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SUPERSEDING
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MILITARY SPECIFICATION

THERMOCOUPLE AND RESISTANCE TEMPERATURE ELEMENT 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 the requirements for the design, manufacture, testing, and packaging of thermocouple and resistance temperature element assemblies for Naval ships. Assembly includes the sensing element and mounting hardware, but does not include thermowells.

1.2 Classification. Assemblies shall be classified as follows and as specified (see 3.1, 6.2.1, and 6.5):

RTE	N	6	2	TW
Type (see 1.2.1)	Temperature element (see 1.2.2)	Designation number (see 1.2.3)	Insertion length (see 1.2.4)	Installation (see 1.2.5)

1.2.1 Type. Assembly shall be designated by the three letter symbols as follows:

RTE - Resistance temperature element.
TCE - Thermocouple temperature element.

1.2.2 Temperature element. Temperature element shall be designated by the corresponding letter symbol as follows:

Resistance (RTE):
N - Nickel.
P - Platinum.
Thermocouple (TCE):
K - Type K in accordance with ANSI C96.1.

1.2.3 Designation number. Designation number shall be assigned to a specific length for each assembly which is listed in the applicable detail specification. This does not apply to embedment installations.

1.2.4 Insertion length. Insertion length shall indicate the penetration of the assembly stem (either 2 or 4) into the sensed medium. This applies to thermowell applications only.

1.2.5 Installation. Installation shall be one of the following:

TW - Thermowell.
BB - Bare bulb.
BY - Bayonet.
EM - Embedment.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

QQ-T-390 - Tin Alloy Ingots and Castings, and Lead Alloy Ingots and Castings (Anti-Friction Metal) for Bearing Applications.

MILITARY

MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-W-5846 - Wire, Electrical, Chrome And/Or Alumel, Thermocouple.
MIL-T-15377 - Temperature Monitor System, Naval Shipboard.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories and Repair Parts; Packaging, and Packing of.
MIL-W-24270 - Wells for Indicators or Thermal Elements, General Specification.
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.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-248 - Welding and Brazing Procedure and Performance Qualification.
MIL-STD-271 - Nondestructive Testing Requirements for Metals.
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.
MIL-STD-831 - Test Reports; Preparation of.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND

NAVSEA 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.
NAVSEA 0900-LP-003-8000 - Acceptance Standards for Metals Surface Inspection.
(See supplement-1 for list of associated detail specifications.)

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting 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)

A249 - Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes.
A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
B167 - Nickel-Chromium-Iron Alloy, Seamless Pipe and Tube.

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
C96.1 - Temperature Measurement Thermocouples.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Detail specifications. The individual assembly requirements shall be as specified herein and in accordance with the applicable detail specifications. In the event of any conflict between requirements of this specification and the detail specification, the latter, shall govern.

3.2 Qualification. 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 6.3).

3.3 Reliability. Reliability of operation shall be 5000 hours mean-time-between-failure (MTBF). The contractor 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 deratings from the part specification values, where required, in order to insure high equipment reliability under all service conditions. 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. Assemblies shall be as described in the applicable detail specification. Temperature elements shall sense a temperature and convert this temperature into an electrical output that can be used for an electrical input to a temperature signal conditioner. Temperature element assemblies are intended for use with temperature measurement equipment in accordance with MIL-T-15377 and MIL-T-24387, and where the assemblies are to be installed in a thermowell, the thermowells shall conform to MIL-W-24270.

3.5 General features. 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. Materials shall be in accordance with MIL-E-917. (Whenever a requirement of MIL-E-917 conflicts with a requirement of this specification, the requirement of this specification shall govern.) Mercury, cadmium, and asbestos shall not be used.

3.5.1.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall 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 unless otherwise specifically specified.

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. Unless otherwise specified in the applicable detail specification, sheath material shall be series 300 in accordance with ASTM A249 and ASTM A269 or series 600 inconel (nickel-chrome-molybdenum-columbium) in accordance with ASTM B167.

3.5.4 Welding. Welding shall be performed in accordance with MIL-STD-248. The gas tungsten arc welding process shall be utilized.

3.5.5 Brazing. Brazing shall be performed and accepted in accordance with NAVSEA 0900-LP-001-7000.

3.5.5.1 Brazing is prohibited where the design temperature exceeds 425°F and where strength of a joint is a requirement.

3.6 Sensor type requirements.

3.6.1 Resistance temperature element.

3.6.1.1 Insulation. 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. Temperature resistance relationship shall conform to 3.6.1.2.1 and 3.6.1.2.2, with the limits of error specified in 3.9.1.2 or 3.9.1.3.

3.6.1.2.1 Nickel. Temperature resistance relationship shall conform to table I. Nickel elements shall not be used for applications above 400°F.

TABLE I. Temperature resistance characteristics for nickel.

Temperature °F	Ohms	Temperature °F	Ohms
-40	92.75	180	184.94
-30	96.39	190	189.81
-20	100.07	200	194.75
-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

3.6.1.2.2 Platinum. Temperature resistance relationship shall conform to table II.

TABLE II. Temperature resistance characteristics for platinum.

Temperature °F	Ohms	Temperature °F	Ohms
-40	83.97	260	149.51
-20	88.44	280	153.76
0	92.90	300	158.00
20	97.34	320	162.22
32	100.00	340	166.43
40	101.77	360	170.63
60	106.18	380	174.81
80	110.58	400	178.97
100	114.96	420	183.12
120	119.33	440	187.26
140	123.69	460	191.38
160	128.03	480	195.49
180	132.35	---	----
200	136.67	---	----
212	139.24	500	199.58
220	140.96	520	203.66
240	145.24	540	207.72

TABLE II. Temperature resistance characteristics for platinum. - Continued

Temperature °F	Ohms	Temperature °F	Ohms
560	211.77	800	259.23
580	215.81	820	263.09
600	219.83	840	266.93
620	223.83	860	270.77
640	227.82	880	274.58
660	231.80	900	278.39
680	235.76	920	282.17
700	239.71	940	285.95
720	243.64	960	289.71
740	247.56	980	293.45
760	251.46	1000	297.18
780	255.35		

3.6.1.3 Resistance temperature element current. Resistance temperature element shall withstand a continuous operating current of 6 milliamperes (mA) direct current (d.c.).

3.6.1.4 Lead wire resistance compensation. Resistance temperature element assembly shall be of 3-wire construction.

3.6.2 Thermocouple temperature element.

3.6.2.1 Insulation. 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 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.

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

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

3.6.2.6 Calibration table. A certified three point calibration table shall be furnished for each element when specified (see 6.2.1).

3.7 General design requirements.

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-24423. Identification marking shall conform to MIL-STD-130.

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

3.7.1.3 Terminal board. Terminal board shall be marked in a clear and permanent, legible manner so as to identify individual terminals and facilitate connection or replacement of ship's wiring to the terminal board.

3.7.2 Leads.

3.7.2.1 General. Wires emerging from the element assembly (sheath) shall be insulated with fray resistant sleeving and the specific American Wire Gage (AWG) shall be as specified in the applicable detail specification.

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.

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

3.7.3 Spring loading. Temperature elements for installation in thermowells shall be spring loaded as specified in the applicable detail specification.

3.7.4 Enclosure. Enclosures shall be as specified in the applicable detail specification.

3.7.5 Thermowell. When assemblies are intended for use with thermowells, the thermowells shall be in accordance with MIL-W-24270 and as specified in table I of the applicable detail specification.

3.7.6 Hermetic seal. A hermetic seal shall be provided at the exit of the wires from the assembly. 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 General assembly performance.

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

3.8.2 Thermal cycling. After the thermal cycling test, assembly shall show no evidence of physical damage and the performance shall conform to the requirements of 3.9.1.2, 3.9.1.3, or 3.9.2.1 (see 4.8.2).

3.8.3 Terminal strength. Connection of leads to the hermetic seal assembly and encapsulation into the protective shell shall be able to withstand a static load of 5 pounds per lead on all leads simultaneously for 15 minutes, without causing circuit failure (see 4.8.10) or loss of watertight integrity.

3.8.4 Overload (excess temperature). Temperature sensor assemblies shall comply with the temperature span and accuracy requirements specified in 3.9.1.2 and 3.9.1.3 after being subjected to the test of 4.8.11. During the test there shall be no shorts, opens, or evidence of intermittent circuits.

3.8.5 Vibration. Assemblies shall withstand the effects of the vibration test specified in 4.8.7. After the completion of the test, the assembly shall perform as specified in 3.9.1.2, 3.9.1.3, or 3.9.2.1.

3.8.6 Shock. Assemblies shall withstand the effects of shock test specified in 4.8.8. After the test, the assembly shall perform as specified in 3.9.1.2, 3.9.1.3, or 3.9.2.1.

3.8.7 Response time. Response time of the assembly shall be as specified in the applicable detail specification.

3.8.8 Insulation resistance. Insulation resistance between each wire and the sheath shall be not less than 10 megohms when tested in accordance with 4.8.9.

3.9 Sensor type assembly performance.

3.9.1 Resistance temperature element.

3.9.1.1 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).

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

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

3.9.1.3 Span and limits of error (see 4.9.1.1). Span and limits of error for nickel shall be as follows:

Temperature range	Limits of error
-40°F to 200°F	+2°F
200°F to 400°F	± 1 percent of temperature measured

3.9.2 Thermocouple temperature element.

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

3.10 Technical data. Contractor shall prepare technical data in accordance with the data ordering documents included in the contract or order (see 6.2.2), and as specified in 3.10.1 through 3.10.2.

3.10.1 Drawings. In addition to the drawing content required by the data ordering document (see 6.2.2), the features specified in 3.10.1.1 through 3.10.1.3 apply.

3.10.1.1 Copies of drawings. Unless otherwise specified (see 6.2.1), two copies of the drawings shall be submitted for initial approval to the Naval Ship Engineering Center (NAVSEC). For subsequent contracts, the number of copies shall be as specified (see 6.2.1).

3.10.1.2 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.

3.10.1.3 Drawings shall include the following minimum information, as applicable:

(a) Descriptive data for the equipment.
- (1) Type (see 1.2.1).
- (2) Designation number (see 1.2.3).
- (3) Installation (see 1.2.4).
- (4) Sheath diameter (see applicable detail specification).
- (5) Measuring junction (see 3.6.2.4).
- (6) A statement that the equipment is in accordance with the requirements of this specification and to referenced specifications.
- (7) A list of referenced drawings.
- (8) Test procedure data, including letter, report numbers, and dates.
- (9) Shock and vibration classification.
- (10) Enclosure, degree of.
- (11) Maximum rated connection head temperature.
- (12) Temperature range.
- (13) Weight of equipment (net).
- (14) Any special features i.e., spring-loaded, calibration table available.

(b) List of material, presenting following data in tabular form:
- (1) Piece number (for flags of assembly drawing).
- (2) Name of part.
- (3) Quantity of each part required per assembly.
- (4) Military or Federal specification number, or NAVSEA 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 assembly manufacturer.
- (7) Name of actual 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. The above information shall be presented on one sheet.

3.10.2 Technical manuals. In addition to the general requirements for technical manuals (see 6.2.2), the content and arrangement shall be as follows:

(a) Front matter.
(b) General information.
(c) Installation.
(d) Operation.
(e) Maintenance, repair, and troubleshooting.
(f) Parts identification.
(g) Drawings - Reduced size drawing inserts.

3.11 Workmanship. Workmanship shall be in accordance with requirement 9 of MIL-STD-454.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Inspection system. Contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. Inspection system shall be in accordance with MIL-I-45208 (see 6.2.1).

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).
(c) Periodic tests (see 4.5).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to NAVSEC. Qualification inspection shall consist of the examination and tests specified in the applicable detail specification.

4.3.1 Samples for qualification. The number of samples to be submitted for the qualification inspection 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. Tests shall be conducted in the order listed in the tables specified in the applicable detail specification.

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

TABLE III. Quality conformance inspection for types RTE and TCE.

Examination and test	Requirement paragraph	Inspection paragraph
General examination	3.5	4.6
Insulation resistance	3.8.8	4.8.9

4.5 Periodic tests (applicable to lots of 100 or more). 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 IV or V, 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 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 IV. Periodic tests for type RTE.

Tests	Requirement paragraph	Test paragraph
Calibration	3.9.1.2 and 3.9.1.3	4.9.1.1
Response time	3.8.7	4.8.1
Self heating	3.9.1.1	4.9.1.2
Thermal cycling	3.8.2	4.8.2
Spring loading	3.7.3	4.8.6

TABLE V. Periodic tests for type TCE.

Tests	Requirement paragraph	Test paragraph
Calibration	3.9.2.1	4.9.2.1
Response time	3.8.7	4.8.1
Thermal cycling	3.8.2	4.8.2
Spring loading	3.7.3	4.8.6

4.6 General examination.

4.6.1 Visual examination. 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 4.8.9. Performance shall conform to 3.8.8.

4.6.3 Radiographic examination. When required (see 6.2.1), each element 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) Sensor shall be placed in a flat position on the film cassett, 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 marked with the radiographic test identification number.

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 75°F ± 10°F.
(b) Relative humidity shall be 50 ± 10 percent.
(c) Calibration bath temperature plus or minus 10°F.

4.7.2 Reference measurement. A reference measurement shall be conducted at temperatures specified in tables IX or X, as applicable.

4.8 Tests.

4.8.1 Response time. 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 VI. Immersion shall conform to insertion length specified in the applicable detail specification. Response time is the time required for the output to rise from T_1 to T_2. Performance shall conform to 3.8.7.

TABLE VI. Response time test conditions.

Test conditions	Low temperature	High temperature
Temperature range °F	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
Stop timing (temperature °F) T_2	143.2	808
Standard cylinder response time (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 VII. Cycle rate shall not exceed two cycles per minute. Connection heat temperature shall not exceed the maximum connection head temperature specified in table I of the applicable detail specification. Prior to and following the test a reference measurement (see 4.7.2) shall be made. Performance shall conform to 3.8.2.

TABLE VII. Thermal cycling conditions.

Temperature range °F	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. Connection head and extension shall be immersed to the test conditions specified for the watertight test of MIL-STD-108 using fresh water. Assemblies designed for useage with thermowells shall be tested in a thermowell. There shall be no leakage of water into the watertight enclosure when subjected to this test. Performance shall conform to 3.8.1.

4.8.4 Hermetic seal. The element alone shall be immersed in a water bath, and the bath subjected to an absolute pressure of 4.0 ± 0.5 pounds per square inch (lb/in^2) for 15 minutes. Seal shall be observed for air leaks. Seal shall conform to 3.7.2.1.

4.8.5 Salt spray. Assembly shall be subjected to a salt spray test in accordance with method 101C of MIL-STD-202. Length of the test shall be in accordance with test condition A. Assemblies designed for useage in thermowells shall be tested in a thermowell. Salt solution shall be a 20 percent concentration. Performance shall conform to 3.8.1.

4.8.6 Spring loading. Assembly shall be mounted in a 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. Assembly shall be mounted so as to simulate actual installation and shall be tested in accordance with type I (environmental vibration) of MIL-STD-167-1 except that the upper limit of the frequency shall be 100 hertz (Hz). Amplitude of vibration shall be in accordance with table VIII. If no resonances are observed, the two hour endurance test shall be conducted at 100 Hz. Assembly output shall be monitored during the test. Performance of the assembly during the test shall conform to 3.9.1.2, 3.9.1.3, or 3.9.2.1. At the conclusion of the test a reference measurement shall be made (see 4.7.2).

TABLE VIII. Vibration test conditions.

Frequency range	Table amplitude
(Hz)	(Inches)
5-20	0.030 ± 0.006
21-50	0.020 ∓ 0.004
51-100	0.010 ∓ 0.002

4.8.8 Shock. Shock test shall be conducted in accordance with grade A, class I, type C for lightweight equipment in accordance with MIL-S-901. Assembly shall be mounted so as to simulate actual installation. 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 3.8.6.

4.8.9 Insulation resistance. Insulation resistance shall be determined by applying 50 volts d.c. between the wires and the sheath. Performance shall conform to 3.8.8.

4.8.10 Terminal strength. With the sensor assembly case firmly held in a holding fixture, a static, tensile load of 5 pounds shall be applied to each lead for 15 minutes. Direction of the load shall be along the longitudinal axis of the sensor assembly (axial load).

4.8.11 Overload (excess temperature). Temperature sensors, while at room ambient temperature, shall be quickly immersed to a depth of 3/16 inch, for a period of 5 minutes, in a bath of Babbitt, grade 2 or 3 in accordance with QQ-T-390. Bath temperature for grade 2 shall be between 680°F and 700°F and grade 3 shall be between 800°F and 900°F. After immersion, sensors shall be removed from the bath, and allowed to cool to room temperature. Cycle shall be repeated four times. Output of the sensor assembly shall be monitored, during the cycling, for evidence of opens, shorts, or intermittencies.

4.9 Type test conditions and test procedures.

4.9.1 Resistance temperature elements.

4.9.1.1 Calibration. Assembly shall be calibrated in accordance with MIL-STD-735 at the temperature shown in table IX plus or minus 10°F. Performance shall conform to 3.9.1.2 and 3.9.1.3.

TABLE IX. RTE calibration temperature.

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

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

4.9.1.2 Self heating. Self heating test shall be conducted in a water bath under the conditions specified in 4.8.1. 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 3.9.1.1.

4.9.2 Thermocouple temperature elements.

4.9.2.1 Calibration. Assembly shall be calibrated in accordance with MIL-STD-735 at the temperature shown in table X plus or minus 10°F. Performance shall conform to 3.9.2.1.

TABLE X. TCE calibration temperature.

Range °F	Calibration values °F
-40 to 200	-20, 1/32, 1/80, 120, 1/180
-40 to 400	-20, 1/32, 80, 1/180, 280, 1/380
-40 to 1000	-20, 1/32, 1/200, 400, 1/600, 800, 1/980
-40 to 1500	-20, 1/32, 1/200, 400, 1/600, 900, 1/1200

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

4.10 Test procedures and test reports. Contractor shall prepare test procedures and quality conformance and periodic test reports in accordance with the data ordering documents included in the contract or order (see 6.2.2), and as specified in 4.10.1 and 4.10.2.

4.10.1 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 3.9.1.2, 3.9.1.3, and 3.9.2.1.

4.10.2 Periodic test reports. A complete report on the 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.

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

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.6.)

5.1 Preservation-packaging, packing, and marking. Thermocouple and resistance temperature elements shall be individually preserved-packaged level A or C, packed level A, B, or C, as specified (see 6.2.1) and marked in accordance with MIL-E-17555 and the following:

(a) For level A preservation-packaging, method III shall apply in lieu of the method specified in MIL-E-17555.
(b) Rough handling tests of MIL-E-17555 are not required.
(c) Unless otherwise specified (see 6.2.1), drawings and technical data including packaging requirements codes are not required.

5.2 Cushioning, dunnage, and wrapping materials.

5.2.1 Level A preservation-packaging and levels A and B packing. Use of all types of loose-fill materials for packaging and packing applications such as cushioning, filler, or dunnage is prohibited for materials destined for shipboard installation/stowage.

5.2.2 Level C preservation-packaging and packing. When loose-fill type materials are used for packaging and packing applications such as cushioning, filler, and dunnage, all containers (unit, intermediate, and shipping) shall be marked or labelled with the following information:

"CAUTION

Contents cushioned with loose-fill material shall not be taken onboard ship. Remove and discard loose-fill material before shipboard stowage. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material."

Cushioning, filler, dunnage and wrapping materials selected, whenever available, shall exhibit improved performance for resistance to fire.

6. NOTES

6.1 Intended use. Assemblies are intended to sense a temperature and convert this to an output for input to a temperature signal conditioner, in accordance with MIL-T-24387 and temperature monitoring equipment in accordance with MIL-T-15377. Dependent upon the individual design noted in the applicable detail specification, the assemblies may be mounted in thermowells in accordance with MIL-W-24270.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification and applicable detail specification.
(b) Classification (see 1.2).
(c) Calibration table (see 3.6.2.6).
(d) Number of drawings required (see 3.10.1.1).
(e) Quantity of assemblies required.
(f) Quality assurance requirements (see 4.1.1).
(g) Radiographic examination results (see 4.6.3).
(h) Levels of preservation-packaging and packing required (see 5.1).
(i) When drawings and technical data are required (see 5.1(c)).

6.2.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirements	Applicable DID	Option
3.10.1	Drawings, engineering and associated lists	DI-E-7031	Level 3 Design activity designation - contractor Drawing numbers - contractor Delivery of hard copies - contracting activity
3.10.2	Technical manual manuscript copy	DI-M-2042	Type I of MIL-M-15071
	Manual, technical, preliminary	DI-M-2043	Type I of MIL-M-15071
	Manual, technical, standard	DI-M-2044	Type I of MIL-M-15071
4.10	Test procedures	UDI-T-23649	------
4.10.1	Test/inspection report	UDI-T-23473	------
4.10.2	Test reports	DI-T-2072	------

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 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 the applicable Qualified Products List QPL-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 Ship Engineering Center, Department of the Navy, Washington, DC 20362 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 6.3.1).

6.3.1 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.

6.4 Definitions. Terminology consistent with ANSI C96.1 and MIL-STD-280 applies in addition to the following definitions:

(a) Length. The distance from the sheath end to the top of the head extension when installed (see applicable detail specification).
(b) Sheath. The protective tube enclosing the sensing element.
(c) Sheath diameter. The outside diameter of the sheath.

6.5 Cross-reference of classifications. Some temperature assemblies covered by this specification were previously described in MIL-T-15377E(SHIPS). Temperature sensor assemblies purchased under MIL-T-24388B(SH) may be used to replace existing equipment purchased under MIL-T-15377E(SHIPS) as follows:

Old classification under MIL-T-15377E(SHIPS)	New classification under MIL-T-24388B(SH)
IC/RTD	RTE
IC/TCD	TCE
1	EM
2	BB
3	TW
N	N
P	P
T	Deleted
K	K
J	Deleted

6.6 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 acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Changes from previous issue. The symbol "#" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

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