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TELEPHONE NO.

SHEET 1 OF 1

PAGE	BACK (L.H.)	FRONT (R.H.)	FACE ONLY	FOLDOUT (11X17,11X22, etc.)	NEGATIVE SUPPLIED	PHOTO SUPPLIED	SPECIAL INSTRUCTIONS
cover			x				
title			x				
iii–iv	x	x					
1–12	x	x					
SDIP			x				KSC Form 21-610 NS
							KSC-STD-E-0002D
							June 11, 2007
							Print as is from double-sided original.
							17 printed sides
							Three-hole drill.
							Staple upper left.
							62 sets

KSC FORM 16-133 (REV. 6/86) (C/G 12/94)

KSC-STD-E-0002D
JUNE 11, 2007
Supersedes
KSC-STD-E-0002C
September 28, 1998

HAZARDPROOFING OF ELECTRICALLY ENERGIZED EQUIPMENT, STANDARD FOR

ENGINEERING DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center

KSC FORM 16-12 (REV. 6/95) PREVIOUS EDITIONS ARE OBSOLETE (CG 11/95)

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KSC-STD-E-0002D
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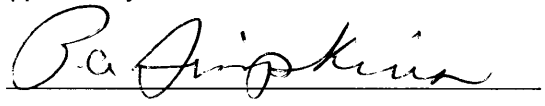
September 28, 1998

HAZARDPROOFING OF ELECTRICALLY ENERGIZED EQUIPMENT, STANDARD FOR

Approved by:



Patrick A. Simpkins
Director of Engineering

JOHN F. KENNEDY SPACE CENTER, NASA

CONTENTS

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HAZARDPROOFING OF ELECTRICALLY ENERGIZED EQUIPMENT, STANDARD FOR

1. PURPOSE AND SCOPE

This standard sets forth requirements for hazardproofing electrical installations and equipment located in hazardous (classified) and other locations designated as hazardous by the authority having jurisdiction (AHJ) at Kennedy Space Center (KSC) to prevent ignition of flammable liquids or hazardous fluids, gases, or vapors.

This document defines the minimum requirement that KSC ground systems and equipment must meet.

This document does not

- define how to design systems and equipment, or
- encompass hazardproofing requirements associated with lightning protection, grounding, operational safety, toxicity, or chemical reactions.

This standard does not apply to locations made hazardous because of the presence of high explosives (such as blasting agents or munitions) or pyrophoric (igniting spontaneously in air) materials.

2. APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. When this document 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. Unless a specific edition is cited, the latest released edition applies.

2.1 Governmental

2.1.1 Specifications

John F. Kennedy Space Center (KSC), NASA

KSC-SPEC-E-0031	Cables, Electrical, General Specification for

Military

MIL-DTL-5015	Connectors, Electrical Circular Threaded, AN Type, General Specification for
MIL-DTL-22992	Connectors, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, General Specification for

2.1.2 Standards

John F. Kennedy Space Center (KSC), NASA

KSC-STD-132	Potting and Molding Electrical Cable Assembly Terminations, Standard for
KSC-STD-E-0006	Instrumentation and Communications Cable Applications, Standard for
KSC-STD-E-0011	Electrical Power Receptacles and Plugs, Standard for
KSC-STD-E-0014	Wire and Cable Applications, Standard for

2.1.3 Handbooks

John F. Kennedy Space Center (KSC), NASA

GP-864, Volume IIA	Electrical Ground Support Equipment Cables Handbook

2.2 Nongovernmental

National Fire Protection Association

NFPA 70	National Electric Code
NFPA 430	Code for the Storage of Liquid and Solid Oxidizers
NFPA 496	Standard for Purged and Pressurized Enclosures for Electrical Equipment

NFPA 497	Recommended Practice for the Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

2.3 Order of Precedence

In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall supersede, except where otherwise noted. The NASA contract, purchase order, or program-level documentation shall take precedence over the contents of this document in the event of conflicting requirements. Nothing in this document supersedes applicable laws and regulation unless a specific exemption has been obtained.

3. DEFINITIONS

For the purpose of this document, the following definitions shall apply.

a. **authority having jurisdiction (AHJ):** Organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure. At KSC, the NASA Fire and Rescue Office is the AHJ.

b. **control drawing:** Drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus (or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus) that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus.

c. **facility:** Structure or building that serves a particular purpose.

d. **hazardous location:** Location where fire or explosion hazards may exist because of the presence of flammable gases, vapors, or liquids; combustible dust; or ignitable fibers or flyings. The area is classified in accordance with properties of the material responsible for the potential hazard and with the likelihood of the hazard actually being present.

e. **purged and pressurized:** Condition achieved by (1) purging, or supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level; and (2) pressurizing, or supplying an enclosure with a protective gas, with or without continuous flow, at sufficient pressure to prevent the entrance of flammable gas or vapor, combustible dust, or ignitable fibers. (For further information, see NFPA 496.)

f. **intrinsically safe:** "An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits" (NFPA 70).

4. GENERAL REQUIREMENTS

Design for all new electrical equipment to be used in hazardous (classified) locations shall comply with the intent of the applicable guidelines of NFPA 70 (latest released edition), NFPA 430 (latest released edition), NFPA 496 (latest released edition), and NFPA 497 (current version at start of project unless otherwise stated in project documentation).

The lead design engineer shall coordinate the design and implementation of hazardproofing for electrically energized equipment with the NASA Fire and Rescue Office, the AHJ over such activities at KSC.

5. GUIDELINES

Guidelines have been extracted from the NFPA 70A, Article 500, and have been tailored to KSC specific environment and requirements.

5.1 Hazardous Locations and Classifications

All areas designated as hazardous (classified) locations shall be properly documented in KSC drawings (see Appendix A). This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at the location.

Hazardous locations are where fire or explosion hazards may exist because of the presence of flammable gases, vapors, or liquids; combustible dust; or ignitable fibers or flyings. Although combustible dust and flammable gases and vapors exist almost everywhere, they are usually present in only minute quantities, much less than necessary for a fire or explosion hazard to exist. Thus, the presence of flammable gases or vapors or combustible dust does not in itself define a hazardous location. These materials must be present in sufficient quantities (concentrations) to present a potential explosion hazard. Hazardous locations at KSC involve the storage, handling and distribution of liquid oxygen, liquid hydrogen, nitrogen tetroxide, monomethylhydrazine, and open-grain solid propellants.

NFPA 497 does not assign the following items as hazardous substances nor does it assign an NEC group classification. The substances shall be treated as follows:

- nitrogen tetroxide – Class I, Group C
- oxygen – Class I, Group D
- solid propellants – Class II, Group E

- methane – Class I, Group D

In North America, hazardous (classified) locations are divided into three classes, based on the explosive characteristics of the material. The classes of material are further divided into divisions or zones, based on the risk of fire or explosion that the material presents. Zones have three levels of hazard, whereas divisions have two levels. Table 1 illustrates the relationships among classes, divisions, and zones.

Table 1. Classes, Divisions, and Zones of Hazardous Materials

Hazardous Material	Class, Division	Zone
Gases or vapors	Class I, Division 1	Zone 0 and Zone 1
Gases or vapors	Class I, Division 2	Zone 0

Locations shall be classified depending on the properties of the flammable vapors, liquids, or gases, or the combustible dust or fibers that may be present, and the likelihood that a flammable or combustible concentration or quantity is present. Where pyrophoric materials are the only materials used or handled, these locations shall not be classified. Each room, section, or area shall be considered individually in determining its classification.

5.2 Purging and Pressurizing

Purging is the process of supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level. This technique can be used to change a Class I or Class II, Division 1, location into a nonhazardous location or into a Division 2 location, or to change a Class I or II, Division 2, location into a nonhazardous location. It requires a noncombustible enclosure (which may be a control room or a machine room) that is first purged of any combustibles or flammables and then maintained at a positive pressure sufficient to prevent combustibles or flammables from entering the enclosure and being ignited by electrical equipment within the enclosure. The purging may be a continuous process or a single operation with a positive pressure maintained to make up for leaks. The pressurizing medium may be either air, commonly used in control rooms where people will be working, or a nonflammable gas. In instrument enclosures in locations with corrosive atmospheres, specially processed and dried air or gas is used to protect the enclosed equipment against corrosion, as well as to prevent ignition of exterior flammable gases and vapors or combustible dust. (See NFPA 496.)

Where possible, enclosures and distributors that are required by the system should be located outside a hazardous area and an intrinsically-safe design for energized electrical equipment is preferred.

5.3 Equipment for Hazardous Areas

5.3.1 Class and Properties

Equipment shall be identified for not only the class of location but also the explosive, combustible, or ignitable properties of the specific gas, vapor, dust, fiber, or flyings that will be present. In addition, Class I equipment shall not have any exposed surface that operates at a temperature in excess of the ignition temperature of the specific gas or vapor. Class II equipment shall not have an external temperature higher than that specified. Class III equipment shall not exceed the maximum surface temperatures specified in NFPA 70, Article 503.5.

5.3.2 Cable Wiring Methods

Cable shall be protected from spillage of liquid oxygen, hydrogen, or other propellants and from mechanical damage. No electrical lines of any type shall be located in trenches containing propellant lines. Instrumentation, communication, control, and associated power equipment at KSC may be connected by hard-service cabling/cords as specified in GP-864, Volume IIA; KSC-SPEC-E-0031; KSC–STD-E-0006: or KSC-STD-E-0014.

5.3.2.1 Mineral-Insulated Cable

Mineral-insulated cable is suitable for Division 1 locations and for all Class I and Class II locations. (See GP-864, Volume IIA; KSC-STD-E-0014; KSC-SPEC-E-0031; and KSC-STD-E-0006.)

5.3.2.2 Metal-Clad Cable

Metal-clad cable (Type MC) is permitted for application in Class I, Division 2, locations. Use of this type of cable is not limited to any voltage class. Under restrictions, metal-clad cable (Type MC-HL) and instrumentation tray cable (Type ITC-HL) are permitted in Class I, Division 1, locations. (See NFPA 70; GP-864, Volume IIA; KSC-STD-E-0014; KSC-SPEC-E-0031; and KSC-STD-E-0006.)

5.3.2.3 Tray Cable

Power and control cable (Type TC) and other cable assemblies that do not permit gas migration are permitted in Class 1, Division 2, locations where (1) the overall sheath is compatible with materials within the hazardous area, (2) the conditions of maintenance and supervision ensure that only qualified persons service the installation, and (3) the cable is continuously supported and protected against physical damage using mechanical protection, such as struts, angles, or channels.

5.3.2.4 Flexible Cords: Class I, Divisions 1 and 2

5.3.2.4.1 Permitted Uses

Flexible cords are permitted for

a. connection between portable lighting equipment or other portable equipment and the fixed portion of their supply circuit;

b. that portion of the circuit where the fixed wiring methods cannot provide the necessary degree of movement for fixed and mobile electrical equipment, where the flexible cord is protected from damage by location or by a suitable guard, and only in an industrial establishment where conditions of maintenance and engineering supervision ensure that only qualified persons install and service the installation;

c. electric submersible pumps with means for removal without entering the wet-pit (the extension of the flexible cord within a suitable raceway between the wet-pit and the power source is permitted); and

d. electric mixers intended for travel into and out of open-type mixing tanks or vats.

5.3.2.4.2 Required Characteristics

Where flexible cords are used, they shall

a. be a type listed in NFPA 70 for "extra hard use,"

b. be terminated in approved connectors capable of being safety-wired and pre-potted and molded in accordance with KSC-STD-132,

c. contain, in addition to the conductors of the circuit, a grounding conductor complying with all applicable code standards,

d. be connected to terminals or to supply conductors in an approved manner,

e. be supported by clamps or other suitable means so there is no tension on the terminal connections,

f. be provided with suitable seals where the flexible cord enters boxes, fittings, or explosionproof enclosures, and

g. be of continuous length, having no splices.

5.4 Electrical Connections for Meters, Instruments, and Relays

To comply with the intent of NFPA70, process control instruments may be connected through flexible cord, attachment plug, and receptacles and shall be allowed for use in hazardous (classified) locations provided the following conditions are met. (See MIL-DTL-5015, MIL-DTL-22992; GP-864, Volume II; and KSC-STD-E-0011 for approved connectors.)

NOTE

Connectors classified as "weatherproof" with threaded coupling nuts are acceptable for use with instrumentation, communication, controls, and associated power cabling.

a. A switch complying with all applicable standards—not an attachment plug—is used to interrupt current.

b. The current does not exceed maximum specified amperes at rated volts, direct current (dc), for instrumentation, controls and associated power cable for specific hazardous environments, and maximum specified amperes at rated volts dc for communication and associated power cabling for specific hazardous environments.

c. The power supply cord, which may be of any length, is listed in NFPA 70 for "extra hard use" (or for "hard use" if protected by location) and is supplied through an attachment plug and receptacle of the locking and grounding type.

d. Only necessary receptacles are provided.

e. The receptacle carries a label warning against unplugging under load.

f. A method is provided that is outside the hazardous zone to interrupt current prior to disconnecting the connector.

6. QUALITY ASSURANCE PROVISIONS

This section is not applicable.

7. PREPARATION FOR DELIVERY

This section is not applicable.

8. NOTES

8.1 Intended Use

This standard is intended for use by design organizations engaged in the design of electrical equipment to be used in hazardous (classified) and other locations designated as hazardous by the AHJ at KSC.

8.2 Notice

The Government drawings, specifications, and/or data are prepared for the official use by, or on behalf of, the United States Government. The Government neither warrants these Government drawings, specifications, or other data, nor assumes any responsibility or obligation, for their use for purposes other than the Government project for which they were prepared and/or provided by the Government, or any activity directly related thereto. 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 licensing in any manner the holder or any other person or corporation nor conveying the right or permission to manufacture, use, or sell any patented invention that may relate thereto.

Custodian:

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

Preparing Activity:

John F. Kennedy Space Center
Engineering Directorate
Mechanical and Electrical Ground Support Systems Office

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APPENDIX A. SPACE SHUTTLE ELECTRICAL-POWER HAZARDOUS-ZONE DOCUMENTATION

Drawing	Title
79K08945	Launch Complex 39 Pads A & B/MLPs 1, 2, & 3 Electrically Energized Equip. Hazardous Area Zones
79K20198	Launch Complex 39 HMF Electrical Power Hazardous Area Zones
80K60590	Launch Complex 39 VAB Electrical Power Hazardous Area Zones
80K60591	Launch Complex 39 RPSF Electrical Power Hazardous Area Zones
80K60592	Launch Complex 39 SLF Electrical Power Hazardous Area Zones
80K60649	Launch Complex 39 MLP 1, 2 & 3 Electrical Power Hazardous Area Zones
80K60650	Launch Complex 39 TPSF Electrical Power Hazardous Area Zones
80K60686	OPF-1 Electrical Hazardous Area Drawing Hyper Operations
80K60739	OPF-2 Electrical Hazardous Area Drawing Hyper Operations
80K60740	OPF-3 Electrical Hazardous Area Drawing Hyper Operations
80K60467	OPF-1,2,3 Electrical Hazardous Area Zones for Waterproofing & Fuel Cell Hydrogen De-Servicing Operations(Worst Case)
80K61590	OPF-1,2,3 Electrical Hazardous Area Zones Permanent Hazardous Area Classifications

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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.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE
3. DOCUMENT TITLE		
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	b. TELEPHONE *(Include Area Code)*
c. ADDRESS *(Include Zip Code)*	