAU OF STANDARDS (NBS)

NBS Monograph 37, National Bureau of Standards 1961

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 249	Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes
A 269	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service (DOD adopted)
A 276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes (DOD adopted)
A 312	Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe (DOD adopted)
A 466	Standard Specification for Weldless Carbon Steel Chain
B 23	Standard Specification for White Metal Bearing Alloys Known Commercially as "Babbitt Metal"
B 117	Standard Method of Salt Spray (Fog) Testing (DOD adopted)
B 152	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar. (DOD adopted)
B 164	Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire (DOD adopted)
B 167	Standard Specification for Nickel-Chromium-Iron Alloys (UNS NO6600 and NO6690) Seamless Pipe and Tube (DOD adopted)
B 355	Standard Specification for Nickel-Coated Soft or Annealed Copper Wire (DOD adopted)
B 637	Standard Specification for Precipitation-Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High Temperature Service
D 1457	Standard Specification for Polytetrafluoroethylene PTFE Molding and Extrusion Materials (DOD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The thermocouple sensors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3.1 and 6.3).

3.2 Reliability. Reliability of operation shall be 5000 hours mean-time-between-failure (MTBF). The contractor shall assure quality and maximum reliability. In the functional application of parts, adequate factors of safety shall be provided by deratings from the part specification values, where required, in order to ensure high equipment reliability under all service conditions. Construction shall include all possible features which will result in reliable and stable operation, reduced frequency of failure, reduced requirements for maintenance, and simplified maintenance, thus reducing requirements for highly skilled maintenance personnel.

3.3 Materials. Materials of resistance thermometer and thermocouple sensor components shall be as specified in table I.

TABLE I. *Materials.*

Part	Applicable configuration	Material	Material specification	Remarks
Babbitt topping	EM	Babbitt	QQ-T-390, grade 2	ASTM B 23, grade 2 is equivalent
Cap retaining chain	TW	Carbon steel	ASTM A 466	Zinc plated
	TW	Brass	QQ-B-637	
Connecting metal link	TW;NRT, PRT	Nickel-plated copper	ASTM B 152	See 3.5.7.3
	TW;KTC	Type K	MIL-W-5846	
Connecting wire resistance thermometer	TW	22 American Wire Gauge (AWG), stranded nickel-plated copper	MIL-W-16878 and MIL-W-16878/25	

TABLE I. *Materials - Continued.*

Part	Applicable configuration	Material	Material specification	Remarks
		Teflon (polytetrafluo-roethylene) insulated	ASTM D 1457	
	BB	22 AWG, stranded nickel-plated copper	ASTM B 355	
	EM	24 AWG, stranded nickel-plated copper fluorocarbon/ polyimide insulated	MIL-W-81381 and MIL-W-81381/12	
Connecting wire thermocouple sensor	TW	22 AWG, type K	MIL-W-5846	
		PTFE insulated	ASTM D 1457	
	BB	22 AWG, type K	MIL-W-5846	
	EM	24 AWG, type K fluorocarbon/ polyimide insulated	MIL-W-81381/12, except conductors in accordance with MIL-W-5846 and no plating	
Connection head	TW	Aluminum 356T51	MIL-A-8625, type I	Clear anodized
Connection head cap	TW	Aluminum 356751	MIL-A-8625, type I	Clear anodized
Connection head extension	TW	304 SST	ASTM A 312	
Connection head gasket	TW			
Connection head identification plate	TW	Aluminum	MIL-A-8625, type I	Clear anodized
		302 set	MIL-P-15024	
Gasket	BB	Copper	ASTM B 152	Temper 0
Pins, connector	BB.PRT	Nickel-plated copper alloy	For receptacle: MS 3102R 14S-7S	

TABLE I. *Materials - Continued.*

Part	Applicable configuration	Material	Material specification	Remarks
Receptacle plug			For plug: MS 3106F-14S-7P	
	BB:NRT	Nickel-plated copper alloy	For receptacle: MS 3102-R-12S-3P	
	BB:KTC	(+) chromel, (−) alumel	For plug: MS 3106F-12S-3S	
Seal, connecting Ceramic to metal wire end closure	TW			
	BB	Glass to metal		
	EM	Epoxy		
Sheath	TW	316 SST UNS N06600	ASTM A 249 ASTM A 269 ASTM B 167	Required for type KTC
	BB	UNS NO4405	ASTM B 164	
	EM	99 percent pure copper		1 percent not restricted material
		Tin-plated	MIL-T-10727	
Sheath internal insulation	BB,TW: NRT, PRT BB, TW:KTC	Aluminum oxide	Chemical certification on file required	99.8 percent pure
Spring, compression	TW	Inconel UNS N07750	ASTM B 637	Inconel X-750
Spring stop	TW	Inconel 316 SST	QQ-S-763	
Terminal board	TW	Mineral filled glass fiber reinforced alkyd compound	MIL-M-14, type MAT-30	MIL-T-55164
Threaded fasteners	TW	Corrosion-resistant steel	ASTM A 276	-[1]
Washers	TW	316 SST	ASTM A 276	

[1]Unless retained by mechanical means, retaining compound shall be in accordance with grade C of MIL-S-22473.

3.3.1 Nonmetallic materials. Nonmetals, when used for seals, protective finishes, and so forth, shall be moisture and flame resistant, shall not support fungus growth, and shall not be adversely affected by the ambient environments specified in the performance requirements of this specification.

insulation shall be as specified in table I.

3.3.1.1 Connecting wire end closure. The connecting wire end closure shall be airtight, nonhygroscopic, fungus resistant (see 3.3.1.2), flame resistant; and able to form a chemical bond with the connecting wires (thermowell configuration), electrical connector receptacle pins (bare bulb configuration), or the connecting wire insulation (embedded configuration) ~~and~~ with the sheath sufficient to meet the sealing requirements. The connecting wire end closure shall not contain a restricted material as specified in MIL-T-28800. The connecting wire end closure shall not chemically react, degrade, or outgas when subjected to the following: air, distilled water, sea water, salt, petroleum and silicone based oils, oil solvents, prolonged (greater than 1 month) periods of exposure to ambient temperatures, prolonged periods of exposure to elevated temperatures (up to 400 degrees Fahrenheit (°F), and exposure to prolonged cycling periods from ambient to elevated temperatures. A connecting wire and closure consisting of a ceramic-to-metal, or a glass-to-metal seal shall also incorporate other characteristics to make it impenetrable to fluids, and shall be considered a hermetic seal. The connecting wire end closure shall meet all the performance requirements specified in 3.7, including the connecting wire end closure requirement (see 4.9).

3.3.1.2 Fungus-inert materials. Materials which provide a nutrient medium for fungus and insects shall not be used in the construction of any resistance thermometer or thermocouple sensor. Fungus-inert materials shall be in accordance with requirement 4 of MIL-STD-454.

3.3.2 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification.

3.3.3 Restricted materials. The resistance thermometers and thermocouple sensors shall not contain a restricted material as defined in MIL-T-28800. In addition cadmium or cadmium plated parts shall not be used.

3.4 Methods of attachment.

3.4.1 Welding. Welding shall be performed in accordance with MIL-STD-278. The gas tungsten arc welding process shall be utilized except for forming the thermocouple measuring junction.

3.4.2 Brazing. Brazing shall be performed in accordance with NAVSEA 0900-LP-001-7000. Brazing is prohibited where the design temperature exceeds 425 °F.

3.4.3 Threads. Threads shall be in accordance with FED-STD-H28.

3.4.4 Fastening devices. Screws, pins, bolts, and similar parts shall be installed with means for preventing loss of tightness. These parts, when subject to removal or adjustment, shall not be swaged, peened, stacked, or otherwise permanently deformed.

3.5 Construction.

3.5.1 Description. Resistance thermometers and thermocouple sensors are shown on figures 1 through 6. Resistance thermometer and thermocouple sensor construction dimensions and application temperatures for thermowell, bare bulb, and embedded configurations shall be in accordance with tables II, III, and IV respectively.

TABLE II. *Construction dimensions and application temperatures.*

Thermowell configuration									
Type	Designation number	Insertion length into thermowell	Dimensions (see figures 1, 2, 4) (inches)				Temperature range (°F)	Maximum connection head temperature (°F)	Thermowell MIL-T-24270 specification sheet number and designation type
			L ± 0.04	A ± 0.03	Y ± 0.01	Z ± 0.16			
NRT	4	2.71	4.46	1.75	3.75	5.25	Minus 40 to 400	300	2C
NRT	6	2.71	6.71	4.00	6.00	7.50	Minus 40 to 400	300	2C
KTC	9	2.71	9.71	7.00	9.00	10.50	Minus 40 to 1500	500	2C
PRT	9	2.71	9.71	7.00	9.00	10.50	Minus 40 to 1000	500	2C
NRT	6	4.71	6.46	1.75	5.75	7.25	Minus 40 to 400	300	4C
NRT	8	4.71	8.71	4.00	8.00	9.50	Minus 40 to 400	300	4C
KTC	11	4.71	11.71	7.00	11.00	12.50	Minus 40 to 1500	500	4C
KTC	10	4.71	10.21	5.50	9.50	11.00	Minus 40 to 1500	500	4C
PRT	11	4.71	11.71	7.00	11.00	12.50	Minus 40 to 1000	500	4C

TABLE III. *Construction dimensions and application temperatures, bare bulb configuration.*

Type	Designation number	Size (see figure 5) (inches)		Temperature range (°F)
		E ± 0.03	F ± 0.03	
NRT	B1	2.25	3.50	Minus 40 to 400
	B2	6.50	7.75	
PRT	B3	2.25	3.50	Minus 40 to 1000
	B4	6.50	7.75	
KTC	B5	2.25	3.50	Minus 40 to 1500
	B6	6.50	7.75	

TABLE IV. *Construction dimensions and application temperatures, embedded configuration.*

Type	Designation number	Temperature range (°F)
NRT	E1	Minus 40 to 400
PRT	E2	Minus 40 to 400
KTC	E3	Minus 40 to 400

3.5.2 Element.

3.5.2.1 Resistance thermometer element.

3.5.2.1.1 Location. The resistance thermometer element shall be located within the bottom 2 inches of the sheath for the thermowell and bare bulb configurations. The resistance thermometer element for all configurations shall be located in a manner such that the insulation resistance test requirements are met.

3.5.2.1.2 Resistance thermometer current. Resistance thermometers shall withstand a continuous operating current of 6 milliamperes (mA) direct current (dc).

3.5.2.1.3 Temperature versus resistance. Relationships for resistance thermometers shall be in accordance with tables V and VI with limits of error specified in 3.7.2.

TABLE V. *Temperature versus resistance characteristics for resistance thermometers with nickel elements.*[1]

Temperature (°F)	Ohms	Temperature (°F)	Ohms
Minus 40	92.75	180	184.94
Minus 30	96.39	190	189.81
Minus 20	100.07	200	194.75
Minus 10	103.80	210	199.75
0	107.57	220	204.83
10	111.40	230	209.97
20	115.28	240	215.18
30	119.21	250	220.46
32	120.00	260	225.82
40	123.19	270	231.24
50	127.23	280	236.74
60	131.32	290	242.32
70	135.46	300	247.96
80	139.66	310	253.69
90	143.92	320	259.48
100	148.24	330	265.36
110	152.61	340	271.32
120	157.04	350	277.35
130	161.54	360	283.46
140	166.09	370	289.66
150	170.71	380	295.93
160	175.39	390	302.29
170	180.13	400	308.73

[1]Resistance thermometers with nickel elements shall not be used for temperature applications above 400 °F.

TABLE VI. *Temperature versus resistance characteristics for resistance thermometer with platinum elements.*

Temperature (°F)	Ohms	Temperature (°F)	Ohms
Minus 40	83.97	-	-
Minus 20	88.44	-	-
0	92.90	500	199.58
20	97.34	520	203.66
32	100.00	540	207.72
40	101.77	560	211.77
60	106.18	580	215.81
80	110.58	600	219.83
100	114.96	620	223.83
120	119.33	640	227.82
140	123.69	660	231.80
160	128.03	680	235.76
180	132.35	700	239.71
200	136.67	720	243.64
212	139.24	740	247.56
220	140.96	760	251.46
260	149.51	780	255.35

TABLE VI. *Temperature versus resistance characteristics for resistance thermometer with platinum elements – Continued.*

Temperature (°F)	Ohms	Temperature (°F)	Ohms
280	153.76	800	259.23
300	158.00	820	263.09
320	162.22	840	266.93
340	166.43	860	270.77
360	170.63	880	274.58
380	174.81	900	278.39
400	178.97	920	282.17
420	183.12	940	285.95
440	187.26	960	289.71
460	191.38	980	293.45
480	195.49	1000	297.18

3.5.2.2 Thermocouple. (See 6.5.10 and 6.5.28.)

3.5.2.2.1 Location. The thermocouple measuring junction shall be ungrounded and located within the bottom 1/4 inch of the sheath for the thermowell and bare bulb configurations. The thermocouple measuring junction shall be ungrounded and located in the middle of the sheath for the embedded configuration.

3.5.2.2.2 Method of attachment. The thermocouple measuring junction shall be formed by inert gas fusion welding (see 3.4.1).

3.5.2.2.3 Temperature versus electromotive force. The relationship for the type K thermocouple temperature versus electromotive force relationship shall be in accordance with either MIL-W-5846 or the NBS Monograph 37.

3.5.3 Connecting wires. The diameter of the connecting wire shall be the AWG as specified in table I. The connecting wire material shall also be in accordance with table I.

3.5.3.1 Resistance thermometers.

3.5.3.1.1 External insulation (TW and EM configurations). The material for the external insulation shall be as specified in table I.

3.5.3.1.1.1 Color code. The external insulation for the single connecting wire attached to one end of the resistance thermometer element shall be color coded red. The external insulation for the two connecting wires attached to the other end of the resistance thermometer element shall be color coded white.

3.5.3.1.2 Internal insulation (TW and BB configuration). The resistance thermometer connecting wires shall be insulated from the sheath and from each other by alumina ($A1_2 0_3$). The alumina shall be alpha alumina with a minimum content of 99.5 percent alumina. Sulfur shall not exceed 50 parts per million (ppm) while carbon shall not exceed 200 ppm.

3.5.3.1.3 Number of connecting wires. The resistance thermometers shall be of three-wire construction except for the bare bulb configuration with a nickel element which shall be of two-wire construction.

3.5.3.2 **Thermocouple sensors.**

3.5.3.2.1 External insulating (TW and EM configurations). The material for the external insulation shall be as specified in table I.

3.5.3.2.1.1 Color code. The external insulation for the positive (chromel) connecting wire shall be yellow. The external insulation for the negative (alumel) connecting wire shall be red.

3.5.3.2.2 Internal insulation (TW and BB configurations). The thermocouple sensor connecting wires shall be insulated from each other, except at the measuring junction, and from the sheath by magnesia (MgO). The magnesia shall be electrically fused with a 96.5 percent minimum content of magnesia. The sulfur content shall be less than 50 ppm and the carbon content less than 200 ppm.

3.5.4 Thermowell configuration.

3.5.4.1 Temperature exposures. Maximum connecting head temperature shall be 300 °F for resistance thermometers with nickel elements, 500 °F for resistance thermometers with platinum elements, and 500 °F for type K thermocouple sensors.

3.5.4.2 Watertight enclosure. Resistance thermometers and thermocouple sensors shall be watertight as specified in MIL-STD-108 (see 4.9.9).

3.5.4.3 Construction. Thermowell configuration shall consist of resistance thermometer or thermocouple sensor, connection head, and a connection head extension as shown on figures 1 through 4.

3.5.4.3.1 Connection head cap. The connection head of the thermowell configuration shall be provided with a screw-on type cap with a metal link chain.

3.5.4.3.2 Terminal board. Terminal board shall be secured to the connection head by two or more machine screws.

3.5.4.4 Thermowells. When resistance thermometers and thermocouple sensors are intended for use with thermowells, the thermowells shall be in accordance with MIL-T-24270.

3.5.5 Bare bulb configuration.

3.5.5.1 Temperature exposures. The maximum connector receptacle and plug temperature shall be 300 °F.

3.5.5.2 Watertight enclosure. Resistance thermometers and thermocouple sensors shall be watertight as specified in MIL-STD-108 (see 4.9.9).

3.5.5.3 Construction. The bare bulb configuration shall be of one-piece construction as shown on figure 5.

3.5.5.3.1 End cap. The connector receptacle shall be provided with a screw-on end cap.

3.5.5.3.2 Pressure requirements. The resistance thermometer and thermocouple sensor shall withstand 5500 pounds per square inch (lb/in^2) when inserted into air stream at a temperature of 360 °F with velocity of 40 feet per second.

3.5.6 Embedded configuration.

3.5.6.1 Temperature exposures. Resistance thermometers and thermocouple sensors shall withstand a maximum temperature of 400 °F for continuous use, 525 °F for short term exposure of 15 minutes, and 550 °F for short term exposure of 2 minutes.

3.5.6.2 Construction. The embedded configuration shall consist of the resistance thermometer or thermocouple sensor as shown on figure 6.

3.5.6.2.1 Scoring. The material and construction of the resistance thermometer or thermocouple sensor shall be such that in the event the bearing should fail and be wiped to a depth of 0.10 ± 0.01 inch over the area of the resistance thermometer or thermocouple sensor, scoring of a carbon steel shaft having a Brinell hardness of 170 to 180 will be limited to a depth of 300 microinches or less.

3.5.6.2.2 Babbitt topping. The tip of the sheath shall contain a 0.10 + 0.06 − 0.00 inch thick topping of babbitt. The diameter, including maximum to tolerance, of the babbitt topping shall conform to the diameter of the sheath.

3.5.7 Markings.

3.5.7.1 Sheath (TW and BB configurations). Each sheath shall be clearly and permanently marked, that is, engraved or electrochemically etched with the Commercial and Government Entity (CAGE) number, the classification variables as specified in 1.2, a model number, and a unique serial number.

3.5.7.2 Metallic tag (EM configuration). A metallic tag, shall be placed at the opposite end of the connecting wires from the sheath, and shall be clearly and permanently marked with the same information as required in 3.5.7.1. The following notice shall be placed on the opposite side of the tag. NOTICE: Reattach this tag to the connecting wires after bearing installation and keep affixed to the connecting wires when the bearing is placed in service.

3.5.7.3 Connecting metal link (TW configuration). The connecting metal links on the connection head terminal board for resistance thermometers shall be marked "R" and "W", respectively, for the red and white insulated connecting wires (see 3.5.3.1.1.1). The connecting metal links on the connection head terminal board for thermocouple sensors shall be marked "Y(+)" and "R(−)" for the yellow and red insulated connecting wires (see 3.5.3.2.1.1).

3.5.7.4 Connector receptacle (BB configuration). The connector receptacle pins for resistance thermometers with platinum elements shall be marked "B" for the single connecting wire on one side of the resistance thermometer element and shall be marked "A" and "C" for the two connecting wires on the other side of the resistance thermometer element. The connector receptacle pins for resistance thermometers with nickel elements shall be marked "A" and "B" for the two connecting wires on each side of the resistance thermometer element. The connector receptacle pins for thermocouple sensors shall be marked "(+)" and "(−)" for the positive and negative connecting wire respectively.

3.5.7.5 Connecting head plate (TW configuration). A metal identification plate shall be affixed by means of rivets or screws to the connecting head cap.

3.5.7.6 Identification plate type. The identification plate shall be type A, B, C, or D in accordance with MIL-P-15024 and MIL-P-15024/5, except a plastic plate shall not be used.

3.5.7.7 Identification plate marking. The identification plate shall be marked as specified in MIL-P-15024 and MIL-P-15024/5. The marking data shall be as follows:

a. Nomenclature
b. Contractor's part number
c. National stock number
d. Contract number
e. Serial number
f. Detailed specification number
g. Contractor's name or CAGE
h. Temperature range.

3.6 Temperature baths and calibration standards. Temperature baths and calibration standards used in qualification and quality conformance inspection testing shall be in accordance with 4.6.

3.7 Performance.

3.7.1 Insulation resistance. The insulation resistance, measured as specified in 4.8.3, shall be not less than 10 megohms.

3.7.2 Accuracy. The span and limits of error shall be as specified in table VII (see 4.9.2).

TABLE VII. *Accuracy (span and limits of error).*

Resistance thermometers with nickel elements	
Temperature range	Limits of error
Minus 40 to 200 °F 200 to 400 °F	Plus or minus 2 °F Plus or minus 1 percent of temperature measured
Resistance thermometers with platinum elements	
Temperature range	Limits of error
Minus 40 to 530 °F 530 to 1000 °F	Plus or minus 2 °F Plus or minus 3/8 percent of temperature measured
Thermocouple sensors	
Temperature range	Limits of error
Minus 40 to 530 °F 530 to 1500 °F	Plus or minus 2°F Plus or minus 3/8 percent of temperature measured

3.7.2.1 Accuracy repeatability tests 1 and 2. The span and limits of error shall be as specified in table VIII.

TABLE VIII. *Accuracy repeatability tests 1 and 2 (span and limits of error).*

Resistance thermometers with nickel elements	
Temperature range	Limits of error
Minus 40 to 200 °F 200 to 400 °F	Plus or minus 1 °F Plus or minus 0.5 percent of temperature measured
Resistance thermometers with platinum elements	
Temperature range	Limits of error
Minus 40 to 530 °F 530 to 1000 °F	Plus or minus 1 °F Plus or minus 3/16 percent of temperature measured
Thermocouple sensors	
Temperature range	Limits of error
Minus 40 to 530 °F 530 to 1500 °F	Plus or minus 1 °F Plus or minus 3/16 percent of temperature measured

3.7.2.2 Reference measurement. The performance shall conform to 3.7.2 (see 4.9.2.2).

3.7.3 Response time. Response time of the resistance thermometers and thermocouple sensors shall be as follows (see 4.9.3):

a. 8 seconds or less for thermowell configuration
b. 15 seconds or less for bare bulb configuration
c. 5 seconds or less for embedded configuration.

3.7.4 Self-heating (resistance thermometers only). The temperature change due to self-heating of the resistance thermometers shall not exceed 1 °F at an input power level of 5 milliwatts (see 4.9.4).

3.7.5 Thermal cycling. During the thermal cycling test, there shall be no shorts, opens, or evidence of the intermittent behavior. After the test, the resistance thermometers and the thermocouple sensors shall show no evidence of physical damage. The reference measurement performed at the conclusion of this test shall conform to 3.7.2 (see 4.9.5).

3.7.6 Overtemperature (EM configuration). Resistance thermometers and thermocouple sensors shall conform to the temperature span and accuracy requirements specified in 3.7.2 after being subjected to the test of 4.9.6. During the test, there shall be no shorts, opens, or evidence of intermittent behavior. The reference measurement performed at the conclusion of this test shall conform to 3.7.2.

3.7.7 Terminal strength (TW and EM configurations). Attachment of connecting wires to the connecting wire end closure and their encapsulation into the sheath shall withstand the specified static load. The resistance thermometers and thermocouple sensors shall be axially loaded for 15 minutes without causing circuit failure or loss of watertight integrity (see 4.9.7). The reference measurement performed at the conclusion of this test shall conform to 3.7.2.

3.7.8 Connecting wire end closure. There shall be no physical damage to the resistance thermometers and thermocouple sensors. There shall be no observed evidence of air bubbles during the vacuum portion of this test. At the conclusion of this test the performance of the resistance thermometers and thermocouple sensors during insulation resistance test and reference measurement shall conform to 3.7.1 and 3.7.2, respectively (see 4.9.8).

3.7.9 Enclosure (TW and BB configurations). There shall be no leakage of water into the watertight enclosure (see 4.9.9).

3.7.10 Salt spray. Resistance thermometers and thermocouple sensors shall show no appreciable corrosion or other damage when subjected to the salt spray test specified in 4.9.10. The performance of the resistance thermometers and thermocouple sensors during insulation resistance test and reference measurement shall conform to 3.7.1 and 3.7.2, respectively.

3.7.11 Spring loading (TW configuration). When compressed 3/16 inch, the spring shall exert a minimum force of 5 pounds. Spring loading shall be performed as specified in 4.9.11.

3.7.12 Vibration. The resistance thermometers and thermocouple sensors shall show no evidence of improper operation, failure, or damage (see 4.9.12). The electrical signal from the resistance thermometer and thermocouple sensor shall be monitored during this test and there shall be no shift in the temperature indication. A reference measurement performed at the conclusion of this test shall meet the specified accuracy requirements of 3.7.2. A visual inspection performed after the test, revealing significant wear on any vital parts (sheath, connecting wire, and so forth) constitutes failure. Failure also results from any test instrument behavior not covered above which could be a serious vibration performance defect. Wear to other parts is significant if it affects the test instrument performance.

3.7.13 Shock. Resistance thermometers and thermocouple sensors shall withstand the effects of the shock test specified in 4.9.13. A reference measurement performed at the conclusion of this test shall meet the specified accuracy requirements of 3.7.2.

3.7.14 Pressure (EM configuration). The embedded resistance thermometers and thermocouple sensors shall not deform to such a degree that the babbitt surface is visually determined by the Government inspector to be dimpled, cracked or ruptured after exposure to a pressure of 1800 $1b/in^2$ gauge. The insulation resistance between each connecting wire and the babbitt surface shall be not less than 10 megohms when measured both before and at the conclusion of the pressure test. The resistance thermometers and thermocouple sensors shall meet the reference measurement requirements of 3.7.2 both before and at the conclusion of the pressure test, as specified in 4.9.14.

3.7.15 Scoring (EM configuration). The stylus traces of the shaft surface parallel to the shaft axis taken both before and at the conclusion of the scoring test as specified in 4.9.15 shall indicate that the scoring depth does not exceed 300 microinches.

3.8 Cleaning and surface finishes. Surfaces of castings, forgings, molded parts, stampings, machined and welded parts shall be free of defects such as cracks, porosity, undercuts, voids, and gaps as well as sand, dirt, fins, sharp edges, scale, flux, and other harmful or extraneous materials. External surface shall be smooth and edges shall be either rounded or beveled. There shall be no burn-through. There shall be no warpage or dimensional change due to heat from welding operation. There shall also be no damage to adjacent parts resulting from the welding.

3.9 Workmanship. Contractor's production and inspection processes shall be established so that the end results will produce a completed product in accordance with the specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.3)
b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to NAVSEA on the resistance thermometer and thermocouple sensor samples produced with equipment and procedures normally used in production. Any resistance thermometer or thermocouple sensor which successfully meets the requirements of qualification testing shall be considered destroyed and not be included as a deliverable item or counted as part of any lot.

4.3.1 Sample size. Unless otherwise specified, two resistance thermometers and thermocouple sensors of each configuration and range that the contractor wishes to offer the Government for sale shall be subjected to qualification inspection.

4.3.2 General examination and tests. Qualification inspection shall consist of the general examination and tests specified in table IX in the order listed. Any deviation in the test order shall first be approved by NAVSEA. Unless otherwise specified, one new resistance thermometer and thermocouple sensor of each classification shall be selected every 4 years for the general examination and tests specified in table IX in the order listed. The selected resistance thermometer and thermocouple sensors shall have passed the group A tests specified in table IX. The tests specified in 4.9.7, 4.9.8, 4.9.12 and 4.9.13 shall also be required when the design of the resistance thermometer and thermocouple sensor, or the process or material, has been changed.

TABLE IX. *General examination and test.*

Test or examination	Requirement	Procedure	Qualification Inspection	Quality Conformance inspection	
				Group A	Group B
General examination[1]		4.8	TW, BB, EM	X	-[5]
Insulation resistance	3.7.1	4.9.1	-	-	-
Accuracy	3.7.2	4.9.2	TW, BB, EM	X[4]	X
Reference measurement	3.7.2.2	4.9.2.2	-	-	-

4.9.4 tests. Wafer in accordance with ASTM D199 and reagent grade

TABLE IX. *General examination and test - Continued.*

Test or examination	Requirement	Procedure	Qualification Inspection	Quality Conformance inspection	
				Group A	Group B
Response time	3.7.3	4.9.3	TW, BB, EM	-	-
Self-heating[3]	3.7.4	4.9.4	TW, BB, EM	-	X
Thermal cycling[2]	3.7.5	4.9.5	TW, BB, EM	-	X
Overtemperature[2]	3.7.6	4.9.6	EM	-	-
Terminal strength[2]	3.7.7	4.9.7	TW, EM	-	-
Connecting wire end closure	3.7.8	4.9.8	TW, BB, EM	-	-
Enclosure[1,2]	3.7.9	4.9.9	TW, BB	-	-
Salt spray[1,2]	3.7.10	4.9.10	TW, BB, EM	-	-
Spring loading	3.7.11	4.9.11	TW	-	X
Vibration[2]	3.7.12	4.9.12	TW, BB, EM	-	-
Shock [1,2]	3.7.13	4.9.13	TW, BB, EM	-	-
Pressure[1,2]	3.7.14	4.9.14	EM	-	-
Scoring	3.7.15	4.9.15	EM	-	-

[1]An insulation resistance test shall be performed at the conclusion of this test. Performance shall conform to 4.9.1.

[2]A reference measurement (see 4.9.2.2) shall be performed prior to and at the conclusion of this test. Performance shall conform to 3.7.2.2.

[3]The self heating test shall be performed only on the resistance thermometers.

[4]A one-point accuracy test at 32 °F shall be performed. Performance shall conform to 3.7.2.

[5]General examination (see 4.8.5).

4.3.3 Acceptance criteria. The resistance thermometers and thermocouple sensors shall meet all the requirements of the general examination and tests listed in table IX to receive qualification approval. If the tests specified in 4.9.7, 4.9.8, 4.9.12 and 4.9.13 have not been successfully completed 1 year after first failure, the failed items will be deleted from the qualified products list (QPL).

4.3.4 Retention of qualification. To retain qualification, the contractor shall forward a report at 12-month intervals. NAVSEA will establish the initial reporting date. The report shall consist of a summary of quality conformance inspection results of resistance thermometers and thermocouple sensors for delivery, indicating as a minimum the number of lots that have passed, the number that have failed, and the designation of the lots which have failed. The results of inspections of all reworked lots shall be accounted for and identified. If the summary of the inspection results indicates nonconformance with specification requirements, and corrective action acceptable to NAVSEA has not been taken, action may be taken to remove the failing resistance

thermometers and thermocouple sensors from the QPL. Failure to submit the report within 30 days after the end of each 12-month period may result in a loss of qualification for the resistance thermometers and thermocouple sensors. In addition to the periodic submission of inspection data, the contractor shall immediately notify NAVSEA at any time during the 12-month period that the inspection data indicates failure of the qualified resistance thermometers and thermocouple sensor to meet the requirements of this inspection. In the event that no production occurred during the reporting period, a report shall be submitted certifying that company still has the capabilities and facilities necessary to produce the resistance thermometers and thermocouple sensors. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of NAVSEA, to submit his qualified resistance thermometers and thermocouple sensors for testing in accordance with the qualification inspection requirements and the reason for no production.

4.4 Quality conformance inspection.

4.4.1 Inspection lot. An inspection lot shall consist of all resistance thermometers and thermocouple sensors of the same classification (see 1.2), produced under essentially the same conditions and offered for delivery at the same time.

4.4.2 Group A general examination and tests. Resistance thermometers and thermocouple sensors in each lot shall be subjected to the group A general examination and test specified in table IX in the order listed.

4.4.3 Group B general examination and test. A random sample of resistance thermometers and thermocouple sensors shall be selected from each lot (see 4.4.1) for the tests specified in table IX. Group B tests shall be performed in the order listed on resistance thermometers and thermocouple sensors that have passed group A tests.

4.4.4 Acceptance criteria.

4.4.4.1 Acceptance criteria for group A. The resistance thermometers and thermocouple sensors shall meet all the requirements of the group A general examination and tests in order to receive group A quality conformance inspection approval.

4.4.4.2 Acceptance criteria for group B. Selected resistance thermometers and thermocouple sensors shall have passed the group A tests. If any resistance thermometer or thermocouple sensor fails in any test, no resistance thermometer or thermocouple sensor shall be accepted for quality conformance inspection until the contractor has determined the cause of the defect and has taken the necessary action to correct or eliminate the defects from resistance thermometers or thermocouple sensors on hand. The failed test and any other test required shall be repeated to demonstrate that the corrective action will enable the resistance thermometers or thermocouple sensors to conform to the requirements of this specification.

4.5 Test conditions. Except where the following factors are the variables, the tests in this specification shall be conducted with the equipment and instrumentation operating under the following conditions:

a. Ambient temperature shall be 75 ± 10 °F.

b. Relative humidity shall be 50 ± 10 percent.

c. Supply voltage shall be 115 ± 5 volts.

d. Supply frequency shall be 60 ± 2 hertz (Hz).

e. Calibration bath temperature shall be plus or minus 5 °F from the specified temperature.

f. Resistance thermometer element excitation current shall be 1.0 ± 0.1 mA dc.

g. Maximum immersion into the temperature bath shall be as follows:

(1) TW configuration – immersion shall be to the thermowell insertion length minus 0.5 inch

(2) BB configuration – immersion shall be to the "E" dimension minus the thread length (0.875 inch)

(3) EM configuration – each resistance thermometer or thermocouple sensor shall be placed in an individual stainless steel tube and packed with fine aluminum oxide powder. The stainless steel tube shall be immersed in the temperature bath fluid to a depth such that further immersion does not produce a change in the equivalent indicated temperature of more than twice the temperature bath fluid gradient.

h. Unless otherwise specified, the test shall be performed with a sensor input current of 1 mA.

4.6 Temperature baths.

4.6.1 General design. Temperature baths may be of various types or designs. However, all baths shall include one or more pots or tanks (containment vessels), a stirrer, means of heating or cooling, and controls. The containment vessel shall have an adequate volume of fluid so that the temperature will not be excessively lowered when a resistance thermometer or thermocouple sensor is immersed and to accommodate the types of resistance thermometers and thermocouple sensors being tested.

4.6.1.1 Stirrer. Any method of stirring may be used provided temperature gradients throughout the working space of the temperature bath do not exceed plus or minus 1/10 °F (plus or minus 1/2 °F for salt bath), under steady state temperature conditions.

4.6.1.2 Controls. The controls shall maintain the bath fluid temperatures either constant or uniformly increasing or decreasing while the temperature bath is being stirred.

4.6.2 Temperature bath fluids. The temperature bath shall be a stirred liquid bath in which the resistance thermometer or thermocouple sensor and calibration standard may both be immersed for accuracy comparison. Suggested ranges for temperature baths and fluids shall be as specified in table X.

TABLE X. *Temperature bath fluids.*[1]

Temperature bath fluid	Temperature range (°F)
Ethanol or methanol	Minus 140 to 0
Ethylene glycol and water	Minus 40 to 50
Water	40 to 180
Glycerine	150 to 300
Silicone oil	150 to 350
Salt	350 to 1650

[1]Other temperature bath fluids may be used where the fluid will not damage the resistance thermometer or thermocouple sensor being immersed and other conditions specified herein are met.

4.6.2.1 Ethanol, methanol, ethylene glycol and water, glycerine, and silicone oil temperature baths. The temperature bath shall contain heating coils, cooling coils (when required), and a stirrer, none of which shall interfere with the immersion of the calibration standard and the resistance thermometer or thermocouple sensor. Other designs are equally suitable provided they do not conflict with other requirements of this specification.

4.6.2.2 Salt bath. A temperature bath using a heat treating salt as the temperature bath fluid shall be referred to as a salt bath. Salt baths may be of the type frequently used for heat treating purposes, converted to calibration and test work by the addition of a stirrer for uniform temperature distribution and a controller for heat input regulation and temperature control. Heat may be supplied externally, internally, or both, provided the temperature gradient conditions are met.

4.7 Calibration standards. The calibration standard shall consist of a precision resistance thermometer or thermocouple sensor which:

a. Has at least a four to one accuracy ratio over the resistance thermometer or thermocouple sensor being evaluated

b. Has a recorded history of its accuracy

c. Has a dated calibration curve that shows its limits of error

d. Has an accuracy that is traceable through various steps or levels to the National Institute of Standards and Technology.

A resistance thermometer calibration standard shall contain either a 25-ohm or 100-ohm platinum resistance element. A calibration standard containing a 25-ohm platinum resistance element shall be the calibration standard that is used in the range of minus 140 to 1000 for 25-ohm elements.

A calibration standard containing a 100-ohm platinum resistance element shall be the calibration standard that is used in the range of minus 140 to 1200 for 100-ohm elements. A thermocouple sensor calibration standard shall contain platinum rhodium versus platinum thermocouple wire and shall be the calibration standard that is used for temperatures above 1000 or 1200 °F (as appropriate). The resistance thermometer calibration standard shall contain either three or four connecting wires and be of a single element construction.

4.8 General examination.

4.8.1 Visual examination. Resistance thermometers and thermocouple sensors shall be given a thorough examination to determine that they conform to this specification and applicable drawings with respect to material, finish, workmanship, construction, assembly, dimensions, weight, marking of identification, and information plates. This examination shall be limited to those examinations that may be performed without disassembling the resistance thermometers and thermocouple sensors in such manner that their performance, durability, or appearance will be affected.

4.8.2 Radiographic examination (TW and BB configurations). The radiographic examination shall ensure that the resistance thermometer element, the thermocouple sensors measuring junction, and the connecting wires meet the requirements of 3.5.2 and 3.5.3. When required (see 6.2), each resistance thermometer or thermo-couple sensor shall be radiographically examined in accordance with MIL-STD-271, and the following:

a. Radiographs shall be made on extra fine grain film (Kodak type M, DuPont 510, or equivalent).

b. A lead screen of 0.005-inch thickness shall be placed in front of the film and 0.010-inch thickness in back of the film.

c. Resistance thermometer or thermocouple sensor shall be placed in a flat position on the film cassette, radiographed in this position and 90 degrees from this position.

d. A 1/4-inch cube reference block shall be placed adjacent to the resistance thermometer or thermocouple sensor.

e. Each resistance thermometer or thermocouple sensor shall be marked with the radiographic test identification.

4.8.3 Insulation resistance. An insulation resistance check shall be conducted at the conclusion of the general examination in accordance with 4.9.1. Performance shall conform to 3.7.1.

4.8.4 Sheath straightness (TW configuration). A plain ring gauge having a 0.2570 ± 0.0001 inch diameter and a length which is at least the thermowell insertion length shall be used to verify the sheath straightness. The sheath shall pass through the plain ring gauge until it hits the first spring stop.

4.8.5 Group B quality conformance inspection. Resistance thermometers and thermocouple sensors shall be examined to determine conformance to the requirements of 4.8.1 through 4.8.4.

4.9 Test procedures.

4.9.1 Insulation resistance. Insulation resistance shall be determined by applying 50 volts (dc) between the connecting wires and the sheath. Performance shall conform to 3.7.1.

4.9.2 Accuracy. Resistance thermometers and thermocouple sensors shall be calibrated in accordance with the requirements of 4.8. The temperature of the bath fluid shall be as shown in table XI, plus or minus 5 °F, with a temperature gradient as specified in 4.5.1.1. The resistance thermometers and thermocouple sensors shall be calibrated at temperatures listed in the increasing order. Performance shall conform to 3.7.2.

TABLE XI. Calibration temperatures.

Configuration	Type	Temperature range (°F)	Calibration values (°F)
TW, BB	NRT	Minus 40 to 400	Minus 20, 32[1], 80, 180[1], 280, 380[1]
	PRT	Minus 40 to 1000	Minus 20, 32[1], 200[1], 400, 600[1], 800, 980[1]
	KTC	Minus 40 to 1500	Minus 20, 32[1], 200, 400, 600[1], 900, 1200[1]
EM	NRT, PRT, KTC	Minus 40 to 400	Minus 20, 32[1], 80, 180[1], 280, 380[1]

[1] These values shall be used for reference measurement (see 4.9.2.2).

4.9.2.1 Accuracy repeatability. The accuracy test specified in 4.9.2 shall be performed two additional times. Performance shall conform to 3.7.2.1.

4.9.2.2 Reference measurement. The accuracy test as specified in 4.9.2 shall be referred to as a "reference measurement" when performed at the conclusion of another test listed in table IX. The reference measurement shall only be conducted at the three temperatures that are specified for a reference measurement in table XI. Performance shall conform to 3.7.2.2.

4.9.3 Response time. Resistance thermometers and thermocouple sensors shall be tested in accordance with the conditions of table XII using the procedure specified in MIL-STD-735. The low or high temperature test shall be used depending upon the configuration and the type of resistance thermometer or thermocouple sensor criteria in table XIII. The time it takes the standard cylinder output to rise from an equivalent temperature from T_1 to T_2 in table XII shall be the standard cylinder response time. The standard cylinder response time shall be within the values listed in table XII for at least six consecutive trials not counting those performed in establishing the proper temperature bath conditions (temperature, orientation, stirrer speed, and so forth). The response time of the resistance thermometers and thermocouple sensors shall be the average of at least six readings taken during at least six consecutive trials where the standard cylinder was within the values specified in table XII. The test conditions of the resistance thermometers and thermocouple sensors are also those contained in table XIII. Performance shall conform to 3.7.3.

TABLE XII. *Response time test conditions.*

Test conditions	Low temperature test	High temperature test
Maximum temperature (°F)	400	1000, 1500
Bath medium	Water	Salt
Bath temperature (°F)	180	940
Initial temperature (°F)	50	460
(Start timing) temperature T_1 (°F)	80	580
(Stop timing) temperature T_2 (°F)	143.2	808
Standard cylinder response time (seconds)	6.0 ± 0.2	8.0 ± 0.2

4.9.3.1 Embedded configuration. The immersion depth of the standard cylinder thermocouple measuring junction and the immersion depth of the resistance thermometer or thermocouple sensor shall be maintained at the same level.

TABLE XIII. *Conditions for temperature.*

Configuration	Type	Temperature test
TW	NRT	Low
BB	PRT, KTC	High
	NRT	Low
	PRT, KTC	High
EM	NRT, PRT, KTC	Low

4.9.4 Self-heating (resistance thermometers). The self-heating test shall be conducted in a water bath under the conditions specified in 4.9.2. A resistance thermometer shall be immersed in the water bath to at least the minimum immersion depth and allowed to stabilize at 180 °F. A series of direct currents shall be passed through the resistance thermometer elements and maintained until steady state is attained such that the power impact is successively 0.5, 1.0, 3.0, and 5.0 milliwatts. A curve of indicated temperature versus power input shall be plotted and extrapolated to zero power input. The difference between the indicated temperature at 5 milliwatts input and the extrapolated value at the indicated temperature at zero power input is the effect due to self-heating. Performance shall conform to 3.7.4.

4.9.5 Thermal cycling. Resistance thermometers and thermocouple sensors shall be heated and cooled for 1500 cycles in accordance with table XIV. Cycle rate shall not exceed two cycles per minute. The output of the resistance thermometers and thermocouple sensors shall be monitored during thermal cycling. Connection head temperature shall not exceed the maximum connection head temperature specified in table II. Prior to and following the test a reference measurement as specified in 4.9.2.2 shall be conducted. Performance shall conform to 3.7.5.

TABLE XIV. *Thermal cycling conditions.*

Temperature range (°F)	Cycle temperature (°F) plus or minus 10 percent	
	Lower	Upper
Minus 60 to 400	400	360
Minus 40 to 1000	100	900
Minus 40 to 1500	200	1200

4.9.6 Overtemperature (EM configuration). Resistance thermometers and thermocouple sensors, while at ambient temperature, shall be quickly (within 2 seconds) immersed for a period of 15 ± 0.5 minutes in a temperature bath in which the fluid is stabilized to a temperature of 525 ± 5 °F. The resistance thermometer or thermocouple sensor immersion depth shall be 3/16 inch if not installed in a fixture. If the resistance thermometer or thermocouple sensor is installed in a fixture, it shall be immersed to a sufficient depth to provide an accurate bath temperature measurement. The resistance thermometers or thermocouple sensors shall then be quickly immersed in another temperature bath containing the same fluid stabilized at a temperature of 550 ± 5 °F to the specified depth for a period of 2 plus 0.05 minus 0 minutes. The resistance thermometers or thermocouple sensors shall then be quickly immersed in the first temperature bath in which the fluid is stabilized at a temperature of 525 ± 5 °F to the specified depth for a period of 15 ± 0.5 minutes. The output of the resistance thermometers or thermocouple sensors shall be monitored during this test. The resistance thermometers or thermocouple sensors shall reach the bath fluid temperature within 1 minute after immersion into a temperature bath whether or not a test fixture is used. A reference measurement shall be performed at the conclusion of this test. Performance shall conform to 3.7.6.

4.9.7 Terminal strength (TW and EM configurations). With the resistance thermometers and thermocouple sensors firmly held in a holding fixture, a static tensile load of 5 pounds shall be applied to each connecting wire simultaneously for 15 minutes for the thermowell configuration. For the embedded configuration, a static tensile load of 5 pounds shall be applied to each connecting wire separately. The direction of the load shall be along the longitudinal axis of the resistance thermometers and thermocouple sensors. A reference measurement shall be performed at the conclusion of this test. The performance shall conform to 3.7.7.

4.9.8 Connecting wire end closure. During this test the resistance thermometers and thermocouple sensors of the thermowell configuration shall be removed from the connection head. No end cap shall be threaded over the connector receptacle of the resistance thermometers and thermocouple sensors of the bare bulb configuration. Connecting wire end closure shall meet the requirements specified in 3.7.8.

4.9.8.1 Vacuum portion. A desiccator shall be half filled with water and evacuated of dissolved air. The resistance thermometers and thermocouple sensors shall be immersed in this desiccator. The desiccator shall then be subjected to an absolute pressure of 4.0 ± 0.5 lb/in^2 for 15 minutes. The connecting wire end closure shall be observed for evidence of air leaks.

4.9.8.2 Pressure portion. The resistance thermometers and thermocouple sensors shall be placed inside a pressure chamber and the pressure chamber shall be hydrostatically pressurized with water to 25 plus 5 minus 0 lb/in^2 for a period of not less than 15 ± 0.5 minutes.

4.9.8.3 Post test measurements. At the conclusion of this test, an insulation resistance test followed by a reference measurement shall be performed. Performance shall conform to 3.7.8.

4.9.9 Enclosures (TW and BB configurations). The resistance thermometers and thermocouple sensors of the thermowell configuration shall be tested with a thermowell attached to the connection head extension and a threaded plug inserted into the connection head conduit connection. The resistance thermometers and thermocouple sensors of the bare bulb configuration shall be tested with an end cap threaded over the connector receptacle. The resistance thermometers and thermocouple sensors shall be immersed in fresh water. The test conditions for the watertight test of MIL-STD-108 shall apply. Performance shall conform to 3.7.9.

4.9.10 Salt spray. Resistance thermometers and thermocouple sensors shall be subjected to the salt spray test in accordance with ASTM B 117. The salt spray test shall run for a duration of 96 hours. The salt solution shall be 5 ± 1 percent concentration (5 parts by weight of salt in 95 parts by weight of water). At the conclusion of this test an insulation resistance test followed by a reference measurement shall be performed. Performance shall conform to 3.7.10.

4.9.10.1 Thermowell configuration. The resistance thermometer or thermocouple sensor shall be removed from the connection head during this test. A plug shall be threaded into the connection head conduit connection (see figure 3) and a thermowell shall be threaded onto the connection head extension. The connection head (including connection head extension, plug and thermowell) and the resistance thermometer or thermocouple sensor shall separately be subjected to the salt spray test.

4.9.10.2 Bare bulb configuration. The resistance thermometers and thermocouple sensors shall be subjected to the salt spray test without an end cap threaded over the connector receptacle.

4.9.11 Spring loading (TW configuration). Resistance thermometers and thermocouple sensors shall be mounted in a jig and compressed 3/16 inch three successive times. The compressive force of the spring shall be measured. Performance shall conform to 3.7.11.

4.9.12 Vibration. The vibration test shall consist of the exploratory test, the variable frequency test, and the endurance test. These tests shall be conducted in the sequence listed and shall meet the requirements specified in 3.7.12. Each of the three tests shall be conducted in each of the three mutually perpendicular axes. All three tests shall be completed in one axis before performing the tests in another axis. The resistance thermometers and thermocouple sensors shall be secured to the fixture in the surface mounted configuration.

a. **Exploratory test**

(1) Maintain each discrete frequency from 5 to 100 Hz at 1 Hz intervals for a minimum of 15 seconds, or a sweep rate that shall not exceed 4 Hz per minute.

(2) Displacements or accelerations shall be as specified in table XVI.

(3) Frequencies and locations where resonance occurs during this test shall be noted.

b. **Variable frequency test**

(1) Discrete frequency interval of 1 Hz

(2) Frequency range 5 to 100 Hz

(3) Each discrete frequency shall be maintained for a minimum of 5 minutes.

(4) Displacements shall be as specified in table XVI.

(5) Frequencies and locations where resonance occurs during this test shall be noted.

c. **Endurance test**

(1) The resistance thermometers and thermocouple sensors shall be subjected to a 2-hour endurance run at each resonance.

(2) Displacement or accelerations shall be the variable frequency test values that are specified in table XVI.

(3) If no resonance is found, a 2-hour endurance run shall be performed at 100 Hz. A reference measurement shall be performed after the conclusion of the vibration test. Performance shall conform to 3.7.12.

TABLE XVI. *Vibration displacement criteria.*

Frequency range (Hz) (inclusive)	Table displacement exploratory test	Variable frequency test (inch, peak to peak)
5 to 20	0.020 ± 0.004	0.060 ± 0.012
21 to 50	0.010 ± 0.002	0.040 ± 0.008
51 to 100	0.005 ± 0.001	0.020 ± 0.004

4.9.13 Shock. Shock test shall be conducted in accordance with grade A, class I, type C for lightweight equipment in accordance with MIL-S-901. Resistance thermometers and thermocouple sensors shall be mounted so as to simulate actual installation. Resistance thermometers and thermocouple sensors shall be mounted not less than 3 inches from the side and 3 inches from the rear of the platform. Output during the test shall be monitored. A reference measurement shall be performed at the conclusion of this test. Performance shall conform to 3.7.13.

4.9.14 Pressure (EM configuration). The resistance thermometers and thermocouple sensors under test, which will be used only for this one test, shall be installed in a fixture made from mild steel. The critical dimensions to which the fixture shall conform are shown on figure 7. The entire counterbored 3/4-inch diameter surface shall be babbitted over flush with the top of the test fixture using babbitt that conforms to grade 2 of QQ-T-390. The insulation resistance between each connecting wire and the babbitt surface shall then be measured. The babbitt surface shall then be exposed to a pressure of 1800 ± 10 lb/in^2 for 5 ± 0.25 minutes. After completion of this test, the insulation resistance shall be measured in the same manner as before the test. The fixture shall be unbabbitted and a reference measurement shall be performed. Performance shall conform to 3.7.14.

4.9.15 Scoring. The resistance thermometers and thermocouple sensors under test, which will be used only for this one test, shall be installed in a fixture made from mild steel. The critical dimensions to which the fixture shall conform are shown on figure 8. The resistance thermometers and thermocouple sensors under test shall not contain a babbitt topping and the connecting wire shall be severed at the connecting wire end closure of the sheath. The entire 3/4-inch diameter counterbored surface shall be babbitted over with 0.12 plus 0.01 minus 0 inch of the resistance thermometers and thermocouple sensors protruding above the babbitt surface using babbitt that conforms to grade 2 of QQ-T-390. The protruding tip of the resistance thermometers and thermocouple sensors shall be brought into contact with a 2.00 ± 0.01-inch diameter shaft that is rotating at 3000 ± 30 r/min. The shaft shall be made from carbon steel having a Brinell hardness between 170 to 180 and a surface finish between 15 to 25 root mean square (rms). A force of 8 ± 1 pounds shall be applied to the resistance thermometers and thermocouple sensors to ensure contact between the resistance thermometers and thermocouple sensors and the circumference of the shaft during the test. The resistance thermometers and thermocouple sensors shall be oriented so that the axis perpendicular to the face of the resistance thermometer and thermocouple sensor tip shall intersect and be perpendicular to the longitudinal axis of the shaft. Prior to the start of the test, the shaft and the fixture shall be cleaned with a suitable solvent and wiped dry. A stylus trace of the shaft surface parallel to the axis of the shaft shall be performed at six equally spaced intervals around the circumference of the shaft. No lubrication shall be used between the resistance thermometers and thermocouple sensors and the shaft during the scoring test. The rotating shaft shall remove 0.10 plus 0.10 minus 0 inch of material from the protruding tip of the resistance thermometers and thermocouple sensors. Upon completion of the test, removal of any babbitt from the surface of the shaft shall be accomplished by the use of 20 percent sodium hydroxide solution. A stylus trace of the shaft surface parallel to the axis of the shaft shall be performed at the same six equally spaced intervals around the circumference of the shaft. Performance shall conform to 3.7.15.

4.10 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.8.)

5.1 Packaging requirements. Thermocouple and resistance temperature element assemblies shall be preserved level A, C, or commercial, packed level A, B, C or commercial as specified (see 6.2) and marked in accordance with MIL-E-17555 and shall include bar codes and applicable packaging acquisition options therein as specified (see 6.2). In addition, for Navy acquisitions, the following applies:

a. **Navy shipboard stowage fire-retardant requirements.**

(1) *Lumber and plywood.* When specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container construction members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B – Type II – weather resistant
Category 1 – general use

Level C – Type I – non-weather resistant
Category 1 – general use.

(2) *Fiberboard.* When specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packaging forms shall meet the flamespread and the specific optic density requirements of PPP-F-320.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Resistance thermometers and thermocouple sensors are intended to sense a temperature and convert this to an electrical output for input to a temperature signal conditioner.

6.1.1 Selection guidelines.

6.1.1.1 Resistance thermometer. Resistance thermometers have the following characteristics:

a. The two resistance thermometer elements have different temperature ranges (excluding the EM configuration):

Nickel minus 40 to 400 °F
Platinum minus 40 to 1000 °F.

b. High accuracy

c. Excellent stability and reproducibility but slow in response

d. Easily interchangeable but damages easily if not handled properly. Can be matched to close tolerances for temperature difference measurements.

e. Resistance thermometers with platinum elements should be specified for new construction and new instrument installations. Resistance thermometers with nickel elements should be restricted to retrofit and replacements only.

6.1.1.2 Thermocouple sensors. Thermocouple sensors have the following characteristics:

a. Simple construction

b. Small signal output is produced which requires sensitive measuring instruments.

c. Lower cost and faster response time than the resistance thermometer.

d. Type K thermocouple covers a temperature range of minus 40 to 1500 °F (excluding EM configuration).

e. Compensation for reference junction temperature is required.

f. Attains high accuracy but subject to changes within the accuracy limit with use. These changes become more pronounced as the temperature increases.

g. Preferable for use with thermowells having a 2-inch immersion depth since the thermocouple sensor's minimum immersion depth is significantly smaller than that of a resistance thermometer.

h. Preferable for use in the EM configuration since extremely fine resistance thermometer element wire is very susceptible to electrical opens, shorts, or intermittent behavior in service.

6.1.1.3 New construction. Resistance thermometers with platinum elements should be specified for new construction and new instrument installations with the following exceptions:

a. Thermowells have a 2-inch immersion depth (see 6.1.1.2(g)).
b. EM configuration installations (see 6.1.1.2(h)).

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number and date of this specification

b. Classification (see 1.2)

c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2)

d. Quantity of resistance thermometers and thermocouple sensors required.

c. When radiographic examination is required (see 4.8.2)

f. Levels of preservation, packing and marking required (see 5.1)

g. When material should be fire-retardant treated and when fiberboard should meet flamespread and specific optic density requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24388 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with Provisions Governing Qualification SD-6 (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.4 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.4.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.5 Definitions. Terminology consistent with ASTM standard definitions and MIL-STD-280 applies in addition to the following definitions:

6.5.1 Assembly, thermocouple sensor or resistance thermometer. A thermometer/thermocouple sensor assembly consists of a thermocouple sensor or resistance thermometer, connection head and connection head extension. This item is applicable to the thermowell configuration (see figure 4).

6.5.2 Calibration. Calibration is the process of determining if an instrument is within its specified accuracy limits. This can be accomplished by developing an error curve so that its reading can be correlated to the actual value being measured. For instruments in which an adjustment to its accuracy is possible, calibration can also include adjustments, when required, to bring the instrument within its specified accuracy limits.

6.5.3 Connection wires, resistance thermometer. Connecting wires in resistance thermometers refer to the wires which are a part of the resistance thermometer and which serve as a means to electrically connect the resistance thermometer element to an external terminal board or internal connector plug pins. The connecting wires originate at the resistance thermometer element, run up the inside of the sheath, and pass through the connecting wire end closure.

6.5.4 Connecting wires, thermocouple sensor. Connecting wires in thermocouple sensors refers to the portion of the thermocouple that is a part of the thermocouple sensor, and that originates on both sides of, but does not include, the measuring junction. The connecting wires originate at the measuring junction, run up to the inside of the sheath, and pass through the connecting wire end closure. The free end of the connecting wires are either attached to an external terminal board or are crimped to internal connector plug pins.

6.5.5 Connection head. The connection head is an encasement which holds a terminal board and acts as a junction box for connecting wires and extension wires. The connection head is supported by a connection head extension (see figures 1 and 2).

6.5.6 Connection head extension. A connection head extension is a piece of tubing or pipe, with threaded ends, used to attach the connection head to the thermowell (see figure 2).

6.5.7 Electrical connector. An electrical connector is a connector with a receptacle end and plug end which is used to electrically connect the end of a cable run to a junction box, monitoring system, or other instrumentation. One electrical connector end is attached to the ends of the cable extension wires either by soldering or by crimping. The electrical connector is also known as an MS connector, canon plug, bendix connector, BNC connector, and so forth.

6.5.8 Electromotive force. Electromotive force is the difference of potential produced by sources of electrical energy which can be used to drive currents through circuits.

6.5.9 Element, resistance thermometer. A resistance thermometer element is composed of nickel or platinum wire wrapped around a mandrel, which behaves like a variable resistor being influenced by temperature. The element is manufactured so that it produces a precise resistance versus temperature relationship.

6.5.10 Element, thermocouple sensor. A thermocouple sensor element is another term for thermocouple.

6.5.11 Extension wire. An extension wire is the wire located between the thermocouple sensor assembly or the resistance thermometer assembly and the monitoring system that serves to electrically connect either of these two types of sensors to the monitoring system.

6.5.12 Gauge. Gauge refers to the thickness of the wire. The thickness is an important dimension since it is a factor in determining the resistance and pull strength of the wire.

6.5.13 Immersion depth, minimum. Minimum immersion depth refers to the depth at which a resistance thermometer or thermocouple sensor should be immersed, such that further immersion does not produce a change in indicated temperature beyond the accuracy limits.

6.5.14 Insulation, sheath interior. Sheath interior insulation refers to a magnesium oxide powder, an aluminum oxide powder, or a solid ceramic cylinder with penetration holes located inside the resistance thermometer or thermocouple sensor sheath. The purpose of this insulation is to isolate the connecting wires from each other and the sheath. The insulation also electrically isolates the resistance thermometer element or thermocouple sensor measuring junction from the sheath.

6.5.15 Junction, grounded thermocouple. A grounded thermocouple junction refers to a thermocouple sensor construction where the element is in electrical contact with the sheath.

6.5.16 Junction, ungrounded thermocouple. An ungrounded thermocouple junction refers to a thermocouple sensor construction where the elements are insulated from the sheath.

6.5.17 Measuring junction. Measuring junction is the point on a thermocouple where the two wires, each made from different metals, are attached (welded together). This is the same point or junction of a thermocouple which is subjected to the temperature being measured. When the measuring junction is at a higher temperature than the reference junction, the measuring junction is commonly called the hot junction.

6.5.18 Medium. Medium is the fluid in which a resistance thermometer or thermocouple sensor is placed to measure temperature.

6.5.19 Monitoring system. The monitoring system is the instrumentation that receives the electrical responses from the resistance thermometer or thermocouple sensor. The instrumentation may also convert this response to temperature readings.

6.5.20 Resistance. Resistance is electrical opposition that a device (load) offers to the flow of dc.

6.5.21 Reference junction. Reference junction refers to the ends of two unattached wires, each made of a different metal, that comprise the thermocouple. These two ends of the wires are separated, but are held at the same stable known temperature. The standard reference temperature is 32 °F, however, any other temperature, as long as it is known, can be used.

6.5.22 Resistance thermometer. A resistance thermometer is a temperature measurement device whose element behaves as a variable resistor as influenced by temperature. This resistance variation is accurately correlated as a function of temperature. The resistance thermometer consists of a platinum or nickel element, sheath, interior sheath insulation, connecting wires, and a connecting wire end closure.

6.5.23 Resistor variable. A resistor variable is a resistor constructed so that its resistance value may be changed without interrupting the circuit to which it is connected.

6.5.24 Sheath. A sheath is a cylindrical metal tube welded closed at the end in which the resistance thermometer element or thermocouple sensor measuring junction is located (see figure 1).

6.5.25 Spring. A spring is part of a resistance thermometer or a thermocouple sensor used to ensure that the sheath is in contact with the thermowell. The spring is used only in the thermowell configuration (see figure 1).

6.5.26 Terminal board. A terminal board is a component used to provide a means to both mechanically secure and electrically connect two wires or sets of two wires.

6.5.27 Terminal board binding screws. Terminal board binding screws are the screws in the terminal board which are used to mechanically secure and electrically connect two wires or sets of two wires.

6.5.28 Thermocouple. A thermocouple is a pair of wires in which each wire is of a different metal. At one end, the two wires are joined (measuring junction) and at the other end (reference junction), the two wires are individually connected to a cold junction compensating circuit. Holding the two ends at different temperatures generates a voltage across the wires. The voltage varies in relation to the temperature depending on which two wires, each of a different metal, are used.

6.5.29 Thermocouple sensor. A thermocouple sensor is a temperature measurement device whose element is comprised of a thermocouple. The open circuit millivolt output generated by the thermocouple is accurately correlated as a function of temperature. The thermocouple sensor consists of the thermocouple, sheath, interior sheath insulation, and connecting wire end closure or a fused glass-to-metal seal.

6.5.30 Thermowell. A thermowell is a closed-end tube designed to protect the resistance thermometer or thermocouple sensor sheath from such adverse conditions as a corrosive environment, high pressures, and large flow rates. The thermowell is connected to and becomes an integral part of the pressure boundary (piping) of the system. The thermowell material is designated to be compatible with the sheath material. The thermowell sensor or resistance thermometer can be removed from the thermowell without disturbing the pressure boundary (see figure 4).

6.5.31 Tip. Tip refers to the end of the sheath in which the resistance thermometer element or the thermocouple sensor measuring junction is located.

6.6 Cross-reference of classifications. Some resistance thermometers and thermocouple sensors covered by this specification were previously described in MIL-T-15377 and previous revision of MIL-T-24388. Resistance thermometers and thermocouple sensors purchased under previous revisions of MIL-T-24388 may be used to replace existing equipment purchased under MIL-T-15377 and MIL-T-24388 as follows:

Old classification under MIL-T-15377	Old classification under MIL-T-24388B	New Classification under MIL-T-24388C
IC/RTD	RTE	NRT, PRT
IC/TCD	TCE	KTC
1	EM	EM
2	BB	BB

Old classification under MIL-T-15377	Old classification under MIL-T-24388B	New Classification under MIL-T-24388C
3	TW	TW
N	N	NRT
P	P	PRT
T	Deleted	Deleted
K	K	KTC
J	Deleted	Deleted

6.7 Supercession data. This specification supersedes the requirements of MIL-T-24388/1(SH) through MIL-T-24388/8(SH) dated 26 April 1979.

6.8 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.9 Subject term (key word) listing.

Calibration
Extension wire
Immersion depth, minimum
Sheath
Thermowell

6.10 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 6685-N803)

qualification of products of the Navy, Washington, DC 20362, and information pertaining to

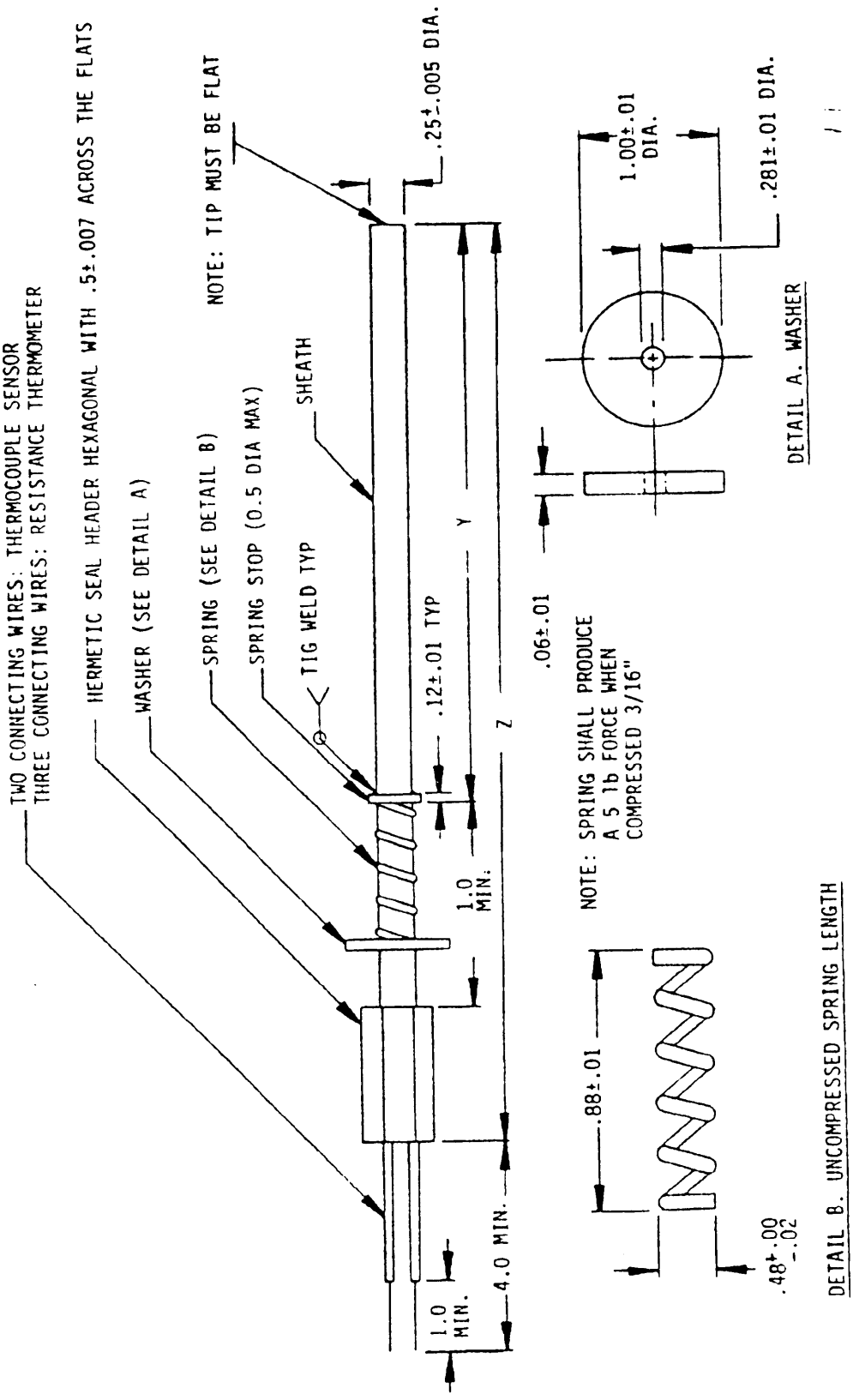
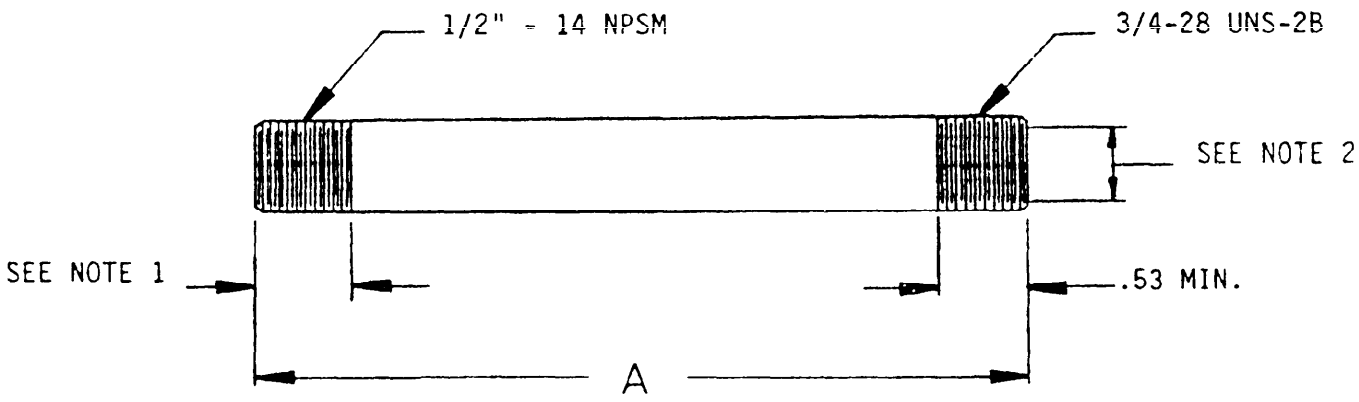


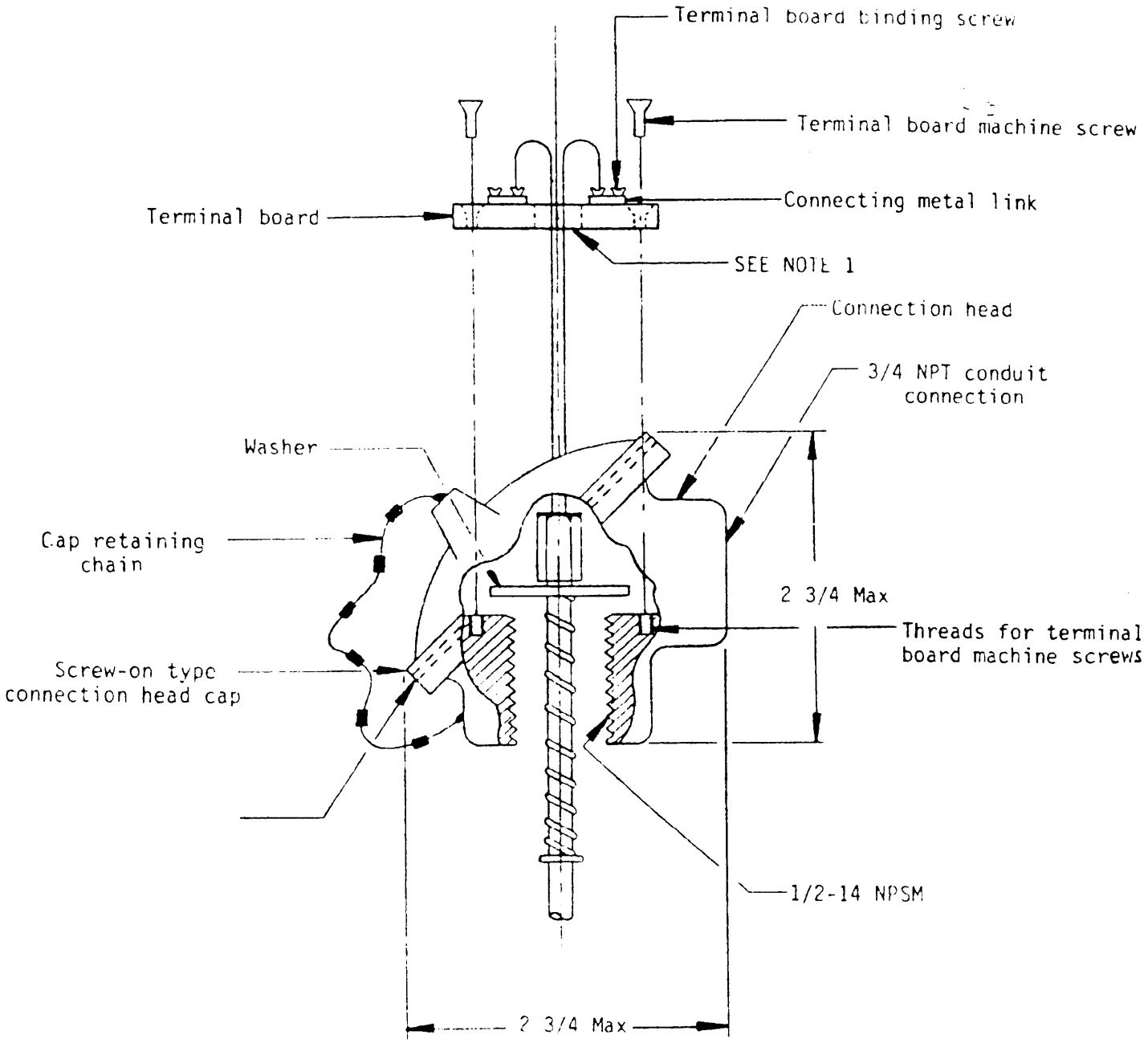
FIGURE 1. *Resistance thermometer/thermocouple sensor construction.*



NOTES:
1. Dimension to suit particular head design.
2. Inside diameter shall be sized to allow clearance for sensor sheath, spring stop, and spring.
3. Minimum wall thickness shall be 0.109 inch.

SH 13203089

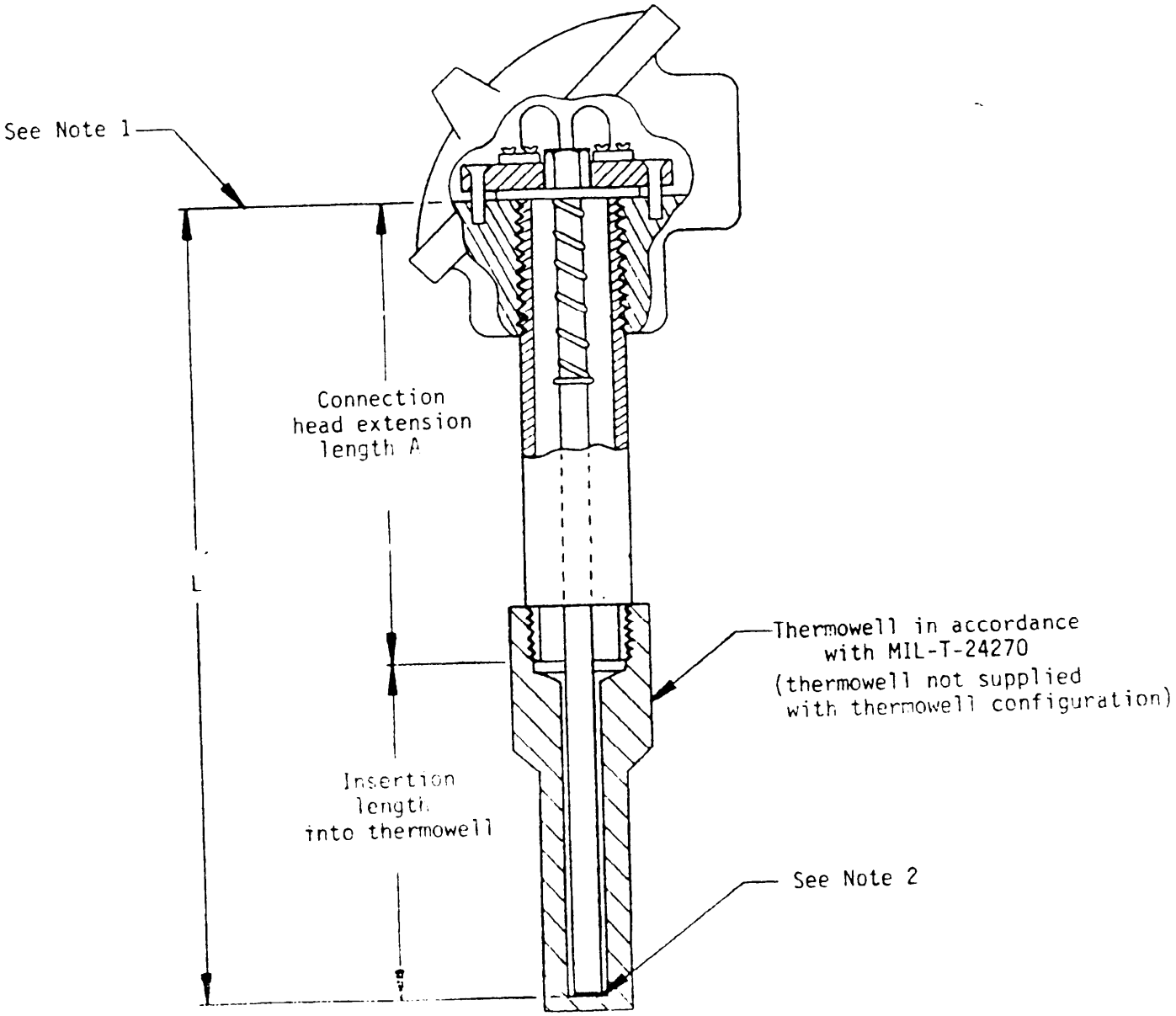
FIGURE 2. *Connection head extension.*



NOTES:
1. Thru hole in terminal board shall be hexagonal and shall be 0.515 ± 0.005 across the flats.
2. Variations in head design are permissible except for specific details shown herein.

SH 13203090

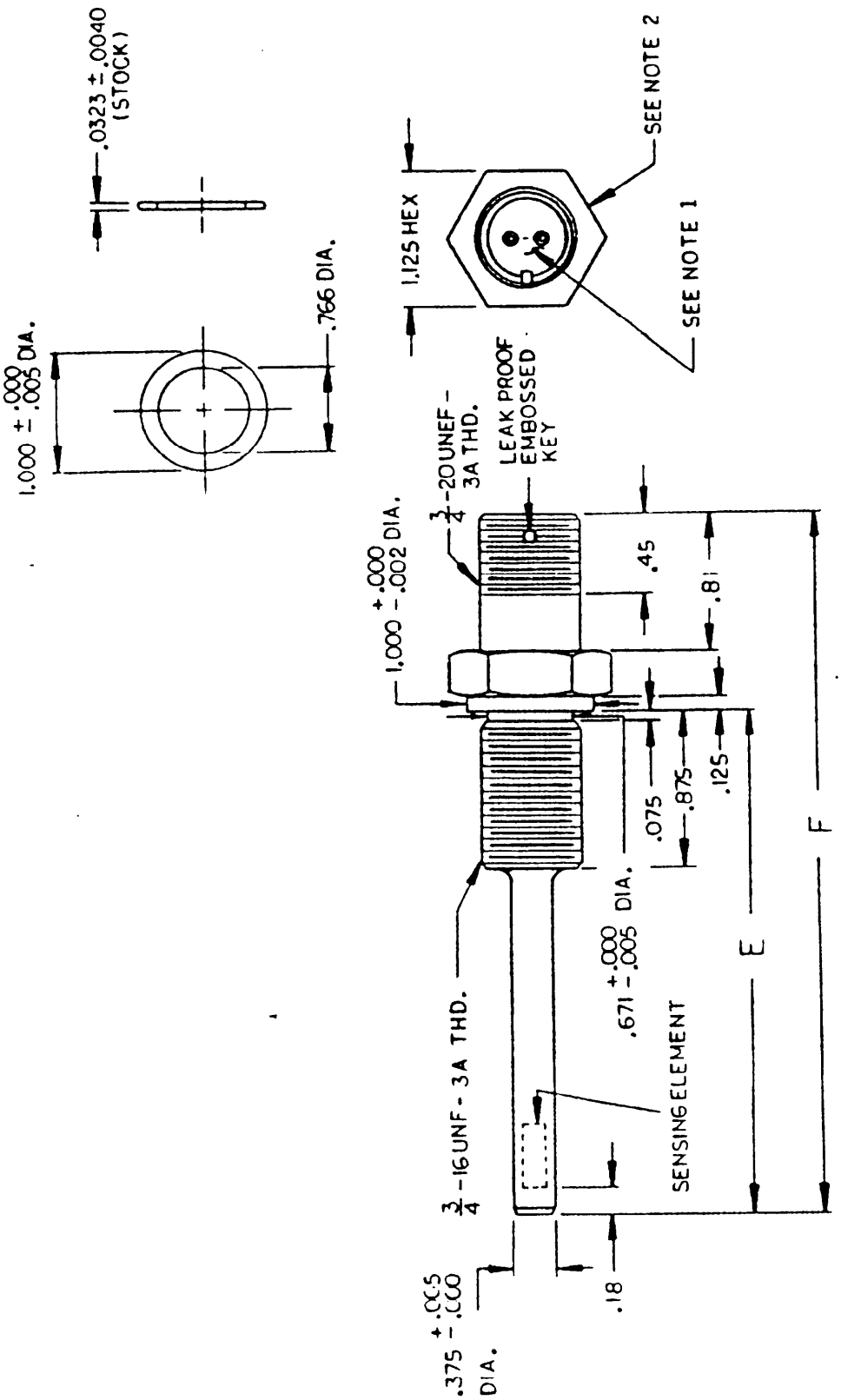
FIGURE 3. *Connection head construction.*



NOTES:
1. Top of connection head extension and bottom of washer shall be on same datum line.
2. Resistance thermometer or thermocouple sensor tip is compressed against bottom of thermowell.

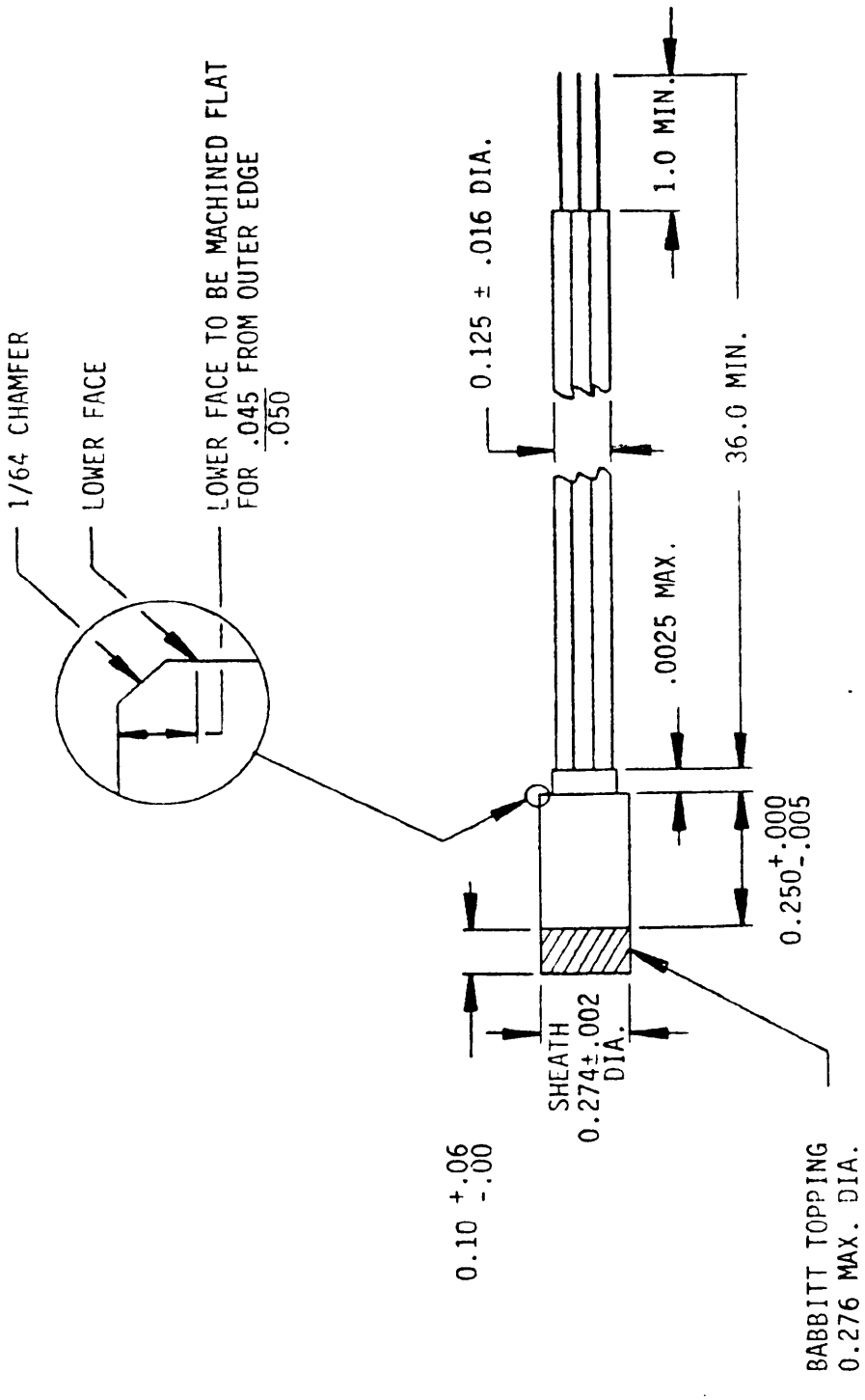
SH 13203091

FIGURE 4. *Thermowell type resistance thermometer/thermocouple sensor assembly.*



NOTES:
1. Glass-to-metal hermetic seal between pins and the connector receptacle portion of the sheath.
2. Bare bulb type resistance thermometer and thermocouple sensor shall be one-piece construction. The configuration for the connector receptacle portion shall be equivalent to MS 3102R-12S-3P for type K thermocouple sensors and resistance thermometers with nickel elements. The configuration for the connector receptacle portion shall be equivalent to MS 3102R-14S-7S for resistance thermometers with platinum elements.

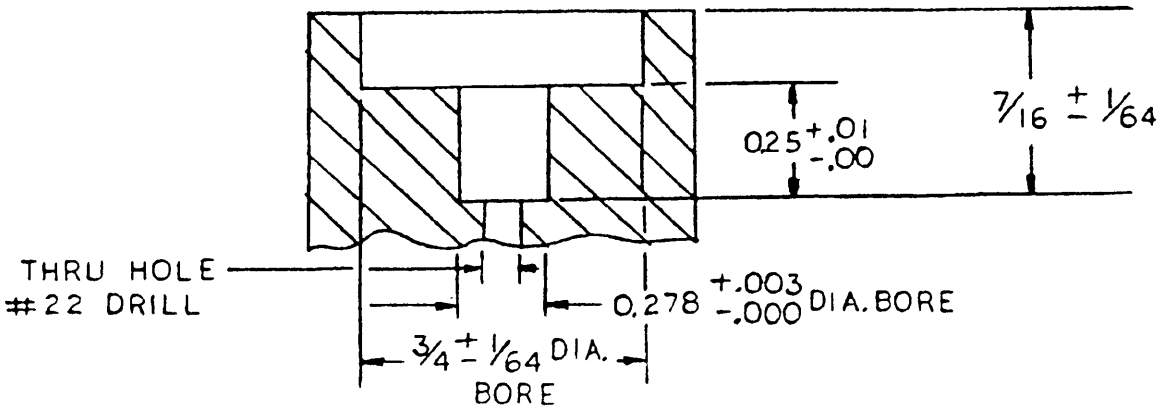
FIGURE 5. *Bare bulb type resistance thermometer/thermocouple sensor.*



NOTES:
1. All dimensions are in inches.
2. Break all sharp edges.

SH 13203093

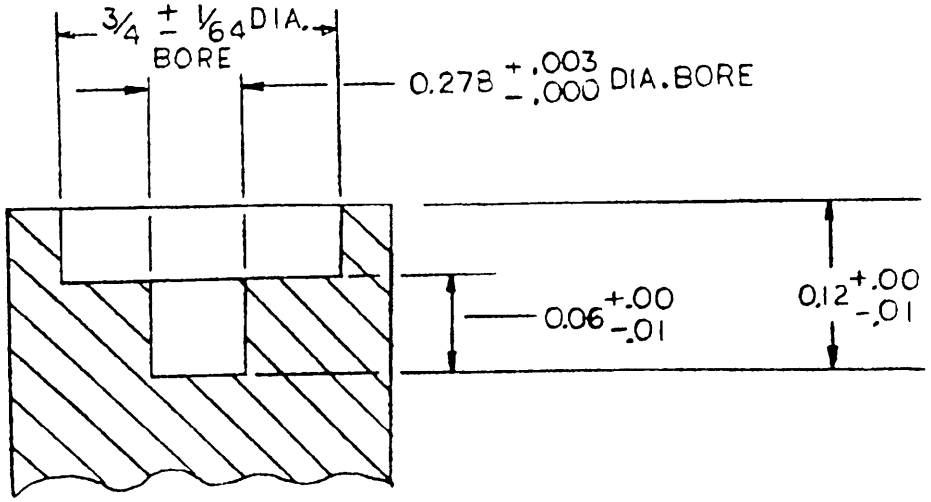
FIGURE 6. *Embedded type resistance thermometer or thermocouple sensor.*



NOTES:
1. All dimensions are inches.
2. Break all sharp edges.

SH 13203094

FIGURE 7. *Pressure test fixture critical dimensions.*



NOTES:
1. All dimensions are inches.
2. Break all sharp edges.

SH 13203095

FIGURE 8. *Scoring test fixture critical dimensions.*

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-T-24388C(SH)	THERMOCOUPLE AND RESISTANCE TEMPERATURE DETECTOR ASSEMBLIES, GENERAL SPECIFICATION FOR (NAVAL SHIPBOARD)

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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