REVISIONS

SYMBOL	DESCRIPTION	DATE	APPROVAL
E	RN A083 Re-format, Change Dimension Tolerance	2/23/96	

SHEET REVISION STATUS

SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REV	E	E	E	E	E	E	E	E	E	E	E	E								
SH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
REV																				

	DATE	FSC: 4540
ORIGINATOR: T. King/Unisys		
APPROVED: S.E. Archer-Davies/Unisys		**Procurement Specification for Thermofoil Heater**
CODE 311 APPROVAL: P. J. Jones/GSFC		
CODE 311 SUPERVISORY APPROVAL: G. P. Kramer, Jr./GSFC		
ADDITIONAL APPROVAL:		**S-311-P-079**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

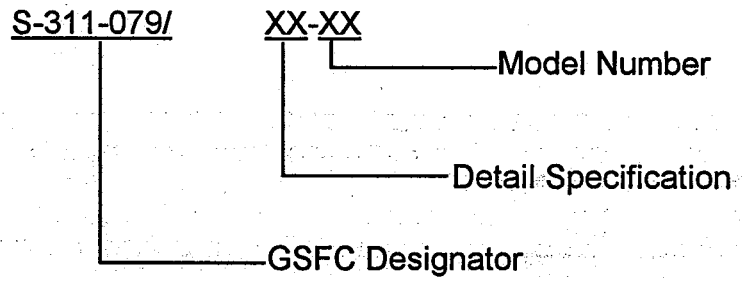
CAGE CODE: 25306

1. SCOPE

1.1 Purpose This specification establishes the requirements for flexible strip resistive heaters used in space flight application.

1.2 Detail specification sheets. Detail sheets, which are referenced in this document, and the specific purchase order, are a part of this specification.

1.3 Goddard part number. Parts procured in complete compliance with the requirements of this specification shall be identified by a Goddard part number of the following form.



2. APPLICABLE DOCUMENTS

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

MILITARY

SPECIFICATIONS

MIL-W-22759	Wire, Electric, Fluoropolymer-Insulated Copper or Copper Alloy
MIL-I-45208	Inspection System Requirements
MIL-P-46112	Plastic Sheet and Strip, Polyimide

STANDARDS

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-STD-129	Marking for Shipment and Storage

OTHER PUBLICATIONS

ASTM E595	Total Mass and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

2.2 Order of precedence. In the event of any conflict between the text of this specification and the references cited herein , the text of this specification shall take precedence. In the event of any conflict between requirements of this specification and the detail specification, the later shall have precedence. However, nothing in this text shall supersede applicable laws and regulations unless a specific exemption has been obtained.

2.3 Copies of documents. Copies of federal and military documents can be obtained from the Standardization Document Order Desk, 700 Robbins Avenue, Building #4-Section D, Philadelphia, PA. 19111-5094. Copies of ASTM publications are available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

3. REQUIREMENTS

3.1 Qualification. Heaters furnished to this specification shall be products which have been granted qualification approval by NASA/GSFC. Qualification approval shall be based on the following criteria:

3.1.1 Design and source approval. Prior to qualification, the manufacture's facility shall be subjected to survey at the option of GSFC, by the office of Flight Assurance, GSFC. Compliance with MIL-I-45208 is required. In addition, the history and detailed engineering of the specific heater design will be reviewed, as will the documented manufacturing and quality control procedures. Only those sources approved in the design and source approval phase shall be eligible for qualification or award of contract under this specification. Source approval and design approval do not constitute part qualification or an equivalent thereof.

3.1.2 Part qualification. Heater product(s) granted qualification shall be that which has passed the qualification inspection requirement of this specification.

3.2 Materials. Materials shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the heaters to meet the performance requirement of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of finished product.

3.2.1.1 Heater element. The heater element shall be of copper-nickel-chromium-iron alloy foil. The foil shall be uniform in cross-section, unwrinkled, free of cracks, raised spots and.overcuts that will adversely affect performance of the heater. Spacing between elements shall not be less than 0.0127 cm (.005 in.).

3.2.1.2 Non-magnetic heater element. The heater element shall be copper-nickel (70% Cu - 30% Ni) or nickel-chromium (80% Ni - 20% Cr) when a non-magnetic requirement appears in the detail specification.

3.2.1.3 Leads. The leads shall be extruded TFE-fluoropolymer silver-coated copper wire (26 gauge minimum) and shall be approved to MIL-W-22759. The termination of heating element to lead wire shall be of welded construction and the transition shall be free of points, sharp edges or projections that

could cause failure of the protective covering. Lead wires shall be secured to the heater in such a way that lead pull stresses are not transmitted to the weld joint.

3.2.1.4 Protective coating for enclosure. Heater assemblies shall be protected by a coating or enclosure of Polyimide Polymer/FEP in accordance with MIL-P-46112, type II, grade A which shall completely cover the exterior of the heater element, including connections or terminations. The coating shall not crack, craze, drip, run, from globules or delaminate at any temperature up to and including 200°C.

3.2.2 Thermal vacuum outgassing. Materials must meet outgassing requirements of 1.0% total mass loss (TML) maximum and 0.1% collected volatile condensable materials (CVMC) maximum when tested in accordance with 4.7.10.

3.3 Design and construction. Heaters shall be of the design, construction and physical dimensions as specified herein and by GSFC detail specifications. The length and width of each heater shall not vary by more than ±1% of the values specified in Table I of the applicable detail specification.

3.3.1 Exterior dimensional tolerance. The length and width of each heater shall not vary by more than ±2% of the values specified in Table I of the applicable detail specification.

3.3.2 Interior dimensions.

3.3.2.1 Heater element. Heater elements shall not contain any localized reduction in width of more than 30% of the minimum width dimension.

3.13 Marking. Heaters shall be marked with the part number, source code, date code, characteristics and ratings. Date and cage codes shall be in accordance with MIL-STD-1285. Only heaters that have met the qualification inspection and qualification conformance inspection requirements shall be marked with a part number as specified herein. Markings shall be with an opaque permanent low outgassing ink and shall remain legible at the end of all tests.

3.14 Workmanship. Heaters shall be processed in such a manner to be uniform in quality when inspected in accordance with 4.7.1. Heaters shall also be free of any defects affecting life, serviceability or performance.

3.4 DC resistance (DCR). When heater elements are tested as specified in 4.7.5, the nominal resistance shall be within the tolerance of value specified.

3.5 Power rating. Heaters shall have a power rating of 0.54 w/cm^2 (3.5w/in^2) for effective element area, based on continuous full-load operation with the heater suspended in still air at 25°C. This power rating is dependent on the ability of heaters to operate with full-load for 1000 hours and not change in DCR>±1%. (See paragraph 6.1).

3.6 Dielectric Withstanding Voltage (DWV). When heaters are tested per paragraph 4.7.3, the leakage current between the element and outer surface shall not exceed one mA.

3.7 Insulation Resistance (IR). When heaters are tested as specified in 4.7.4, the insulation resistance shall not be less than 1000 megohms.

3.8 Conditioning. When heaters are tested as specified in 4.7.2, there shall be no mechanical damage including blistering, delamination, or bubbles. The change in DCR shall not exceed ±1%, the insulation resistance shall not decrease and DWV leakage current shall not exceed on mA.

3.9 Lead pull strength. When heaters are tested as specified in 4.7.6, there shall be no break in the wire lead terminals and the heater element shall remain securely connected mechanically and electrically to the terminals. The change in DCR shall not exceed ±1%.

3.10 Thermal shock. When heaters are tested as specified in 4.7.7 there shall be no evidence of mechanical damage. The change in DCR shall not exceed ±1%.

3.11 Low temperature operation. When heater elements are tested as specified in 4.7.8, there shall be no evidence of mechanical damage. The change in DCR between the initial and final measurement at 25°C shall not exceed ±1%.

3.12 Life. When heaters are tested as specified in 4.7.9, the change in DCR between the initial and final measurement at 25°C shall not exceed ±1%.

3.13 Marking. Heaters shall be marked with the part number, source code, date code, characteristics and ratings. Date and source codes shall be in accordance with MIL-STD-1285. Only heaters that have met the qualification inspection and qualification conformance inspection requirements shall be marked with a part number as specified herein. Markings shall be with an opaque permanent low outgassing ink and shall remain legible at the end of all tests.

3.14 Workmanship. Heaters shall be processed in such a manner to be uniform in quality when inspected in accordance with 4.6.1. Resistors shall also be free of any defects affecting life, serviceability or performance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The manufacturer is responsible for the performance of all inspection requirements, as specified herein, using his own or any other suitable facility acceptable to Goddard Space Flight Center. Upon receipt of product, Goddard reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to verify conformance to prescribed requirements.

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

a. Qualification Inspection (see 4.4)
b. Quality Conformance Inspection (see 4.6)

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.4 Qualification inspection see (4.2). Qualification inspection shall be performed by the manufacturer on sample units produced with equipment, processes and procedures normally used in production. At the option of the qualifying activity, data from an established reliability program subjecting same or similar parts to equivalent or more stringent testing may be submitted for part or all of the qualification requirements.

4.4.1 Sample. The number of heaters to be subjected to qualification inspection shall be 22.

4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in Table I.

4.4.3 Failures. Failures in excess of those allowed in Table I shall be cause for refusal to grant qualification.

4.4.4 Inspection report. Qualification test data and the qualification test samples shall be submitted to the following activity:

NASA/GSFC
Greenbelt, MD 20771
Attn: QPLD Administrator
Code 311

4.5 Requalification. Requalification shall be imposed following any change in design, manufacture, materials or quality-control procedures as reviewed and approved during qualification. Requalification shall be required if it is demonstrated that any stipulations initially presented in the manufacturer's certification no longer apply.

4.6 Quality Conformance Inspection (QCI-see 4.2). Quality Conformance Inspection (QCI) shall be performed on all products furnished to this specification.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of the QCI per Table II in the order shown.

4.6.2 Inspection lot. An inspection lot shall consist of all heater products of the same style and value, manufactured at essentially the same time under the same manufacturing process conditions and identified by a common date code (see 3.13).

4.6.3 Sample. The QCI shall be performed on 100% of the products furnished to this specification.

4.6.4 Failures. Heaters that do not pass the QCI shall be removed from the inspection lot and shall not be furnished to this specification.

4.6.5 Lot rejection. Only lots containing not more than 20% rejects shall be furnished to this specification.

4.6.6 Inspection record. The manufacturer shall be required to maintain a record of all QCI inspection results (see 4.6.7). The manufacturer is required to report any discrepancies disclosed during periodic examination of its product and production process controls.

Table I. Qualification inspection.

Examination or Test	Requirement Paragraph	Method Paragraph	Number of Samples to be Inspected	Number of Failures Allowed
Group I				
Conditioning	3.8	4.7.2		1
DC Resistance	3.4	4.7.5	22	1
Visual and Mechanical	3.1, 3.2, 3.2.1.1, 3.2.1.2, 3.2.1.3, 3.2.1.4, 3.3, 3.13	4.7.1		
Group II				
Thermal Shock	3.10	4.7.7		
Low temperature Operation	3.11	4.7.8	10*	
DWV	3.6	4.7.3		1
IR	3.7	4.7.4		
DCR	3.4	4.7.5		
Lead Pull Strength	3.9	4.7.6		
Group III				
Life	3.12	4.7.9	10*	1
Group IV				
Thermal Vacuum Outgassing	3.2.2	4.7.10	2*	0

*Group II, III, and IV samples shall come from Group I.

Table II. Quality conformance inspection.

Examination or test	Requirement Paragraph	Method Paragraph	Sampling Procedure
			100% Inspection
Conditioning	3.8	4.7.2	
Thermal Shock	3.10	4.7.7	
DWV	3.6	4.7.3	
IR	3.7	4.7.4	
DCR	3.4	4.7.5	
Visual and Mechanical Examination	3.2.1.1, 3.2.1.2, 3.2.1.3, 3.2.1.4 3.3, 3.13	4.7.1	

4.6.7 Retention of qualification. As a basis for retention of qualification, the manufacturer shall be requested to furnish a summary of QCI inspection results annually. The test summary shall be submitted to the activity specified in 4.4.4.

4.7 METHODS OF EXAMINATION AND TEST

4.7.1 Visual and mechanical examination. Heaters shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.2, 3.3, 3.13, 3.14).

4.7.2 Conditioning. Heaters shall be conditioned by suspension in still air at 25°C ±5° by their terminal leads. The voltage specified in the detail specification shall be applied continuously for 168 + 48 - 0 hours; after which the heaters shall meet the requirements of paragraph 3.8.

4.7.3 Dielectric Withstanding Voltage (DWV). Heaters shall be tested per MIL-STD-202 Method 301 at 500 VRMS for one minute. The potential shall be applied between the element and conductive plates which are in intimate contact with the complete outer surface of the heater. The maximum leakage current shall be less than specified in paragraph 3.6.

4.7.4 Insulation Resistance (IR). The insulation resistance shall be measured between the element and the entire outside surface at 25°C per MIL-STD-202, Method 302, Test Condition B, and meet the requirements of paragraph 3.7.

4.7.5 DC resistance (DCR). The DCR shall be measured between the heater leads at 25°C per MIL-STD-202, Method 303 and meet the requirements of the appropriate detail specification.

4.7.6 Lead pull strength. The leads shall be tested per MIL-STD-202, Method 211, Test Condition A at 1.36Kg (3 lbs.) and meet the requirements of paragraph 3.8.

4.7.7 Thermal shock. The unmounted heaters shall be tested per MIL-STD-202, Method 107, Test Condition D with the exception of a high temperature limit of 200°C. The heaters shall meet the requirements of paragraph 3.10.

4.7.8 Low temperature operation. The unmounted heaters shall be placed in a chamber at -65°C and after one hour stabilization at this temperature, full rated continuous power shall be applied for forty-five minutes. Fifteen minutes after removal of power, the heaters shall be brought to 25°C + 5° in a period not exceeding eight hours and DC resistance measured after approximately twenty-four hours at 25°C. The heaters shall meet the requirements of paragraph 3.11.

4.7.9 Life. Heaters shall have rated power applied while suspended in still air at 25°C. DC current shall be applied for 1000 hours continuously.

4.7.10 Thermal vacuum outgassing. Heaters shall meet the requirements of paragraph 3.2.2 of this specification when tested in accordance with ASTM—E595.

5 PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Heaters shall be individually packaged and shall be afforded preservation and packaging in accordance with the suppliers normal commercial practice.

5.2 Packaging. Heaters packaged as specified, shall be packed in containers of the type, size, and kind commonly used for the purpose, and in a manner that will insure acceptance by a common carrier and a safe delivery at destination. Shipping containers shall comply with the uniform freight classification rules or regulations of other carriers as applicable to the mode of transportation.

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

6. NOTES

6.1 Power levels. Power levels in the general specification are primarily for test purposes only with the heater suspended in still air. Application power levels are governed by the type of adhesive used to bond the heater to the heat sink. It is important that an adhesive is used that will maintain the bond throughout the design life of the equipment. Rating curves for three attaching systems and one for heaters suspended in still air are given in Figure 1. Use of these curves implies that heater fastened with an adhesive will be free of voids, delaminations, and bubbles at the bonding interface. Operating temperature limits are given by the curves (extrapolation of these curves is not permissible).

When other adhesive systems are to be used the Parts Branch may be contacted for aid in developing the necessary curves.

6.2 Ordering data. Acquisition documents should specify the following:
a. Number, title, and date of the specification and applicable detail specification
b. Goddard Part Number
c. Quantity

6.3 Qualification provisions. With respect to product requiring qualification, awards will be made only for products which have been tested and approved by GSFC before the time for opening of bids. The attention of the suppliers is called to the following requirement: manufacturers should arrange to have qualification tests made on product which they propose to offer to GSFC to become eligible for awards of contracts or orders for product covered by this specification. The manufacturer shall bare the cost of qualification inspection to this specification. Information pertaining to qualification of product may be obtained from the activity whose address is listed in 4.4.4.

6.4 NOTICE. When GSFC drawings, specifications, or other data are sent for any purpose other than in connection with a definitely related GSFC procurement operation, the United States Government thereby incurs no responsibility whatsoever. The fact that GSFC might have formulated, furnished or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying the right or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:

Code 311.2
Goddard Space Flight Center
Greenbelt, MD 20771

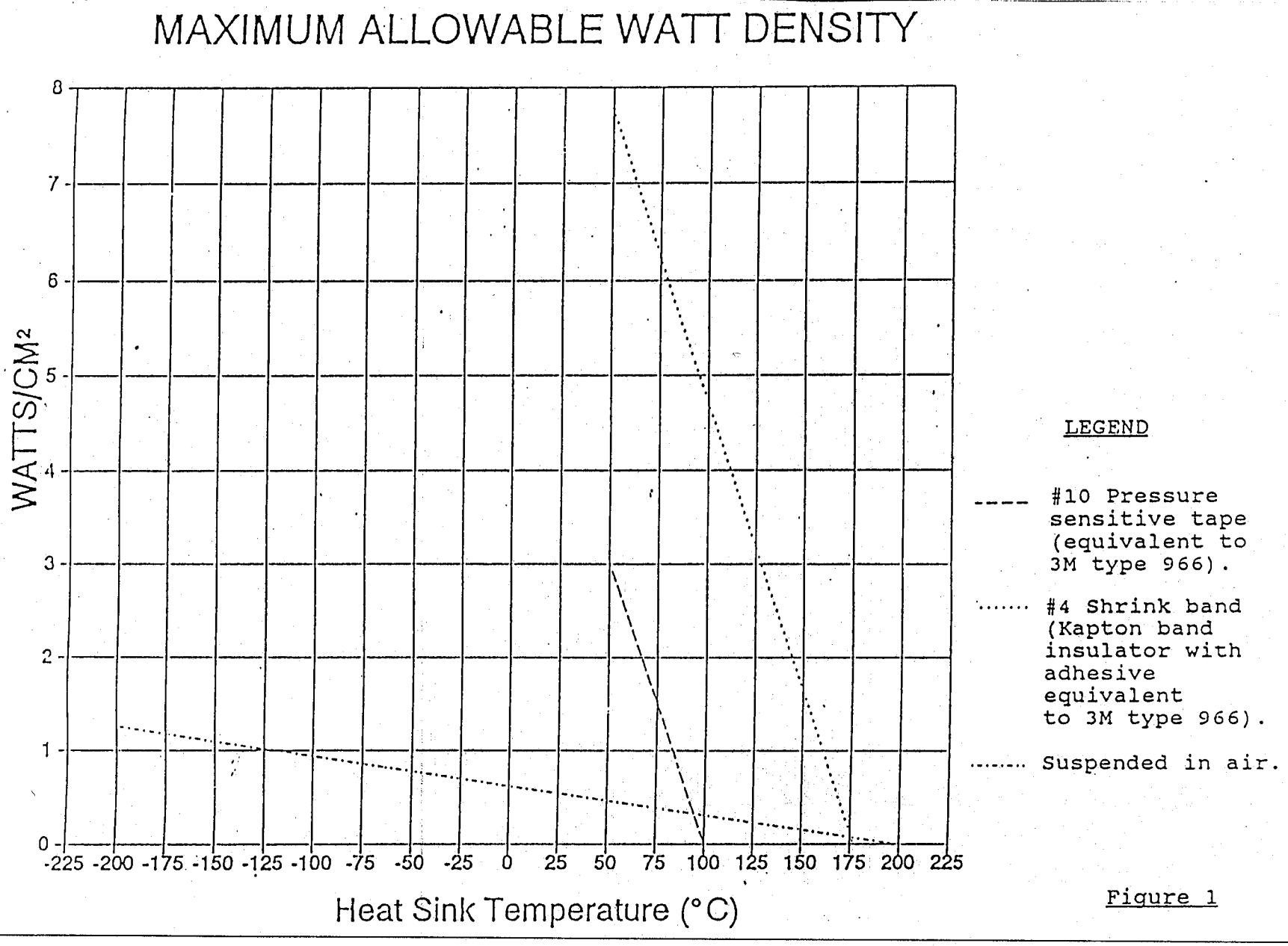

MAXIMUM ALLOWABLE WATT DENSITY
WATTS/CM²
0
1
2
3
4
5
6
7
8
-225 -200 -175 -150 -125 -100 -75 -50 -25 0 25 50 75 100 125 150 175 200 225
Heat Sink Temperature (°C)
LEGEND
#10 Pressure sensitive tape (equivalent to 3M type 966).
#4 Shrink band (Kapton band insulator with adhesive equivalent to 3M type 966).
Suspended in air.

Figure 1