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SEALING OF ELECTRICAL COMPONENTS, SPECIFICATION FOR

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Approved:

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SEALING OF ELECTRICAL COMPONENTS, SPECIFICATION FOR

1. SCOPE

1.1 Introduction. - This specification defines four grades of seals for noncryogenic use in the design of electrical components and their assemblies, containers, and equipment used in ground support equipment at the John F. Kennedy Space Center (KSC). The requirements specified herein shall not be applicable to the National Electrical Manufacturers Association (NEMA) electrical enclosures.

1.2 Classification. - Seals shall be classified in accordance with the following grades:

1.2.1 Grade A. - A grade A seal is metal-to-metal (welded, brazed, or soldered joints) or metal-to-glass or -ceramic (brazed or solder joints). A grade A seal is accomplished by the bonding of metallic and ceramic materials or a combination of the two. This includes the bonding of metals by welding, brazing, or soldering; the fusion of ceramic materials under heat or pressure; and the fusion of ceramic materials into a metallic support.

1.2.2 Grade B. - A grade B seal is accomplished by fusion, vulcanizing, or adhesion to the metallic case using a chemical or mechanical process (or combination of the two) with any material such as thermosetting plastics or elastomers (Teflon, Kel-F, and silicones). A grade B seal can also be accomplished by encapsulating, molding, or potting a component or assembly with a plastic or elastomer.

1.2.3 Grade C. - A grade C seal is a gasket-type seal. The seal is accomplished using gaskets, O-rings, or other similar items held in proper relation to the abutting surface by pressure exerted from screws, bolts, or other clamping devices.

CAUTION

Where grade B or C seals are specified, consult the responsible design organization for information about environmental conditions, such as sun rays, radioactivity, and hazardous liquids or vapors, that could cause deterioration of the seals.

1.2.4 Grade D. - A grade D seal is a ground, lapped, or polished abutting surface seal. The seal is accomplished by having the abutting surface ground, lapped, or polished to produce a precision fit. The mating surfaces are held in intimate contact by bolts, screws, or other suitable clamping devices.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. When this specification is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents shall be specified in an attachment to the Solicitation/Statement of Work/Contract.

2.1 Governmental.

John F. Kennedy Space Center (KSC), NASA

KSC-STD-164	Environmental Test Methods for Ground Support Equipment, Standard for

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

2.2 Non-Governmental.

American Society for Testing and Materials (ASTM)

ASTM E493	Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector in the Inside-Out Testing Mode
ASTM E498	Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode, Methods of Testing for
ASTM E499	Leaks Using the Mass Spectrometer Leak Detector in the Detector Probe Mode, Method of Testing for

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

3. REQUIREMENTS

3.1 Leakage Rates. - Drawings and specifications that include seals shall specify: (1) the grade of seal required and (2) the total leakage rate permissible. When the total permissible leakage rate is not specified, the rate shall be determined on the basis of seal length as specified by the grade definition. Seals shall comply with the leakage limits both before and after the environmental tests required by the respective grade of seals specified herein.

3.1.1 Grade A Seal. - At a pressure differential of 1 atmosphere, a grade A seal shall have a leakage rate not to exceed 0.39 standard cubic centimeter ($stdcm^3$) of air per year per centimeter of seal, 0.75×10^{-6} $stdcm^3$ of air per minute per centimeter of seal, and/or 1.25×10^{-8} $stdcm^3$ of air per second per centimeter of seal.

3.1.2 Grade B Seal. - At a pressure differential of 1 atmosphere, a grade B seal shall have a leakage rate not to exceed 39 $stdcm^3$ of air per year per centimeter of seal, 0.75×10^{-4} $stdcm^3$ of air per minute per centimeter of seal, and/or 1.25×10^{-6} $stdcm^3$ of air per second per centimeter of seal.

3.1.3 Grade C Seal. - At a pressure differential of 1 atmosphere, a grade C seal shall have a leakage rate not to exceed 3,937 $stdcm^3$ of air per year per centimeter of seal, 0.75×10^{-2} $stdcm^3$ of air per minute per centimeter of seal, and/or 1.25×10^{-4} $stdcm^3$ of air per second per centimeter of seal.

3.1.4 Grade D Seal. - At a pressure differential of 1 atmosphere, a grade D seal shall have a leakage rate not to exceed 39,370 $stdcm^3$ of air per year per centimeter of seal, 0.75×10^{-1} $stdcm^3$ of air per minute per centimeter of seal, and/or 1.25×10^{-3} $stdcm^3$ of air per second per centimeter of seal.

3.2 Environmental Test Requirements. - Unless otherwise specified, the environmental tests and sequence for the grade of seals specified herein shall be in accordance with table 1. Leakage measurements shall be made before and after each environmental test in accordance with 4.1. Additional leakage measurements shall be made when included as a part of the respective test instruction.

Table 1. Required Test Sequence

Environmental Test Sequence	Seal Grade			
	A	B	C	D
1. High temperature	X	X	X	X
2. Temperature shock	X	X	X	--
3. Vibration	X	X	X	X
4. Shock	X	X	X	X
5. Salt fog	X	X	X	X
6. Explosion	X	--	--	--
7. Solar radiation	X	X	X	X

3.2.1 High Temperature Test. - The seals shall be subjected to the high temperature test for the respective class, as specified in 4.2.1, to determine the capability of the seals to withstand exposure to the extremes of high temperatures for extended periods of time. The seal temperature classes shall be defined as follows:

a. Class I applies to those seals that are confined in an enclosure exposed to direct solar radiation.

b. Class II applies to seals that are exposed to direct solar radiation and are not confined in an enclosure.

3.2.2 Temperature Shock Test. - All seals fabricated with glass, ceramic, or other electrical insulating materials shall be subjected to the temperature shock test as specified in 4.2.2, to determine the capability of the seals to withstand cracking and flaking caused by rapid changes in temperature. The temperature shock test shall be performed following the high temperature test.

3.2.3 Vibration Test. - Seals shall be subjected to the vibration test, as specified in 4.2.3, for the purpose of: (1) determining the effects of vibration on the seals and (2) detecting any mechanical damage from vibration that would allow leakage through cracked seams or cracked ceramic or terminal seals.

3.2.4 Shock Test. - Seals shall be subjected to the shock test, as specified in 4.2.4, for the purpose of: (1) determining the effects of shock on the seals and (2) detecting any mechanical damage that would allow leakage through cracked seams or cracked ceramic or terminal seals.

3.2.5 Salt Fog Test. - Seals shall be subjected to the salt fog test, as specified in 4.2.5, for the purpose of determining the capability of the seals to withstand exposure to such conditions.

3.2.6 Explosion Test. - Grade A seals shall be subjected to the explosion test, as specified in 4.2.6, for the purpose of determining the capability of the seals to provide ignitionproof protection when exposed to explosive environments. Grade B, C, and D seals shall be subjected to an explosion test only when directed by the responsible design organization.

3.2.7 Solar Radiation. - Seals that are exposed to direct solar radiation shall be subjected to the solar radiation test, as specified in 4.2.7, for the purpose of determining the capability of the seal to withstand sunlight and perform its sealing function.

4. QUALITY ASSURANCE PROVISIONS

Leakage tests and detection methods shall be submitted to the responsible design organization for approval in accordance with the provisions of the contract. Except as otherwise specified, environmental tests shall be conducted in accordance with KSC-STD-164. Inspection and test records shall be kept complete and, upon request, made available to the procuring organization.

4.1 Leakage Measurement. - Leakage measurements for all grades of seals shall be accomplished by helium mass spectrometer leak detector methods specified in one of the following: ASTM E493, ASTM E-498, or ASTM E499. Breaking of seals to facilitate leakage measurement method shall be avoided. At a temperature of 25 degrees Celsius (°C), the leakage measurement for all seals shall be made with 1 atmosphere of pressure on one side of the seal and a vacuum in the order of 1 micron of mercury on the other side (or any combination netting a pressure differential equal to 1 atmosphere from one side of the seal to the other). Table 2 lists the allowable leakage rates of various gases relative to air. The pressure differential shall be applied in the direction that would be seen in actual usage. The failure mode of the seal shall also be considered in applying the pressure differential.

Table 2. Leakage Rates

Gas	Leakage Rate Relative to Air (Percent)
Helium	0.91
Hydrogen	2.0
Oxygen	0.863
Water vapor	1.82
Nitrogen	1.04

4.2 Environmental Tests.

4.2.1 High Temperature Test.

4.2.1.1 Procedure. - The test specimen shall be placed within the test chamber and subjected to the applicable temperature cycles shown in KSC-STD-164 for a total of five cycles. The test requirements, specifications, procedures, and documentation shall be in accordance with section 6 of KSC-STD-164.

4.2.1.2 Measurements. - Following the temperature test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seals.

4.2.2 Temperature Shock Test.

4.2.2.1 Procedure. - The test specimen shall be placed within a test chamber at the temperatures specified in KSC-STD-164 for a total of five cycles. The test requirements, specifications, procedures, and documentation shall be in accordance with section 7 of KSC-STD-164.

4.2.2.2 Measurements. - Following the temperature shock test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seals.

4.2.3 Vibration Test.

4.2.3.1 Procedure. - Vibration test requirements, specifications, procedures, verification of test input, and documentation shall be in accordance with section 9 of KSC-STD-164.

4.2.3.2 Measurements. - Following the vibration test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seals.

4.2.4 Shock Test.

4.2.4.1 Procedure. - Shock test requirements, specifications, procedures, verification of test input, and documentation shall be in accordance with section 10 of KSC-STD-164.

4.2.4.2 Measurements. - Following the shock test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seals.

4.2.5 Salt Fog Test.

4.2.5.1 Procedure. - The salt fog test shall be performed in accordance with KSC-STD-164. A sealing material, which also serves as an electrical insulator, shall be tested for insulation resistance and breakdown after the salt fog test in accordance with applicable electrical specifications of the particular assembly. Following the salt fog test, electrical conductors, contacts, etc., that pass through the seals shall be tested for corrosion and conductivity in accordance with applicable electrical specifications.

4.2.5.2 Measurements. - Following the salt fog test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seals.

4.2.6 Explosion Test. - The explosion test shall be performed in accordance with KSC-STD-164, using the explosionproof test procedure. The test temperature used shall be the maximum temperature identified in table 3 of this specification. Failure to meet this explosionproof test shall be cause for rejection.

4.2.7 Solar Radiation.

4.2.7.1 Procedure. - The solar radiation test requirements, specifications, procedures, and documentation shall be in accordance with KSC-STD-164.

4.2.7.2 Measurements. - Following the solar radiation test, leakage measurements shall be made as specified in 4.1. The leakage rate shall not exceed the limits specified in 3.1 for each grade of seal.

5. PREPARATION FOR DELIVERY

Delivery shall be in accordance with the manufacturer's standard methods.

6. NOTES

6.1 Intended Use. - This specification is intended to establish uniform procedures and methods for testing seals for electrical components and enclosures. Drawings or detailed specifications shall specify: (1) the grade of seal required, (2) the total leakage rate permissible, and (3) the temperature class.

NOTICE. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may 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 other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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