

MIL-T-24388A (SHIPS)
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 SUPERSEDING
 MIL-T-24388 (SHIPS)
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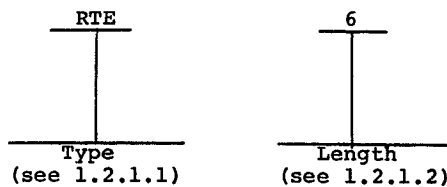
MILITARY SPECIFICATION
 THERMOCOUPLES AND RESISTANCE TEMPERATURE ELEMENT
 ASSEMBLIES (NAVAL SHIPBOARD USE)

1. SCOPE

1.1 Scope. This specification covers the requirements for the design, manufacture, testing, and packaging of thermocouple and resistance temperature element assemblies for Naval ships but does not include the wells. The assembly includes the sensing element and all mounting hardware, but does not include the well.

1.2 Classification.

1.2.1 The classification shall be of the following format as specified (see 6.2).



1.2.1.1 Type. The assembly shall be designated by the three letter symbols as follows:

RTE - Resistance temperature element - Platinum
 TCE - Thermocouple temperature element - Type K

1.2.1.2 Length. The length in inches shall be the designation number shown in table II.

2. APPLICABLE DOCUMENTS

2.1 The following documents of issue in effect on date of invitation for bids or request for proposal form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

PPP-B-566 - Boxes, Folding, Paperboard.
 PPP-B-636 - Boxes, Shipping, Fiberboard.
 PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall.
 PPP-B-665 - Boxes; Paperboard, Metal Stayed (Including Stay Material).
 PPP-B-676 - Boxes, Setup.
 PPP-T-45 - Tape, Gummed, Paper, Reinforced And Plain, For Sealing And Securing.

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MIL-P-116 - Preservation, Methods of.
 MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements For.
 MIL-D-1000 - Drawings, Engineering and Associated Lists.
 MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
 MIL-W-5846 - Wire, Electrical, Chrome And/Or Alumel, Thermocouple.
 MIL-W-8611 - Welding, Metal Arc and Gas, Steels, And Corrosion And Heat Resistant Alloys, Process For.
 MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
 MIL-P-15024/5 - Plates, Identification.
 MIL-M-15071 - Manuals, Technical: Equipments and Systems Content Requirements For.
 MIL-W-24270 - Wells for Indicators or Thermal Elements, General Specification For.

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- MIL-T-24387 - Temperature Measurement Equipment, Signal Conditioner and Power Supply (Electrical) (Naval Shipboard Use).
- MIL-P-24423 - Propulsion and Auxiliary Control Consoles and Associated Control and Instrumentation Equipment Naval Shipboard Use, Basic Design Requirements.
- MIL-I-45208 - Inspection System Requirements.
- MIL-T-55164 - Terminal Boards, Molded, Barrier, Screw and Stud Types, and Associated Accessories, General Specification For.

STANDARDS

MILITARY

- MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
- MIL-STD-202 - Test Methods for Electronic And Electrical Component Parts.
- MIL-STD-271 - Nondestructive Testing Requirements for Metals.
- MIL-STD-280 - Definitions of Item Level, Item Exchangeability, Models, and Related Terms.
- MIL-STD-735 - Test Methods and Test Equipment for Thermometers Used in Machinery and Piping Systems.
- MIL-STD-831 - Test Reports; Preparation of.

HANDBOOK

MILITARY

- MIL-HDBK-H-1 - Cross Index of Chemically Equivalent Specifications and Identification Code.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A376-72 - Seamless Austenitic Steel Pipe for High Temperature Central Station Service.

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- C96.1-1964 - Temperature Measurement Thermocouples.

(Application for copies should be addressed to the American National Standards Institute, 10 East 40th Street, New York, N.Y. 10016.)

3. REQUIREMENTS

3.1 Qualification. The assemblies furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.4).

3.2 Definitions. Terminology consistent with ANSI C96.1-1964 and MIL-STD-280 shall apply in addition to the following definition:

- (a) Length. The distance from the sheath end to the top of the head extension when installed in well (see table II and figure 1).

3.3 Design objectives. The basic design objectives are that the assemblies will meet the needs of the naval service and that the final product will reflect the utmost in simplicity, have maximum reliability consistent with the state of the art, and be easy to install and maintain.

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3.3.1 Reliability. Reliability of operation shall be considered of prime importance in the design and manufacture of the assemblies. The supplier shall employ all reasonable methods possible in the process of manufacture which will assure quality and maximum reliability consistent with the state of the art. In the functional application of parts, adequate factors of safety shall be provided by suitable deratings from the part specification values, where required, in order to insure high equipment reliability under all service conditions. The design 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.

3.4 Description. The assemblies specified herein shall be designed for insertion into a well to sense a temperature and convert this temperature into a usable output for input to a temperature signal conditioner. These assemblies are intended to be used with temperature measurement equipment designed in accordance with MIL-T-24387, and wells fabricated to conform to MIL-W-24270. The assemblies shall consist of the following parts (see figure 1):

- (a) Sheathed sensing element.
- (b) Spring to maintain sheath in contact with the bottom of a well.
- (c) Extension between a well and connection head.
- (d) Connection head containing a terminal block and provided with threaded openings for the extension nipple and for attachment of a conduit.

3.5 General features. The assemblies shall be in accordance with section 3 of MIL-P-24423 and as specified herein. (Whenever a requirement of MIL-P-24423 conflicts with a requirement of this specification, the requirement of this specification shall govern.)

3.5.1 Materials. Except where specifications are referenced, materials shall be in accordance with commercial specifications having material compositions considered suitable for the intended service. Where commercial specifications are referenced equivalent materials shall be in accordance with MIL-HDBK-H-1.

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

3.5.3 Sheath material. The sheath material shall be series 300 in accordance with ASTM A376-72.

3.5.4 Welding and brazing. All welding shall be the inert gas shielded fusion in accordance with MIL-W-8611 without the use of fluxes or other materials which may introduce contaminants. Welds shall be free from cracks and pores.

3.6 Type requirements.

3.6.1 Resistance temperature element.

3.6.1.1 Insulation. The resistance temperature element and enclosed wires shall be insulated from the sheath by materials suitable for the requirements of this specification.

3.6.1.2 Temperature relationship. The temperature resistance relationship shall conform to table I, with the limits of error stated in 3.11.1.1.

3.6.2 Thermocouple temperature element.

3.6.2.1 Insulation. The thermocouple wires shall be insulated from each other except at the junction and from the metal sheath, by compacted magnesium oxide.

3.6.2.2 Wire material. Thermocouple wire used shall be type I, class A, in accordance with MIL-W-5846 except that the temperature-electromotive force shall be as specified in 3.6.2.3.

3.6.2.3 Temperature relationships. Temperature-electromotive force relationships for type K shall be in accordance with ANSI C96.1-1964.

3.6.2.4 Measuring junction. The measuring junction shall be ungrounded and located within the bottom 1/4-inch of the sheath.

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Table I - Temperature resistance characteristics for platinum.

Temperature °F	Ohms	Temperature °F	Ohms
-40	83.97	--	--
-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
220	140.96	740	247.56
240	145.24	760	251.46
260	149.51	780	255.35
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

3.7 General design requirements. The assemblies shall be designed for an expected life of 40,000 hours of operation when installed and subjected to the conditions encountered in naval service.

3.7.1 Designation and marking.

3.7.1.1 Assembly. Identification plates, instruction plates, other designation plates, and marking for assemblies shall be in accordance with MIL-P-15024 and MIL-P-15024/5.

3.7.1.2 Sheath. Each protecting sheath shall be clearly marked (i.e., engraved) with the manufacturer's number, the type element contained therein as designated in 1.2.1.1 and a unique serial number.

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3.7.2 Leads.

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3.7.2.1 General. Wires emerging from the sheath shall be suitably insulated and shall be 18 to 22 American Wire Gage (AWG).

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3.7.2.2 Resistance temperature element leads. There shall be three leads. The single lead connected to one end of the sensor shall be color coded red; the two leads connected to the other end of the sensor shall be color coded white.

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3.7.2.3 Thermocouple element leads. The thermocouple lead insulation shall be color coded in accordance with ANSI C96.1-1964.

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3.7.3 Spring loading. The element shall be spring loaded similar to that shown on figure 1. Spring material shall be suitable for the temperature range (see table II). Minimum spring compression shall be 3/16-inch. A minimum force of 5 pounds shall be exerted by the spring each time under this compression (see 4.8.6).

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3.7.4 Enclosure. The assembly shall have a metal connection head similar to that shown on figure I. The connection head and extension shall be watertight as defined in MIL-STD-108. The head shall be provided with a screw-on type cap with a chain provided to connect it to the head. The head extension connection shall be a 1/2-inch - 14 NPSM thread and the conduit connection shall be 3/4-inch NPT. The head shall be capable of satisfactory performance when continuously subjected to the connection head temperature listed in table II. The assembly shall show no evidence of leakage following the enclosure test (see 4.8.3).

3.7.5 Connection head extension. The connection head extension shall be corrosion resistant steel minimum wall thickness 0.109 inches, the length of which shall be suitable for the particular installation. The head extension length shall be selected from table II.

Table II - Application.

Element type	Designation number	Size (inches) (figure 1)		Temperature range (°F)	Maximum connection head temp. (°F)	Thermowell MIL-W-24270/slash sheet no.	Insertion length (in)
		L	A				
RTE	4	4-7/16	1-3/4	-40 to 200	300	19, 20, 21	1-7/8
	6	6-11/16	4	-40 to 400			
	9	9-11/16	7	-40 to 1000	500	24	3-3/8
	10	10-3/16	5-19/32	-40 to 1000			
TCE	4	4-7/16	1-3/4	-40 to 200	300	19, 20, 21	1-7/8
	6	6-11/16	4	-40 to 400			
	9	9-11/16	7	-40 to 1500	500	24	3-3/8
	10	10-3/16	5-19/32	-40 to 1500			

3.7.6 Terminal block. The terminal block shall be in accordance with MIL-T-55164. The terminal block shall be secured to the head by two or more machine screws.

3.7.7 Sheath diameter. The sheath diameter shall be 0.250 plus 0.004, minus 0.000 inches.

3.7.8 Thermowell. These assemblies are intended for use with the thermowells in accordance with MIL-W-24270 (see table II).

3.7.9 Hermetic seal. A hermetic seal shall be provided at the exit of the wires from the sheath. The seal shall be suitable for the requirements of this specification. There shall be no evidence of leakage when tested in accordance with 4.8.4.

3.8 Type design requirement.

3.8.1 Resistance temperature element.

3.8.1.1 Resistance temperature element current. The resistance temperature element shall be designed to withstand a continuous operating current of 6 milliamperes (Ma) direct current (dc).

3.8.1.2 Lead wire resistance compensation. The resistance temperature element assembly shall be of 3 wire construction.

3.8.1.3 Calibration table. A certified calibration table shall be furnished for each element when specified (see 6.2).

3.8.2 Thermocouple temperature element.

3.8.2.1 Thermocouple junction. The thermocouple junction shall be formed by fusing the conductors by inert gas fusion welding (see 3.5.4).

3.9 Drawings.

3.9.1 General requirements. Drawings shall conform to form 2, categories A, B and G of MIL-D-1000 and to the detail requirements herein. The number of drawings and the amount of detail shall be held to a minimum consistent with the fulfillment of their function.

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3.9.2 Copies of drawings. Unless otherwise specified in the contract or order, two copies of the drawings shall be submitted for initial approval to the Naval Ship Engineering Center (NAVSEC) (Elect Systems-Subs/Electrical Systems Analysis Branch). For subsequent procurement the number of copies shall be as specified (see 6.2).

3.9.3 Approval of drawings. Drawings shall be approved by NAVSEC. Approval shall be required only on the first submittal of an item and whenever changes are made. Where drawing approval has previously been obtained, it shall be necessary only to submit copies of the approved drawing to meet drawing requirements on subsequent contracts. No changes shall be made to approved drawings without prior approval of NAVSEC.

3.9.4 Master drawings. Master drawings shall be type II of MIL-D-1000/2 and shall include the following minimum information, as applicable:

- (a) Descriptive data for the equipment.
 - (1) Type (see 1.2.1.1).
 - (2) Length (see 1.2.1.2).
 - (3) A statement that the equipment is in accordance with the requirements of this specification and to referenced specifications.
 - (4) A list of referenced drawings.
 - (5) Test procedure data, including letter, report numbers and dates.
 - (6) Shock and vibration classification.
 - (7) Enclosure, degree of.
 - (8) Ambient temperature.
 - (9) Weight of equipment (net).
 - (10) Any special features.
- (b) List of material, presenting following data in tabular form.
 - (1) Piece number (for flags of assembly drawing).
 - (2) Name of part.
 - (3) Number of each part material required per assembly.
 - (4) Military or Federal Specification number, or NAVSEC drawing number, if any.
 - (5) Type, class, grade, size, military designation or other classification of any referenced specification.
 - (6) Part number or identification assigned by manufacturer.
 - (7) Name of manufacturer of part.
 - (8) Part number or identification assigned by part manufacturer.
 - (9) Remarks column.
- (c) Electrical schematic diagrams. A single electrical schematic diagram for each assembly to represent clearly the operation of the equipment. Emphasis shall be placed on simplicity and ease of understanding. Physical placement of components and connecting wiring may be ignored in the interest of simplicity and clarity of this diagram.
- (d) Constructional details.
 - (1) Two representative assembly views, as required, to show clearly the details of the design, construction and assembly of the unit and to identify each part and its location. Identification of parts shall correspond to the list of materials.
 - (2) Sectional views or notes as necessary to show internal details.
 - (3) Details such as cable entrance provisions, gaskets, special mounting requirements and other details as applicable.
- (e) Installation drawings. Data to be shown on these drawings shall be as follows:
 - (1) Dimensional outline of the assembly showing overall and principle dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation and servicing, exclusive of space required for personnel. Include the clearance required for withdrawal of the assembly from the well.
 - (2) A table of reference drawings to include drawing number of each major assembly, weight of each enclosure.
 - (3) Location, type and dimensions of cable entrance connectors.
 - (4) Any special instructions for preservation, painting, installation or assembly as necessary.
- (f) Drawing format. All of the above information shall be presented on one sheet.

3.9.5 Manuals. Manuals shall be supplied in the quantity specified (see 6.2) and shall be in accordance with type I of MIL-M-15071 with content and arrangement as follows:

- (a) Front matter.
- (b) General information.
- (c) Installation.

- (d) Operation.
- (e) Maintenance, repair and troubleshooting.
- (f) Parts identification.
- (g) Drawings - Reduced size master drawing inserts.

3.10 General assembly performance.

3.10.1 Salt spray. The assembly shall show no appreciable corrosion or other damage when subjected to the salt spray test specified in 4.8.5.

3.10.2 Thermal cycling. After the thermal cycling test, assembly shall show no evidence of physical damage and the performance shall conform to the requirements of 3.11.1.1 or 3.11.2.1 (see 4.8.2).

3.10.3 Vibration. The assemblies shall be capable of withstanding the effects of the vibration test specified in 4.8.8. After the completion of the test, the assembly shall perform as specified in 3.11.1.1 or 3.11.2.1.

3.10.4 Shock. The assemblies shall be capable of withstanding the effects of shock test specified in 4.8.9. After the test the assembly shall perform as specified in 3.11.1.1 or 3.11.2.1.

3.10.5 Response time. The response time of the assembly shall be 8 seconds or less when tested in accordance with 4.8.1.

3.10.6 Insulation resistance. The insulation resistance between each wire and the sheath shall be not less than 10 megohms when tested in accordance with 4.8.10.

3.11 Type assembly performance.

3.11.1 Resistance temperature element.

3.11.1.1 Span and limits of error (see 4.9.1.1). The span and limits of error for platinum shall be as follows:

<u>Temperature range</u>	<u>Limits of error</u>
-40° to 530°F	+2°F
530° to 1000°F	±3/8 percent of temperature measured

3.11.1.2 Self heating. Temperature change due to self heating shall not exceed 1°F at an input power level of 5 milliwatts (see 4.9.1.2).

3.11.1.3 Thermal cycling. After the thermal cycling test, the resistance temperature element performance shall be within the limits of error specified in 3.11.1.1 (see 4.8.2).

3.11.2 Thermocouple temperature element.

3.11.2.1 Span and limits of error. Performance shall conform to the standard limits of error of ANSI C96.1-1964 (see 4.9.2.1).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The inspection system which the supplier is required to maintain, as provided in the inspection clause of the contract or order, shall be in accordance with MIL-I-45208 (see 6.2 and 6.3).

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4.2 Classification of inspection. Examination and tests shall consist of the following:

- (a) Qualification tests (see 4.3).
- (b) Quality conformance inspection (see 4.4).
- (c) Periodic tests (see 4.5).

4.3 Qualification tests.^{1/} Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of the tests specified in 4.3.1.

4.3.1 Sample for qualification. The number of samples to be submitted for the qualification tests specified in table III or IV shall depend on the assembly design. If each range is covered by a separate and distinct design, a sample for each range will require testing. Only one sample of a basically similar design series which may cover many ranges need be submitted for testing if mechanical and electrical similarity is deemed sufficient by NAVSEC. The range which has successfully passed the qualification tests for this design will qualify all other ranges of the same design. The test shall be conducted in the order listed in table III or IV.

Table III - Qualification examination and tests for type RTE.

Examination and tests	Requirement paragraph	Inspection paragraph
General examination	3.5	4.6
Calibration	3.11.1.1	4.9.1.1
Response time	3.10.5	4.8.1
Self heating	3.11.1.2	4.9.1.2
Thermal cycling	3.10.2	4.8.2
Hermetic seal	3.7.9	4.8.4
Salt spray	3.10.1	4.8.5
Insulation resistance	3.10.6	4.8.9
Vibration	3.10.3	4.8.7
Shock	3.10.4	4.8.8
Spring compression	3.7.3	4.8.6
Enclosure	3.7.4	4.8.3

Table IV - Qualification examination and tests for type TCE.

Examination and tests	Requirement paragraph	Inspection paragraph
General examination	3.5	4.6
Calibration	3.11.2.1	4.9.2.1
Response time	3.10.5	4.8.1
Thermal cycling	3.10.2	4.8.2
Hermetic seal	3.7.9	4.8.4
Salt spray	3.10.1	4.8.5
Insulation resistance	3.10.6	4.8.9
Vibration	3.10.3	4.8.7
Shock	3.10.4	4.8.8
Spring compression	3.7.3	4.8.6
Enclosure	3.7.4	4.8.3

4.4 Quality conformance inspection. Each assembly offered for delivery shall be subjected to the inspection listed in table V and shall be conducted in the order listed. Failure of any assembly to meet the requirements of this specification shall be cause for rejection.

^{1/} Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4 and 6.4.1).

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Table V - Quality conformance inspection for types RTE and TCE.

Examination and test	Requirement paragraph	Inspection paragraph
General examination ^{1/}	3.5	4.6
Insulation resistance	3.10.6	4.8.9

^{1/} Radiographic examination (see 4.6.3) not required.

4.4.1 Quality conformance inspection reports. A test report shall be packed with each assembly to attest to the performance of the inspection specified in 4.4. Reports shall include a complete identification of the assembly with a check notation of "passed" or "not passed" for each examination and test, the requirement paragraph and applicable examination and test paragraph. An assembly calibration record shall be included to determine conformance with the requirements of 3.11.1.1 and 3.11.2.1.

4.5 Periodic tests. One assembly shall be selected at random out of every 100 assemblies which have satisfactorily passed the tests in 4.4 from each lot offered for delivery and shall be subjected to the tests in table VI or table VII as applicable. If any assembly fails in any test, no assembly shall be accepted for quality conformance inspection until the manufacturer has determined the cause of the defect and has taken the necessary action to correct or eliminate the defects from all units on hand. The failed test and any other periodic test required shall be repeated to demonstrate that the corrective action will enable the assembly to conform to the requirements of this specification.

Table VI - Periodic tests for type RTE.

Tests	Requirement paragraph	Test paragraph
Calibration	3.11.1.1	4.9.1.1
Response time	3.10.5	4.8.1
Self heating	3.11.1.2	4.9.1.2
Thermal cycling	3.10.2	4.8.2
Spring compression	3.7.3	4.8.6

Table VII - Periodic tests for type TCE.

Tests	Requirement paragraph	Test paragraph
Calibration	3.11.2.1	4.9.2.1
Response time	3.10.5	4.8.1
Thermal cycling	3.10.2	4.8.2
Spring compression	3.7.3	4.8.6

4.5.1 Periodic test reports. A complete report on all periodic tests conducted as specified in 4.5 shall be submitted to NAVSEC for review. Format of the reports shall be as specified in MIL-STD-831.

4.6 General examination.

4.6.1 Visual examination. The assembly shall be given a thorough examination to determine that it conforms 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 assembly in such a manner that its performance, durability or appearance would be affected.

4.6.2 Insulation resistance. An insulation resistance check shall be performed in accordance with 4.8.10. Performance shall conform to 3.10.6.

4.6.3 Radiographic examination. Each element shall be radiographically examined in accordance with the requirements of method 209 of MIL-STD-202, MIL-STD-271, and the following:

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

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- (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) Sensor shall be placed in a flat position on the film casset, radiographed in this position and 90 degrees from this position.
- (d) A 1/4-inch cube reference block shall be placed adjacent to the sensor.
- (e) Each sensor shall be suitably marked with the radiographic test identification number.

The element shall conform to requirements of 3.6.1 or 3.6.2.

4.7 General test conditions.

4.7.1 Test conditions. Except where the following factors are the variables, the tests specified in 4.8 shall be conducted with the equipment operating under the following conditions:

- (a) Ambient temperature shall be $25^{\circ} \pm 5^{\circ}\text{C}$.
- (b) Relative humidity shall be 50 ± 10 percent.

4.7.2 Reference measurement. A reference measurement shall be conducted at temperatures specified in tables XI or XII as applicable.

4.8 Tests.

4.8.1 Response time. The response time of the assembly shall be determined in accordance with the type A test procedure (variable speed) outlined in MIL-STD-735. The test shall be performed under the conditions specified in table VIII. Immersion shall conform to insertion length specified in table II. The response time is the time required for the output to rise from T_1 to T_2 . Performance shall conform to 3.10.5.

Table VIII - Response time test conditions.

Temperature range °F (see table II)	200 to 400	1000 to 1500
Bath medium	Water	Salt
Bath temperature °F	180	940
Initial temperature °F	50	460
Start timing (temperature °F) T_1	80	580
Start timing (temperature °F) T_2	143.2	808
Standard cylinder response time ² (sec)	6 ± 0.2	8 ± 0.2

4.8.2 Thermal cycling. The element mounted in the assembly shall be heated and cooled for 1500 cycles in accordance with table IX. Cycle rate shall not exceed two cycles per minute. Prior to and following the test a reference measurement (see 4.7.2) shall be made. Performance shall conform to 3.10.2.

Table IX - Thermal cycling conditions.

Temperature range °F (see table II)	Cycle temperature (°F) plus or minus 10 percent	
	Lower	Upper
200	20	180
400	40	360
1000	100	900
1500	200	1200

4.8.3 Enclosure. The connection lead and extension shall be subjected to the test conditions specified for the watertight test of MIL-STD-108 using fresh water. There shall be no leakage of water into the watertight enclosure when subjected to this test. Performance shall conform to 3.10.1.

4.8.4 Hermetic seal. The element alone shall be immersed in a water bath, and the bath subjected to a pressure of 4.0 ± 0.5 pounds per square inch absolute (psia) for 15 minutes. The seal shall be observed for air leaks. The seal shall conform to 3.7.2.1.

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- # 4.8.5 Salt spray. The assembly shall be subjected to a salt spray test in accordance with method 101C of MIL-STD-202. The length of the test shall be in accordance with test condition A. Salt solution shall be a 20 percent concentration. Performance shall conform to 3.10.1.
- # 4.8.6 Spring compression. The assembly shall be mounted in a suitable jig and the sensor compressed $3/16$ inch three successive times and the compressive force of the spring measured. Performance shall conform to 3.7.3.
- # 4.8.7 Vibration. The assembly shall be tested in the well specified in table II in accordance with type I (environmental vibration) of MIL-STD-167 except that the upper limit of the frequency shall be 100 Hz. The amplitude of vibration shall be in accordance with table X. If no resonances are observed, the two hour endurance test shall be conducted at 100 Hz. The assembly output shall be monitored during the test. At the end of the test a reference measurement shall be made (see 4.7.2). The performance of the assembly during the test shall conform to 3.11.1.1 or 3.11.2.1. Following the test, performance shall conform to 3.10.3.

Table X - Vibration test conditions.

Frequency range	Table amplitude
Hz	Inches
5-20	0.030 \pm 0.006
21-50	0.020 \mp 0.004
51-100	0.010 \mp 0.002

- # 4.8.8 Shock. The shock test shall be conducted in accordance with grade A, class I, type C for light weight equipment in accordance with MIL-S-901. Assembly shall be mounted in the well specified in table II on fixture 4C, mounting platform 2. Assembly 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 made following the test (see 4.7.2). Performance shall conform to 3.10.4.
- # 4.8.9 Insulation resistance. Insulation resistance shall be determined by applying 50 volts dc between the wires and the sheath. Performance shall conform to 3.10.6.
- 4.9 Type test conditions and test procedures.
- 4.9.1 Resistance temperature element.
- # 4.9.1.1 Calibration. The assembly shall be calibrated in accordance with MIL-STD-735 at the temperature shown in table XI plus or minus 10°F. Performance shall conform to 3.11.1.1.

Table XI - RTE calibration temperature.

Range °F	Calibration values °F
-40 to 200	-20, 32 ^{1/} , 80 ^{1/} , 120, 180 ^{1/}
-40 to 400	-20, 32 ^{1/} , 80, 180 ^{1/} , 280, 380 ^{1/}
-40 to 1000	-20, 32 ^{1/} , 200 ^{1/} , 400, 600 ^{1/} , 800, 980 ^{1/}

^{1/} These values shall be used for reference measurement (see 4.7.2).

- # 4.9.1.2 Self heating. The self heating test shall be conducted in a water bath under the conditions specified in 4.8.1. The element shall be immersed in the bath and allowed to stabilize at 180°F. A series of direct currents shall be passed through the 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 3.11.1.2.

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4.9.2 Thermocouple temperature elements.

4.9.2.1 Calibration. The assembly shall be calibrated in accordance with MIL-STD-735 at the temperature shown in table XII plus or minus 10°F. Performance shall conform to 3.11.2.1.

Table XII - TCE calibration temperature.

Range °F	Calibration values °F
-40 to 200	-20, 32 ^{1/} , 80 ^{1/} , 120, 180 ^{1/}
-40 to 400	-20, 32 ^{1/} , 80, 180 ^{1/} , 280, 380 ^{1/}
-40 to 1500	-20, 32 ^{1/} , 200 ^{1/} , 400, 600 ^{1/} , 900, 1200 ^{1/}

^{1/} These values shall be used for reference measurement (see 4.7.2).

4.10 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.5.)

5.1 Preservation and packaging.5.1.1 Level A.

5.1.1.1 Cleaning. Unless otherwise specified herein, prior to packaging, assemblies shall be cleaned in accordance with process C-1 of MIL-P-116.

5.1.1.2 Packaging.

5.1.1.2.1 Thermocouple and resistance temperature elements. Units shall be individually cushioned and packaged in accordance with method III of MIL-P-116 one to a box (see 5.1.1.2.2).

5.1.1.2.2 Unit containers. Unit containers shall conform to any of the following containers at the option of the contractor:

<u>Specification</u>	<u>Classification</u>
PPP-B-566	Variety 4, style 1
PPP-B-636	Type CF, weather resistant
PPP-B-665	Style A
PPP-B-676	Type 1, class A

Container closure and sealing shall be in accordance with the applicable container specification or appendix thereto.

5.1.2 Level C. Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage. This level may conform to the supplier's commercial practice.

5.2 Packing. Packing shall be level A or B, as specified (see 6.2).

5.2.1 Level A. Assemblies packaged as specified (see 5.1.1.2) shall be packed in weather resistant fiberboard containers in accordance with PPP-B-636 or class 2, fiberboard-corrugated triple-wall containers in accordance with PPP-B-640, at the contractors' option. All center and edge seams and manufacturer's joints shall be sealed and waterproofed with pressure sensitive tape in accordance with the applicable fiberboard box specifications or appendix thereto. Shipping containers shall be closed and banded in accordance with the applicable box specification or appendix thereto. Banding (reinforced) shall be accomplished with use of pressure sensitive, reinforced tape. The gross weight of triple-wall boxes should not exceed 250 pounds. PPP-B-636 containers shall not exceed the weight limitations of the specifications. When specified, unit fiberboard containers conforming to weather resistant class of PPP-B-636 closed, sealed and banded as specified herein may be used as the shipping container and need not be over packed.

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5.2.2 Level B. Assemblies packaged as specified (see 5.1.1.2) shall be packed in containers conforming to PPP-B-636, domestic type or PPP-B-640, class 1. Shipping containers shall be closed in accordance with the applicable container specification or appendix thereto, except that fiberboard containers may be sealed with PPP-T-45 tape. Shipping containers shall not exceed the weight limitations of the applicable box specification. Unit fiberboard containers conforming to PPP-B-636 closed as specified herein may be used as the shipping container and need not be overpacked.

5.3 Marking. In addition to any special marking required by the contract or order, interior packages and exterior shipping containers shall be marked for shipment in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. These assemblies are intended to sense a temperature and convert this to a suitable output for input to a suitable temperature signal conditioner, and will be mounted in 1/4-inch wells in accordance with MIL-W-24270.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Classification required (see 1.2.1).
- (c) Calibration table (see 3.8.1.3).
- (d) Number of drawings required (see 3.9.2).
- (e) Quantity of manuals required (see 3.9.5).
- (f) Quantity of assemblies required.
- (g) Quality assurance requirements (see 4.1.1).
- (h) Level of packing required (see 5.2).

6.2.2 Contract data requirements. Data generated by this document are not deliverable unless specified on the Contract Data Requirements List (DD Form 1423) or the contract schedule. The data required by this specification include, but are not restricted to the following:

- (a) Drawings (see 3.9).
- (b) Technical manuals (see 3.9.5).
- (c) Quality conformance inspection reports (see 4.4.1).
- (d) Periodic test reports (see 4.5.1).

6.3 Management control system document. The following management control system document should be included on DD form 1660:

- (a) MIL-I-45208 (see 4.1.1).

6.4 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL 24388 whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, 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 Ship Engineering Center, Department of the Navy, Center Building, Hyattsville, Maryland 20782 and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.5 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in Section 2 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

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6.6 THE MARGINS OF THIS SPECIFICATION ARE MARKED "#" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Preparing activity:
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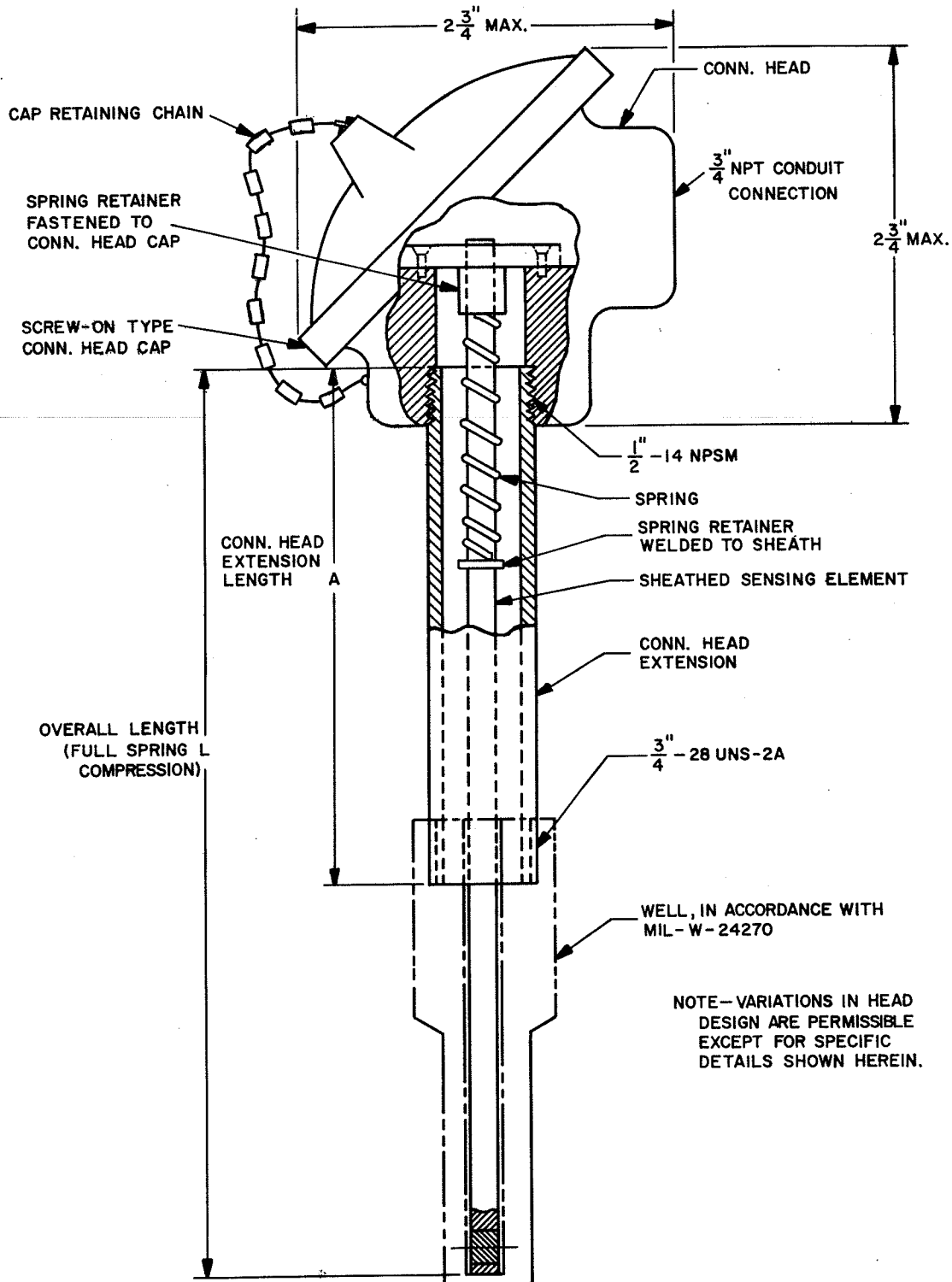


Figure 1 - Typical thermocouple or resistance temperature assembly.

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