**METRIC**

# KSC-S-126B
# OCTOBER 29, 2008

Supersedes
KSC-S-126A
December 7, 1990

# SEALING OF ELECTRICAL COMPONENTS, SPECIFICATION FOR

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# ENGINEERING DIRECTORATE

National Aeronautics and
Space Administration

**John F. Kennedy Space Center**

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# SEALING OF ELECTRICAL COMPONENTS, SPECIFICATION FOR

Approved by:

Patrick A. Simpkins, D.B.A.
Director, Engineering Directorate

## JOHN F. KENNEDY SPACE CENTER, NASA

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## TABLES

# ABBREVIATIONS, ACRONYMS, AND SYMBOLS

| | |
|---|---|
| °C | degree Celsius |
| ASTM | American Society for Testing and Materials |
| cm | centimeter |
| KSC | Kennedy Space Center |
| NASA | National Aeronautics and Space Administration |
| NEMA | National Electrical Manufacturers Association |
| s | second |

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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 are not applicable to the National Electrical Manufacturers Association (NEMA) electrical enclosures.

### 1.2 Classification

Seals shall be classified as described in the following subsections.

#### 1.2.1 Grade A

A Grade A seal is (1) metal-to-metal (welded, brazed, or soldered joints), (2) metal-to-glass, or (3) 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, vulcanization, 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 (e.g., polytetrafluoroethylene, polychlorotrifluoroethyene, and silicones). A Grade B seal can 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 by screws, bolts, or other clamping devices.

**CAUTION**

Where Grade B or Grade 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 deteriorate 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 grinding, lapping, or polishing the abutting surface to produce a precise 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 E 493 | Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector in the Inside-Out Testing Mode |
| ASTM E 498 | Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode |
| ASTM E 499 | Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector in the Detector Probe Mode |

# 3. REQUIREMENTS

## 3.1 Leakage Rates

Drawings and specifications that include seals shall specify (1) the grade of seal required and (2) the total permissible leakage rate. 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 $1.25 \times 10^{-8}$ cubic centimeters per second ($cm^3/s$) of air 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 $1.25 \times 10^{-6}$ $cm^3/s$ of air 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 $1.25 \times 10^{-4}$ $cm^3/s$ of air 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 $1.25 \times 10^{-3}$ $cm^3/s$ of air 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 shall be measured 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. The seal temperature classes are defined as follows:

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

b. Class II applies to seals that are neither exposed to direct solar radiation nor confined in an enclosure exposed to solar radiation.

### 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 rapid changes in temperature without cracking or flaking. 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 purposes 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 purposes 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. Grades 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 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 for all grades of seals shall be measured by the use of helium mass spectrometer leak detector methods specified in one of the following: ASTM E 493, ASTM E 498, or ASTM E 499. Breaking of seals to facilitate leakage measurement method shall be avoided. At 25 degrees Celsius (°C), the leakage measurement for all seals shall be made with 1 atmosphere of pressure (759.999 micrometers of mercury) on one side of the seal and a vacuum in the order of 1 micrometer 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 permissible 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 KSC-STD-164.

#### 4.2.1.2 Measurements

Following the temperature test, leakage shall be measured 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 KSC-STD-164.

#### 4.2.2.2 Measurements

Following the temperature shock test, leakage shall be measured 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 KSC-STD-164.

#### 4.2.3.2 Measurements

Following the vibration test, leakage shall be measured 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 KSC-STD-164.

#### 4.2.4.2 Measurements

Following the shock test, leakage shall be measured 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 shall be measured 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 test procedure for performing the explosion proof test. 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 shall be measured 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. 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 permissible leakage rate, and (3) the temperature class.

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Custodian:

NASA – John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

Preparing Activity:

John F. Kennedy Space Center
Engineering Directorate
Electrical Division

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
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| **I RECOMMEND A CHANGE:** | 1. DOCUMENT NUMBER<br>KSC-S-126B | 2. DOCUMENT DATE<br>October 29, 2008 |
|---|---|---|

3. DOCUMENT TITLE
Sealing of Electrical Components, Specification for

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

**6. SUBMITTER**

| a. NAME *(Last, First, Middle Initial)* | b. ORGANIZATION | |
|---|---|---|
| c. ADDRESS *(Include Zip Code)* | d. TELEPHONE *(Include Area Code)* | 7. DATE SUBMITTED |

**8. PREPARING ACTIVITY**

| a. NAME *(Last, First, Middle Initial)*<br>Denson, Erik C. | b. ORGANIZATION<br>Engineering Directorate, Electrical Division |
|---|---|

c. ADDRESS *(Include zip code)*
Kennedy Space Center, FL 32899