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MODULAR ELECTRICAL ENCLOSURES, RACKS, CONSOLES, AND ACCESSORIES,

SPECIFICATION FOR

NOT EXPORT CONTROLLED

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May 15, 2020

Engineering Directorate

National Aeronautics and
Space Administration

John F. Kennedy Space Center

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KSC-SPEC-E-0002
Revision A, Change 1

MODULAR ELECTRICAL ENCLOSURES, RACKS, CONSOLES, AND ACCESSORIES,

SPECIFICATION FOR

Approved by:

SHAWN QUINN Digitally signed by SHAWN QUINN
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Shawn M. Quinn
Director, Engineering

May 15, 2020

JOHN F. KENNEDY SPACE CENTER, NASA

RECORD OF REVISIONS/CHANGES

REV LTR	CHG NO.	DESCRIPTION	DATE
		Basic issue.	March 15, 1967
A		General revision.	August 24, 2010
	A-1	1. Updated signature approval page. 2. Added KSC-STD-E-0012 in section 2.1. 3. Updated IEEE 299-1997 to IEEE 299-206 in section 2.2. 4. Added aluminum as a material option for frame fabrication in section 3.3.a. (1). 5. Added aluminum as a material option for panel fabrication in section 3.3.b. (1). 6. Added KSC-DE-512 SM in section 3.7.a. (2).	May 15, 2020

CONTENTS

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
AWS	American Welding Society
C	centi (1×10^{-2})
dB	decibel
E^3	electromagnetic environmental effects
ECA	Electronic Components Association
EIA	Electronic Industries Alliance
EMC	electromagnetic compatibility
EMI	electromagnetic interference
FED	Federal
FSS	facility support systems
ft	foot
G	giga (1×10^{9})
GSE	ground support equipment
GSS	ground support systems
Hz	hertz
IEEE	Institute of Electrical and Electronics Engineers
k	kilo (1×10^{3})
KSC	John F. Kennedy Space Center
m	meter; milli (1×10^{-3})
MIL	military
NASA	National Aeronautics and Space Administration
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
RU	rack units
SAE	Society of Automotive Engineers
STD	standard
TGIC	triglycidyl isocyanurate
USG	U.S. Standard Gauge
V	volt
VESA	Video Electronics Standards Association

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1. SCOPE

This specification establishes the general characteristics, construction, and material requirements for industrial/commercial racks and enclosures for use by KSC designers as components of facility support systems (FSS), ground support systems (GSS), and ground support equipment (GSE). Design details are provided by engineering drawings or procurement specifications. Electrical racks are defined as floor-mounted, modular, framed containers designed to protect electrical/electronic equipment. Electrical enclosures are defined as floor/wall-mounted cabinets designed to protect electrical/electronic equipment. The requirements for racks/enclosures are categorized by their environment. Standard racks/enclosures are intended for indoor use where they will be protected from harsh vibration and acoustics. Heavy-duty racks/enclosures will be exposed to harsh launch environments.

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

Federal

Americans with Disabilities Act	
Architectural Barriers Act	
FED-STD-595	Colors Used in Government Procurement

John F. Kennedy Space Center (KSC)

KSC-DE-512 SM	Facility, System, and Equipment General Design Requirements
KSC-E-165	Electrical Ground Support Equipment Fabrication, Specification for
KSC-E-166	Installation and Assembly, Electrical Ground Support Equipment (GSE), Specification for
KSC-STD-164	Environmental Test Methods for Ground Support Equipment, Standard for

KSC-STD-E-0002	Hazardproofing of Electrically Energized Equipment, Standard for
KSC-STD-E-0012	Facility Grounding and Lightning Protection, Standard for
KSC-STD-E-0015	Marking of Ground Support Equipment, Standard for

Military

MIL-STD-171	Finishing of Metal and Wood Surfaces
MIL-STD-889	Dissimilar Metals

National Aeronautics and Space Administration (NASA)

NASA-STD-5005	Standards for the Design and Fabrication of Ground Support Equipment
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum of Launch Structures, Facilities, and Ground Support Equipment

(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 Welding Society (AWS)

AWS D1.1	Structural Welding Code – Steel – Reference Manual
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D17.2/17.2M	Specification for Resistance Welding for Aerospace Applications

Electronic Components, Assemblies and Materials Association (ECA)

ECA EIA/ECA-310	Cabinets, Racks, Panels, and Associated Equipment

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 299-2006	Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

National Classification Board

National Motor Freight Classification Rules

National Electrical Manufacturers Association (NEMA)

NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)

Official Classification Committee

Uniform Classification Rules

Society of Automotive Engineers (SAE)

SAE J405	(R) Chemical Compositions of SAE Wrought Stainless Steels

3. REQUIREMENTS

3.1 General Configuration and Dimension

Electronic racks, panels, mounting fixtures, and modular enclosures shall conform to the configuration and dimension requirements of ECA EIA/ECA-310. (For soft metric units, refer to Section 4. For hard metric units, refer to Sections 5 and 6.) Adjustable mounting-rack angles shall be spaced according to ECA EIA/ECA-310.

3.2 Hazardproofing

Racks, panels, and enclosures in hazardous locations shall be hazardproofed in accordance with KSC-STD-E-0002.

3.3 Physical Construction of Standard Racks

a. Frame Construction

(1) Frames shall be fabricated from aluminum or a minimum of U.S. Standard Gauge (USG) 14-gauge steel.

(2) Seams shall be continuously welded and ground smooth.

(3) Base construction shall be specified in engineering drawings or procurement specifications. The base shall be a solid plate. If internal equipment is not sensitive to electromagnetic interference (EMI), base construction may be open for air flow.

(4) Adjustable utility rails and rack angles for equipment mounting may be specified in engineering drawings or procurement specifications.

(5) All gasket mating surfaces shall be flush and true.

(6) All interfaces of stainless steel to stainless steel shall be lubricated before assembly to prevent galling.

(7) Racks shall provide a stainless-steel ground stud 0.635 centimeter (cm) (0.25 inch) in diameter by 2.54 cm (1 inch) in length, with 7.87 threads per centimeter (20 threads per inch). Studs location shall be specified in the engineering drawings or procurement specifications. Studs shall typically be located on the top inside rear of each rack for connection to facility ground.

b. Top- and Side-Panel Construction

(1) Panels shall be fabricated from aluminum or a minimum of USG 14-gauge steel. When specified in engineering drawings or procurement specifications, top panels shall be removable. Otherwise, panels shall be fixed.

(2) When specified in engineering drawings or procurement specifications, cutouts shall be provided for cable entry and venting. Otherwise, no cutouts are required.

(3) When specified in engineering drawings or procurement specifications, removable panels shall be provided with tamper-resistant fasteners, such as Security Torx.

c. Door Construction

(1) When specified in engineering drawings or procurement specifications, front and rear doors shall be solid (no windows).

(2) Doors shall be configured with at least a three-point latching system, which includes a slide detent/pivoting mechanism integrated with the door handle.

(3) Handles shall be padlock-type or shall accommodate locks with removable keys.

(4) Hinges shall be liftoff-pin-type, permitting the door to be lifted up and off without removal of pins or other attaching hardware. The door hinge configuration shall allow for multiple-bay or side-by-side arrangements such that the doors can swing a minimum of 135 degrees from the closed position to the fully opened position while adjacent cabinet doors are closed.

(5) Racks may be procured with or without front or rear doors. Requirements for door venting or transparent doors shall be as specified by engineering drawings or procurement specifications.

(6) For applications where the base is enclosed (solid plate), engineering drawings or procurement specifications shall specify rear-door fan installation. The enclosure shall include ventilation accommodations equivalent to two 25.4 cm (10-inch) fans configured as an inlet fan at the bottom and an exhaust fan at the top. As specified in engineering drawings or procurement specifications, inlet and outlet ventilation penetrations may be located in the rear door, front panel, bottom panel, or top panel.

d. Finishing and Coating

(1) Racks shall be coated to protect them from the environment in which they will be located.

(2) Painting shall be in accordance with NASA-STD-5008.

(3) When powder coating is specified, exterior racks shall be treated with a triglycidyl isocyanurate (TGIC) powder coat system. At a minimum, interior racks shall be treated with a polyester urethane powder coat.

e. Lifting Eyes

(1) When specified, provisions shall be made for installation of removable lifting eyes on all four corners of the top frame.

(2) Composition of lifting eyes shall be compatible with the environment in which the enclosure is to be installed and galvanically compatible with the material from which the enclosure is constructed; for all outdoor stainless-steel enclosures, the lifting eyes shall be of stainless steel composition.

3.4 Physical Construction of Heavy-Duty Racks

Heavy-duty racks shall adhere to the same specifications as standard racks, with the addition of the following specifications. Where conflicts arise, the specifications for physical construction of heavy-duty racks shall govern.

a. Frame Construction

(1) Frames shall be fabricated from USG 10-gauge steel.

(2) Seams shall be continuously welded and ground smooth.

b. Top- and Side-Panel Construction

(1) Top panels shall be fabricated from USG 12-gauge steel.

(2) When specified in engineering drawings or procurement specifications, top panels shall be removable. Otherwise, top panels shall be fixed.

c. Side-Panel Construction

(1) Side panels shall be fabricated from USG 12-gauge steel.

(2) One vertical hat stiffener shall be constructed of USG 12-gauge steel.

d. Door Construction

(1) When specified in engineering drawings or procurement specifications, cutouts shall be provided for ventilation. Otherwise, no cutouts are required.

(2) One vertical hat stiffener shall be constructed of USG 12-gauge steel.

3.5 Physical Construction of Standard Enclosures

a. Enclosure Construction

(1) Standard enclosures shall be fabricated from aluminum or a minimum of USG 16-gauge steel.

(2) Other enclosures may be constructed of fiberglass or other composite materials, such as polycarbonate and ABS, for applications where it has been determined that a nonconducting cabinet will meet the electromagnetic-compatibility (EMC) requirements of the enclosed system, and the enclosure material is compatible with the local natural and artificial environment, as specified in design drawings or procurement specification.

(3) Seams shall be continuously welded and ground smooth.

(4) When specified in engineering drawings or procurement specifications, cutouts shall be provided for cable entry. Otherwise, no cutouts are required.

(5) All gasket mating surfaces should be flush and true.

(6) All interfaces of stainless steel to stainless steel shall be lubricated before assembly to prevent galling.

(7) Enclosures shall be rated for the expected environment according to NEMA 250.

(8) Exterior enclosures shall be NEMA 4X-rated.

(9) Interior enclosures shall be NEMA 12-rated or higher (NEMA 4).

(10) Enclosures shall provide a stainless-steel ground stud 0.635 cm (0.25 inch) in diameter by 2.54 cm (1 inch) in length, with 7.87 threads per centimeter (20 threads per inch). Stud location shall be specified in the engineering drawings or procurement specifications. Studs shall typically be located on the top (interior/exterior) rear of each enclosure for connection to facility ground.

b. Back-Panel Construction

(1) Back panels shall be fabricated from aluminum or a minimum of USG 14-gauge steel.

(2) The back (interior) panel shall be removable.

c. Door Construction

(1) Doors shall be fabricated from aluminum or a minimum of USG 16-gauge steel.

(2) Doors shall be solid (no windows).

d. Finishing and Coating

(1) Enclosures shall be coated to protect them from the environment in which they will be located.

(2) Painting shall be in accordance with NASA-STD-5008.

(3) When powder coating is specified, exterior enclosures shall be treated with a TGIC powder coat system. At a minimum, enclosures shall be treated with a polyester urethane powder coat.

3.6 Physical Construction of Heavy-Duty Enclosures

Heavy-duty enclosures shall adhere to the same specifications as standard enclosures, with the addition of the following specifications. When specifications conflict, the specifications for the physical construction of heavy-duty enclosures shall govern.

a. Enclosure Construction

(1) Enclosures shall be fabricated from USG 12-gauge steel for interior applications or stainless steel for exterior applications (type 316L or equivalent, as specified in SAE J405).

(2) Bases shall be a solid plate, and enclosures shall be sealed.

(3) The bases of enclosures exceeding 1.83 meters (m) by 1.83 m (6 feet [ft] by 6 ft) shall have 10-gauge steel angle reinforcements.

(4) Enclosures exceeding 76.2 cm (30 inches) in height, width, or depth shall have stiffeners. Stiffeners shall be constructed of USG 12-gauge steel for interior applications or stainless steel for exterior applications. Rear walls shall have an "X" brace stiffener.

(5) When specified in engineering drawings or procurement specifications, cutouts shall be provided for cable entry and venting. Otherwise, no cutouts are required.

b. Back-Panel Construction

(1) Back panels shall be fabricated from a minimum of USG 16-gauge galvanized steel.

(2) The interior back panel shall be removable.

c. Center-Post Construction

Enclosures exceeding 1.83 m by 1.83 m (6 ft by 6 ft) shall have a center post. The center post shall be mounted with machine screws, between the two front doors, and shall be easily removable.

d. Door Construction

(1) Doors shall be fabricated from USG 12-gauge steel for interior applications or stainless steel for exterior applications.

(2) Doors shall be solid (no windows).

(3) Doors shall be outfitted with latching handles, perimeter clasps, and locking hasps.

(4) Enclosures exceeding 76.2 cm (30 inches) in height, width, or depth shall have vertical hat stiffeners. Vertical hat stiffeners shall be constructed of USG 12-gauge steel for interior applications or stainless steel for exterior applications.

3.7 Physical Construction of Consoles

Consoles are used as modular mounting systems for writing surfaces, display devices, panel-mounted equipment, computer workstations, communication equipment, cabling, and internal power distribution. The enclosures are designed specifically for mission operations and emphasize operator ergonomics and ease of access to equipment. They support a design that promotes situational awareness for multiple users.

a. Console Construction

(1) A console consists of an independent base, a hood, and a desktop.

(2) Console design shall conform to directives established by the Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities and the Architectural Barriers Act (ABA), as well as the guidelines for human factors in NASA-STD-5005 and KSC-DE-512 SM.

(3) Though not specifically addressed in the ADA or ABA, console design shall consider viewing distance to displays, visibility of displays when the user is standing, and how easily equipment can be reached. There shall be no protrusions or obstructions below the desktop that would interfere with or injure the seated user.

(4) Consoles shall adhere to appearance, fit, dimensions, and tolerances specified in engineering drawings or procurement specifications.

(5) Consoles shall be constructed of finished metal and high pressure/quality laminates, with no exposed, unfinished wood on any interior or exterior surface of the console.

(6) Exterior surfaces shall be washable and resistant to mild abrasion. Exterior surfaces shall not be subject to damage by common liquid spills or common cleaning agents.

(7) Parts such as hinges, catches, handles, or knobs shall be configured to avoid damaging hardware or surfaces.

(8) The adherence or removal of standard industrial tape shall not affect the painted surface of a console.

b. Colors

Colors shall be selected from those specified in NASA-STD-5005 and KSC-DE-512 and in accordance with FED-STD-595.

c. Displays

(1) The quantity of displays shall be specified by engineering drawings or procurement specifications.

(2) Workstation displays shall be mounted in compliance with the applicable standard of the Video Electronics Standards Association (VESA).

(3) Monitor arms (if required) shall conform as follows.

(a) Monitor arms shall provide user-adjustable tilt, swivel, and horizontal articulation.

(b) Monitor arms may be mounted on a pole, slat board, or other mounting scheme as proposed by the enclosure manufacturer.

(c) Monitor arms or mounting structures shall be removable to enable the enclosure to be reconfigured. Monitor arms or mounting structures shall not interfere with equipment above the desktop.

(d) Monitor arms or mounting structures shall provide a way to hide cables and protect them when displays are moved.

3.7.1 Base Construction

The base shall be designed according to a "bay" concept so partitioned equipment can be placed below the desktop and concealed. Depending on configuration, the enclosure base houses workstation towers, network and communications patch panels, satellite network switches, power distribution units, and power strips.

a. Bases shall be constructed as specified in engineering drawings or procurement specifications.

b. Exposed holes and penetrations not used for a particular configuration can be sealed or plugged for aesthetic purposes or to maintain EMI shielding.

c. Enclosure bases shall be rigid enough to keep seams and joints from separating during normal transportation and installation.

d. Bases shall provide internal cable management, cable penetrations through the desktop, and below-floor and cabinet ventilation when specified in engineering drawings or procurement specifications.

e. When specified in engineering drawings or procurement specifications, low-noise fans shall be installed in the rear or ducted through the hood, and ventilation grids shall be provided in the front of the base to cool equipment.

f. Bases shall have lockable, removable front and rear access panels/doors for equipment access and servicing.

g. Cable routing shall be provided between all bays of an enclosure. Each bay shall provide a cable pathway to or through the desktop.

3.7.2 Hood Construction

The hood shall attach to the base or desktop and provide rack-mount space if applicable.

a. If required, a center-mounted brace shall be provided for stability and to enable the hood to support the weight of rack-mounted equipment.
b. The hood shall provide a sound barrier and hidden pathways for cabling to or from the base and desktop.
c. Cable pathways shall be accessible from the front to allow for cable routing when a console is placed against a wall. Hidden cable pathways shall be provided for hood-mounted telephones.
d. Rack-mount space shall accommodate equipment mounted on slides and be electrically grounded to the enclosure base.
e. Rack-mounted equipment shall be independently removable, without removal of the hood or other enclosures.
f. When specified, hoods shall provide for mounting telephone brackets on both sides, inside and outside.
g. Hoods shall have removable rear access panels for equipment installation, removal, and servicing.

3.7.3 Desktop Construction

The desktop shall attach to the base to accommodate workstation displays, keyboards and mouse devices, desktop speakers, card readers, network data ports, power outlets, and laptop computers.

a. The desktop shall provide a support mechanism for pole-mounted or slat-board-mounted monitor arms and a pathway for cables entering the base through inset cutouts.
b. There shall be no protrusions or obstructions below the desktop that would interfere with or injure the seated user.
c. The desktop work surface shall be of seamless construction.

3.8 Materials

The selection of materials shall be at the discretion of the design engineer and specified in engineering drawings or procurement specification. Selected materials shall allow the enclosure to meet the structural, environmental, and attenuation requirements specified herein.

If used, dissimilar metals, as defined in MIL-STD-889, shall be suitably treated in accordance with MIL-STD-171 for prevention of electrolytic corrosion, without degradation of their effectiveness in shielding.

3.9 Standard Plated Hardware

When specified in engineering drawings or procurement specifications, plated fastening devices and other common hardware items shall conform to applicable military standards for the types and sizes required.

3.10 Nonstandard Plated Hardware

Plated nonmilitary-standard items shall meet or exceed the requirements of Section 3.9 of this document.

3.11 Mounting Provisions

Mounting provisions shall be specified in engineering drawings or procurement specifications. Mounting holes shall be free of burrs and shall be spaced in conformance with the universal spacing requirements of ECA EIA/ECA-310.

3.12 Bonding and Grounding

a. Electrical bonding/grounding shall be provided where access doors, panels, plates, or other separable joints form a part of shielding.

b. Internal grounding and bonding of the enclosure structural components shall comply with KSC-STD-E-0012 and engineering drawings or procurement specifications.

c. Maximum resistance across bonded surfaces shall be less than 5 milliohms. (Hinges are not a satisfactory conductive path.)

d. Racks and enclosures shall provide accommodations, such as studs, clamps, and lugs, for the interior and exterior grounding and bonding of installed equipment as specified in engineering drawings or procurement specification according to KSC-STD-E-0012.

e. Stud location shall be specified in the engineering drawings or procurement specifications. Studs shall typically be located on the top (interior/exterior) rear of each rack or enclosure for connection to facility ground.

f. The grounding/bonding stud size shall be 0.635 cm (0.25 inch) in diameter by 2.54 cm (1 inch) in length, with 7.87 threads per centimeter (20 threads per inch). Nuts and washers shall be provided for all bonding and grounding studs.

g. All grounding and bonding shall meet the workmanship requirements of KSC-STD-E-0012, as specified in engineering drawings or procurement specification.

3.13 Sharp Projections

Sharp projections shall be ground smooth.

3.14 Welding

Welds shall meet all Class A requirements of AWS D17.2/17.2M. Welding shall be performed by certified welders according to AWS D1.1, AWS D1.2, AWS D1.3, and AWS D1.6.

3.15 Installation of Fastening Devices

Fastening devices shall be installed according to KSC-E-165.

3.16 Finish and Coating

Painting shall be in accordance with NASA-STD-5008.

Exterior surfaces of racks, enclosures, and accessories for environmentally controlled areas shall be in accordance with NASA-STD-5008.

3.16.1 Cleaning and Pretreatment

Surfaces to be coated shall be cleaned and pretreated according to KSC-E-165 and MIL-STD-171.

3.16.2 Painting

Painting shall be in accordance with NASA-STD-5008. Painting procedures shall conform to MIL-STD-171. Coatings shall be finished according to KSC-E-165.

3.17 Powder Coating

When powder coating is specified, exterior racks and enclosures shall be treated with a TGIC powder coat system. At a minimum, racks and enclosures shall be treated with a polyester urethane powder coat.

3.18 Marking and Identification

Marking and identification shall be in accordance to KSC-STD-E-0015.

3.19 Component Interchangeability

All components bearing the same part number shall be interchangeable, without rework or force fit, within any type of enclosure for which they are designed. Enclosures shall mate, without rework or force fitting, with like enclosures for setup in multiple-bay units. Accessories shall mount, without rework or force fitting, to any enclosure for which designed.

3.20 Electromagnetic Compatibility (EMC)

a. The utilization of enclosures (including all cabinets, racks, and consoles) for EMC compliance shall be determined by the EM environment at the installation location, EM characteristics of the housed equipment (both radiated and conducted, emissions and susceptibilities, transient and surge overvoltages and overcurrents), and EM requirements of the program, project, or institution creating or hosting the enclosure, as specified in the engineering drawings or procurement specification.

b. Nonconductive, composite-material enclosures shall be used only for passive fiber-optic applications and shall not be used to house active or passive electrical equipment or metallic cabling.

c. Enclosures shall provide adequate shielding for signal attenuation between 2 megahertz (MHz) and 30 gigahertz (GHz) as necessary to meet the EM requirements specified in the engineering drawings or procurement specification. Enclosures housing equipment designed for EM-susceptibility limits of 20 volts per meter (V/m) shall provide a minimum shielding signal attenuation of 26 decibels (dB) over the frequency range of 2 MHz to 18 GHz. Enclosures housing equipment designed for EM-susceptibility limits of 50 V/m shall provide a minimum shielding signal attenuation of 34 dB over the frequency range of 2 MHz to 18 GHz. For higher-frequency environments, an upper limit of 30 GHz may be used.

d. Enclosures shall provide EM shielding and sealing of intentional apertures (such as doors, removable panels, usable panel holes and penetrations, cable feedthroughs, cooling ducts, and fan mounts) as necessary to meet the attenuation requirements of Section 3.20.c. Treatment methods may include but are not limited to EM screening, EM gaskets, and latch/operator reinforcement, as specified in the engineering drawings or procurement specification.

e. Enclosures shall provide EM shielding and sealing of unintentional apertures (such as removable or nonremovable panels, unused panel holes and penetrations, other air gaps in assembly and base mounts, and closed latches) as necessary to meet the attenuation requirements of Section 3.20.c. Treatment methods may include but are not limited to EM gaskets, conductive taping, welding and soldering, conductive coatings, and latch/operator reinforcement, as specified in the engineering drawings or procurement specification.

f. Enclosures shall provide cable penetration conduits and/or bulkhead connectors that allow bonding between the enclosure structure and shields of penetrating cables as necessary to meet the attenuation requirements of Section 3.20.c, as specified in the engineering drawings or procurement specification.

g. Enclosures shall provide mounting, bonding, and wiring accommodations for

   (1) internally mounted surge protection of external power supply, signal, and communication lines,

   (2) conducted-emission line filters, and

   (3) internal wiring routing

as required to meet the requirements of Section 3.20.a as specified in the engineering drawings or procurement specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality Control System

The supplier shall provide and maintain a quality control system as specified in the contract.

4.2 Governmental Inspection and Verification

Inspection and verification shall be performed at the supplier's plant by representatives of the NASA/KSC contracting officer to ensure compliance with the contract requirements, drawings, and technical specifications prior to authorization for shipment.

4.3 Notification

Inspections and tests shall be coordinated and scheduled between the supplier and contracting officer's representative.

4.4 Supplier Inspections

The supplier shall perform sufficient inspections and tests of all materials, parts, components, and assemblies to ensure that all articles conform to applicable drawings and specifications with respect to such details as composition, workmanship, finish, construction, performance, interchangeability, identification, and marking. These inspections and tests shall include receiving, processing, fabrication, assembly, end-item, and shipping phases.

4.5 Special-Process Control

The supplier shall establish inspections and controls over processes to ensure compliance with quality requirements that are not readily detectable or measurable by inspection and testing of finished articles. When approval or certification of special processes, operating personnel, special equipment, or procedures is required by the contract, drawing, or specification, the supplier shall obtain the necessary approvals or certification prior to processing the articles intended for delivery to the Government. These special processes may include radiography, magnetic-particle and liquid-penetrant inspection, welding, and soldering.

4.6 Records of Inspections and Tests

The supplier shall maintain records of inspections and tests performed on the items of this specification. These records shall be made available to the Government, upon request, during the contract performance period and for 180 days after acceptance of the items.

4.7 Workmanship

Shapes and dimensions shall be uniform. There shall be no cracks, dents, bends, chips, loose connections, loose attaching parts, misalignment, or other defects that could render the unit unsuitable for its intended purpose. In addition, the unit shall be clean and free of burrs, sharp edges, metal shavings, dirt, and other foreign materials.

4.8 Prototype Sampling

Prototype samples shall be submitted when required and specified by contract. The prototype sample shall be capable of meeting the requirements specified herein and shall be identical to the proposed end product. (Prototype samples are a limited number of contracted articles that are not production runs. When received by the end user, prototype samples are further tested and evaluated to determine whether they are fit for the intended application. Evaluation may result in a configuration change and a subsequent contract modification to purchase modified items that best meet design intent and performance applications).

4.9 Acceptance Tests

Acceptance testing and inspection at Government facilities may be performed at the discretion of the contracting officer to ensure compliance with this specification (independent of any other test and inspections) and may be used as criteria for acceptance or rejection. Final acceptance will be at KSC. When specified, a copy of the certified results for EMC, vibration, and acoustic testing shall be supplied for each distinct type and size of enclosure delivered. Certification tests shall not be conducted by the enclosure manufacturer.

4.9.1 Shielding

Installed shielding material shall be examined to verify that it is evenly and securely bonded to the mating surface and that it makes complete and intimate contact with the adjoining surface. Copper shielding tape used to attach screens or other devices to rack interiors shall be fastened by adhesive and mechanical means to prevent detachment.

4.9.2 Fit and Interchangeability

The assembly of panels at each location of the enclosure shall be tested to verify that panels fit easily, without force, and that mating holes align properly. The fit of doors to enclosures shall be tested to verify that doors move freely, latch properly without undue effort, and bond evenly and firmly around the periphery. Door locks shall be tested for proper action. Enclosures, panels, and accessories shall be selected for testing randomly and in sufficient numbers to constitute a valid sample for assessing interchangeability.

4.9.3 Finish

Coatings shall be inspected for compliance with coating requirements such as thickness, hiding power, gloss, smoothness, and proper color.

4.9.4 Electromagnetic Shielding

The enclosure, rack, or console manufacturer shall provide test results to confirm the attenuation effectiveness of the product. These measurements shall be performed according to the test methodology of IEEE 299-2006.Testing shall prove that the enclosure, rack, or console provides a minimum shielding effectiveness specified in this document.

4.9.5 Environmental Testing

Each test specimen shall be a production item that has undergone final inspection. Tests for determining the specimen's resistance to vibration, acoustics, shock, humidity, rain, solar radiation, salt fog, and other such environments shall be performed according to KSC-STD-164. Tests to be performed and their associated test levels shall be based on data generated by the design engineer or specified in the statement of work. Copies of test results shall be made available to the procuring agency.

5. PREPARATION FOR DELIVERY

All items shall be packaged, handled, and transported according to KSC-E-166. Unless otherwise specified, each unit shall be individually packaged, with suitable cushioning material to protect the unit from damage caused by the normal shock and vibration encountered in commercial shipping. Packaging shall be equivalent to the supplier's best commercial practice and shall be sufficient to protect the unit from damage, deterioration, or loss. The supplier is liable for any damage to units resulting from this phase of the operation. Exterior containers shall conform to Uniform Classification Rules and National Motor Freight Classification Rules.

5.1 Intended Use

This specification is intended for use in the procurement of racks, enclosures, consoles, and related accessories that are compatible with existing installations.

NOTICE: The Government drawings, specifications, 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 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.

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