METRIC/INCH-POUND

KSC-DE-512-SM
REVISION J

FACILITY, SYSTEM, AND EQUIPMENT

GENERAL DESIGN REQUIREMENTS

October 15, 2002

SPACEPORT ENGINEERING AND TECHNOLOGY DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center

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FACILITY, SYSTEM, AND EQUIPMENT

GENERAL DESIGN REQUIREMENTS

Approved:

James R. Heald
Director of Spaceport Engineering and Technology

This Revision Supersedes All Previous
Editions of This Document

October 15, 2002
JOHN F. KENNEDY SPACE CENTER, NASA

RECORD OF REVISIONS/CHANGES

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B		General revision	June 1988
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F		Revised miscellaneous references	August 5, 1996
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J		Updated miscellaneous references and text. Incorporated change H-1	October 15, 2002

FOREWORD

This document establishes the general requirements and practices for the design of facilities, systems, and equipment used by or for the John F. Kennedy Space Center (KSC), NASA. This document applies to the design of facilities and ground-based hardware and software used to support the operations of transporting, receiving, handling, assembly, test, checkout, service, and launch of space vehicles and payloads at the launch, landing, and retrieval sites. These requirements and practices are optional for items used only at the manufacturing, development, and test sites upstream of the launch, landing, and retrieval sites.

The purpose of this document is to establish uniform engineering practices and methods for the design of facilities, systems, and equipment used at KSC. This document is not intended to define how to design facilities, systems, and equipment but to define the minimum requirements this type of hardware must meet. This document is applicable to items that support space vehicle or payload programs or projects and is consistent with the requirements specified in SW-E-0002, SSP 50004, NASA-STD-5005, and ISO 14625.

Requests for improvements to this document should be directed to NASA, Spaceport Engineering and Technology Directorate (mail code: YA, Kennedy Space Center, Florida 32899), using the form attached to the back of this document. Requests for additional copies of this document should be sent to Library-D, Kennedy Space Center, Florida 32899.

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ABBREVIATIONS AND ACRONYMS

ac	alternating current
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
A-50	Aerozine-50
CAPPS	Checkout and Payload Processing Services
CCAFS	Cape Canaveral Air Force Station
CCS	Complex Control System
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CIL	Critical Items List
COTS	commercial off-the-shelf
DB	dry bulb
dc	direct current
DP	dew point
ECS	environmental control system
EEE	electrical, electronic, and electromechanical
e.g.	for example
EIA	Electronic Industries Association
EMI	electromagnetic interference
ESD	electrostatic discharge
EWR	Eastern and Western Range
FED	Federal
FMECA	Failure Mode, Effects, and Criticality Analysis
GFE	Government-furnished equipment
GFI	Government-furnished information
GFL	Government-furnished labor
GFP	Government-furnished property
GFS	Government-furnished software
GP	general publication
GSE	ground support equipment
HDBK	handbook
HGDS	Hazardous Gas Detection System
HVAC	heating, ventilating, and air conditioning
ICD	interface control document
i.e.	that is

ABBREVIATIONS AND ACRONYMS (cont)

IEEE	Institute of Electrical and Electronics Engineers
IPC	Interconnecting and Packaging Electronic Circuits
ISO	International Standards Organization
JBOSC	Joint Base Operations Support Contract
JSC	Lyndon B. Johnson Space Center
KHB	KSC handbook
KMI	Kennedy management instruction
KSC	John F. Kennedy Space Center
LH_2	liquid hydrogen
LHe	liquid helium
LN_2	liquid nitrogen
LO_2	liquid oxygen
MIL	military
MILA	Merritt Island Launch Area
MMH	monomethylhydrazine
MPa	megapascal
MS	military standard
MSFC	George C. Marshall Space Flight Center
MUA	Material Usage Agreement
M&P	materials and processes
NAS	National Aerospace Standard
NASA	National Aeronautics and Space Administration
NCSL	National Conference of Standards Laboratories
NDT	nondestructive test
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NHB	NASA handbook
NIST	National Institute of Standards and Technology
NPD	NASA Policy Directive
NH_3	ammonia
N_2H_4	hydrazine
N_2O_4	nitrogen tetroxide
OMD	operations and maintenance documentation
ORD	operational readiness date
PC	printed circuit
PCB	polychlorobiphenyl
PGOC	Payload Ground Operations Contract
PHE	Propellant Handlers Ensemble

ABBREVIATIONS AND ACRONYMS (cont)

ppb	part per billion
psi	pound per square inch
RF	radio frequency
RH	relative humidity
SAE	Society of Automotive Engineers
SCAPE	self-contained atmospheric protective ensemble
SCC	stress corrosion cracking
SFOC	Space Flight Operations Contract
SI	System International
SPEC	specification
STD	standard
STS	Space Transportation System
TM	technical manual
UFAS	Uniform Federal Accessibility Standard
USTDC	University-Affiliated Spaceport Technology and Development Contract
VAFB	Vandenberg Air Force Base
WB	wet bulb
YA	Spaceport Engineering and Technology Directorate
°C	degree Celsius
°F	degree Fahrenheit
%	percent

JOHN F. KENNEDY SPACE CENTER, NASA

FACILITY, SYSTEM, AND EQUIPMENT GENERAL DESIGN REQUIREMENTS

1. SCOPE

1.1 Introduction. – This document establishes the general characteristics, performance, design, test, safety, reliability, maintainability, and quality assurance requirements for facilities, systems, and equipment intended for use at the John F. Kennedy Space Center (KSC), NASA, or other KSC-responsible locations. This document specifies the minimum requirements to provide simple, robust, safe, reliable, maintainable, environmentally compatible, and cost-effective facilities and ground support equipment (GSE) necessary to support space vehicle launch operations at KSC.

1.2 Applicability. – The current revision of this document shall be applicable to the design of all new facilities and GSE. The revision of this document that was current at the time direction was issued to design, construct, manufacture, or procure the facility or GSE shall be applicable for the useful life of the hardware. Modifications of existing hardware may be done so the modified hardware complies with the revision that is current at the time directions are issued to modify the hardware.

The requirements of this document are optional for hardware used only at the manufacturing, development, or test sites prior to arrival at the launch, landing, and retrieval sites. This document applies to the design of ground-based hardware and software used to support the operations of transporting, receiving, handling, assembly, test, checkout, service, and launch of space vehicles and payloads at the launch, landing, and retrieval sites. The criteria specified in this document are recommended for high-risk programs and projects. Projects for medium- and low-risk programs may use the criteria stated herein at the discretion of the program/project office.

This document applies to facility, systems, and equipment projects accomplished by KSC contractor personnel (e.g., Space Flight Operations Contract [SFOC], Joint Base Operations Support Contract [JBOSC], Checkout and Payload Processing Services [CAPPS], Engineering Development Contract [EDC], and University-Affiliated Spaceport Technology and Development Contract [USTDC]) to the extent specified in the contracts.

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.

2.1 Governmental.

2.1.1 Specifications.

National Aeronautics and Space Administration (NASA)

NASA-SPEC-5004	Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities, Specification for Ref. 3.3.3.3.1

John F. Kennedy Space Center (KSC), NASA

KSC-C-123	Surface Cleanliness of Fluid Systems, Specification for Ref. 3.3.3.3.6, 5.5
KSC-E-165	Electrical Ground Support Equipment, Fabrication, Specification for Ref. 3.3.2.3.3, 3.3.3.2.17
KSC-F-124	Fittings, Flared Tube, Specification for Ref. 3.3.3.2.3
KSC-SPEC-E-0002	Modular Enclosures (Cabinets, Consoles) and Accessories, Radio Frequency Interference Shielded, Specification for Ref. 3.3.3.2.16
KSC-SPEC-E-0017	Electrical Power Cables, Installation of, Specification for Ref. 3.3.1.5.f
KSC-SPEC-E-0029	Compound, Potting and Molding, Elastomeric, Specification for Ref. 3.3.3.1.8
KSC-SPEC-E-0031	Electrical Cables, General Specification for Ref. 3.3.3.2.7
KSC-SPEC-F-0006	Heat and Blast Protection Coating Materials Ref. 3.3.3.1.7

KSC-SPEC-G-0002	Compiling Construction Cost Estimates Ref. 3.3.1.c
KSC-SPEC-G-0003	Ground Support Equipment Cost Estimating Ref. 3.3.2.4
KSC-SPEC-P-0012	Refractory Concrete, Specification for Ref. 3.3.3.1.6
KSC-SPEC-Z-0005	Brazing – Steel, Copper, Aluminum, Nickel, and Magnesium Alloys, Specification for Ref. 3.3.3.3.2
KSC-SPEC-Z-0006	Induction Brazing, Aerospace Tubing Fittings, Specification for Ref. 3.3.3.3.2
KSC-SPEC-Z-0007	Tubing, Steel, Corrosion Resistant, Types 304 and 316, Seamless, Annealed, Specification for Ref. 3.3.3.2.3
KSC-SPEC-Z-0008	Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies, Fabrication and Installation of, Specification for Ref. 3.3.3.3.4
KSC-SPEC-Z-0009	Lubrication, Thread, Corrosion-Resistant Steel and Aluminum Alloy Tube Fittings, Specification for Ref. 3.3.3.3.5
KSC-SPEC-Z-0013	Penetrant, Magnetic Particle and Ultrasonic Inspection, Requirements for, Specification for Ref. 4.2.2
KSC-W-167	Wiring Programming System Patchboards, Specification for Ref. 3.3.2.3.3

79K03040	Transducer, Temperature, Platinum Resistance, Specification for Ref. 3.3.3.2.13
79K03436	Measuring System, Flow, Specification for Ref. 3.3.3.2.13
79K03437	Discrete Valve Position Indicator, Specification for Ref. 3.3.3.2.13
79K03438	Transducer, Pressure, Specification for Ref. 3.3.3.2.13
79K03439	Resistance Temperature Bulb Signal Conditioner, Specification for Ref. 3.3.3.2.13
79K03440	Thermocouple Signal Conditioner With Reference Junction Compensation, Specification for Ref. 3.3.3.2.13
79K03441	Low-Level Thermocouple Reference Junction, Specification for Ref. 3.3.3.2.13
79K03442	Discrete Liquid Sensor and Signal Conditioner, Specification for Ref. 3.3.3.2.13
79K03444	Strain Gage Signal Conditioner, Specification for Ref. 3.3.3.2.13
79K03446	Accelerometer, Specification for Ref. 3.3.3.2.13
79K03447	Transducer, Pressure, Current Output, Specification for Ref. 3.3.3.2.13

79K03448	Probe, Thermocouple, Temperature Sensing, Specification for Ref. 3.3.3.2.13
79K03449	Precision Temperature Bulb With Integral Electronics, Specification for Ref. 3.3.3.2.13
79K03450	Discrete Liquid Sensor With Integral Electronics, Specification for Ref. 3.3.3.2.13
79K03454	Transducer, Load Cell, Specification for Ref. 3.3.3.2.13
79K07981	Hazardous Gas Detection System (HGDS), Specification for Ref. 3.3.3.2.13
79K08419	Hydrogen Leak Detection Sensors, Specification for Ref. 3.3.3.2.13
79K08420	Fixed Hypergolic Vapor Detectors, Specification for Ref. 3.3.3.2.13
79K08421	UV Fire Detector, Specification for Ref. 3.3.3.2.13
79K11356	Portable Hypergolic Vapor Detector (MMH), Specification for Ref. 3.3.3.2.13
79K11357	Portable Hypergolic Oxidizer Vapor Detection Unit, Specification for Ref. 3.3.3.2.13
79K13307	Electronic Control Module Assembly, Specification for Ref. 3.3.3.2.13

79K13308	Printed Wiring Board Assembly, Electronic Control Module, Specification for Ref. 3.3.3.2.13
79K13513	Flow Sensor Simulator/Monitor Assembly, Specification for Ref. 3.3.3.2.13
79K13574	Transducer Simulator Assembly, Specification for Ref. 3.3.3.2.13
79K14192	Converter, Variable Resistance to DC Voltage, Specification for Ref. 3.3.3.2.13
79K14193	Four Channel Isolation Amplifier, Specification for Ref. 3.3.3.2.13
79K14343	AC Current Sensor, Specification for Ref. 3.3.3.2.13
79K14344	DC Current Sensor, Specification for Ref. 3.3.3.2.13
79K18341	Transducer, Watt, Specification for Ref. 3.3.3.2.13
79K22638	Solderless Electrical Connections Procedures, Specification for Ref. 3.3.3.3.8
79K28125	Fiber Optic Cable, Specification for Ref. 3.3.3.2.9
79K32799	UV/IR Fire Detector, Specification for Ref. 3.3.3.2.13
79K33019	Transducer, Mass Flow, Specification for Ref. 3.3.3.2.13

79K33031	McMillan Flow Sensor/Model 100-6, Specification for Ref. 3.3.3.2.13
79K33161	Roton Air Flow Switch, Specification for Ref. 3.3.3.2.13
79K33328	Portable Hypergolic Oxidizer Vapor Detection Unit, Specification for Ref. 3.3.3.2.13
79K33395	Voltage Transducer, Solid Rocket Booster, Specification for Ref. 3.3.3.2.13
79K33689	Temperature Transmitter/Relative Humidity, Specification for Ref. 3.3.3.2.13
79K34313	Portable Hypergolic Fuel Vapor Detector at 10 ppb, Specification for Ref. 3.3.3.2.13

Lyndon B. Johnson Space Center (JSC), NASA

NSTS 08060	System Pyrotechnic Specification Ref. 3.3.2.3.10

George C. Marshall Space Flight Center (MSFC), NASA

MSFC-SPEC-222	Resin Compounds, Electrical and Environmental Insulation, Epoxy Ref. 3.3.3.1.8
MSFC-SPEC-515	Material, Potting, and Molding, Elastomeric, Urethane Ref. 3.3.3.1.8

Military

MIL-C-5015	Connectors, Electrical, Circular Threaded, AN Type, General Specification for Ref. 3.3.3.2.12

MIL-C-22992	Connectors, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, General Specification for Ref. 3.3.3.2.12
MIL-C-26482 (Inactive for new design)	Connectors, Electrical (Circular, Miniature, Quick Disconnect, Environment Resisting), Receptacles and Plugs, General Specification for Ref. 3.3.3.2.12
MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect, (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for Ref. 3.3.3.2.12
MIL-H-81200	Heat Treatment of Titanium and Titanium Alloys Ref. 3.3.3.3.14
QPL-46058-78	Qualified Products, List of Products Qualified Under Military Specification MIL-I-46058 Insulating Compound, Electrical (for Coating Printed Circuit Assemblies) Ref. 3.3.3.3.12
MIL-PRF-38535	Integrated Circuits (Microcircuits) Manufacturing, General Specification for Ref. 3.3.2.3.9
MIL-PRF-39012/1	Connectors, Plug, Electrical, Coaxial, Radio Frequency, (Series N (Cabled), Pin Contact, Class 2) Ref. 3.3.3.2.12.1
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper Ref. 3.3.3.2.11

MIL-W-16878	Wire, Electrical, Insulated, General Specification for Ref. 3.3.3.2.11
MIL-W-22759	Wire, Electrical, Fluoropolymer-Insulated Copper or Copper Alloy Ref. 3.3.3.2.11

2.1.2 Standards.

National Aeronautics and Space Administration (NASA)

NASA-STD-5005	Ground Support Equipment Ref. 3.1.2
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment Ref. 3.2.2.3
NASA-STD-8719.9	Standard for Lifting Devices and Equipment Ref. 3.3.1.4.b, 3.3.2.2.h, 4.2.1
NASA-STD-8719.11	Safety Standard for Fire Protection Ref. 3.3.1.4.a, 3.3.1.5.c
NASA-STD-8719.13	Software Safety Standard Ref. 3.3.2.3.8
NPD 8820.1	Design and Construction of Facilities
NPG 8820.2	Facility Project Implementation Handbook (FPIH)

John F. Kennedy Space Center (KSC), NASA

KSC-STD-132	Potting and Molding Electrical Cable Assembly Terminations, Standard for Ref. 3.3.3.3.9

KSC-STD-141	Load Test Identification and Data Marking, Standard for Ref. 3.3.5.2, 4.2.1
KSC-STD-164	Environmental Test Methods for Ground Support Equipment, Standard for Ref. 3.2.5.7
KSC-STD-E-0001	Design of Electrical Control and Monitor Systems, Equipment (GSE), and Panels, Standard for Ref. 3.3.2.3.1
KSC-STD-E-0002	Hazardproofing of Electrically Energized Equipment, Standard for Ref. 3.2.5.6, 3.3.1.5.d, 3.3.2.3.6
KSC-STD-E-0004	Pneumatic and Hydraulic Mechanical Components, Electrical Design, Standard for Ref. 3.3.2.3.2
KSC-STD-E-0006	Instrumentation and Communication Cable Applications, Standard for Ref. 3.3.3.2.8
KSC-STD-E-0009	Cable Numbering, Outside Plant Communication System, Standard for Ref. 3.3.5.8
KSC-STD-E-0010	Soldering of Electrical Connections (Hand or Machine), Standard for Ref. 3.3.3.3.3
KSC-STD-E-0011	Electrical Power Receptacles and Plugs, Standard for Ref. 3.3.3.2.5
KSC-STD-E-0012	Facility Grounding and Lightning Protection, Standard for Ref. 3.3.1.5.a, 3.3.1.5.b, 3.3.2.3.5, 3.3.2.3.7

KSC-STD-E-0014	Wire and Cable Applications, Standard for Ref. 3.3.3.2.6
KSC-STD-E-0015	Marking of Ground Support Equipment, Standard for Ref. 3.3.5.1, 3.3.5.6.b
KSC-STD-E-0021	KSC Telecommunications Premises Distribution Systems, Design of, Standard for Ref. 3.3.1.5.h
KSC-STD-F-0004	Fire Protection Design, Standard for Ref. 3.3.1.4.a, 3.3.1.5.c
KSC-STD-G-0003	Launch Support and Facility Components, Qualification of, Standard for Ref. 3.7
KSC-STD-P-0006	Quick Release Pins and Pin Tethers, Standard for Ref. 3.3.2.1.h
KSC-STD-SF-0004	Ground Piping Systems Color Coding and Identification, Safety Standard for Ref. 3.3.5.3
KSC-STD-Z-0004	Structural Design, Standard for Ref. 3.3.1.3.a, 3.3.1.3.e, 3.3.2.1.a, 3.3.3.1.2
KSC-STD-Z-0005	Design of Pneumatic Ground-Support Equipment, Standard for Ref. 3.3.2.2.a, 3.3.2.2.e
KSC-STD-Z-0006	Design of Hypergolic Propellants Ground Support Equipment, Standard for Ref. 3.3.2.2.c
KSC-STD-Z-0007	Design of Hydrocarbon Fuel Ground Support Equipment, Standard for Ref. 3.3.2.2.d

KSC-STD-Z-0008	Design of Ground Life Support Systems and Equipment, Standard for Ref. 3.3.2.2.a, 3.3.2.2.g
KSC-STD-Z-0009	Design of Cryogenic Ground Support Equipment, Standard for Ref. 3.3.2.2.b
KSC-STD-Z-0010	Environmental Control Systems, Ground Coolant Systems, Coolant Servicing Systems, and Ground Support Equipment, Design of, Standard for Ref. 3.3.2.2.f
KSC-STD-Z-0012	Flame Deflector Design, Standard for Ref. 3.3.2.1.c

George C. Marshall Space Flight Center (MSFC), NASA

MSFC-STD-156	Riveting, Fabrication, and Inspection, Standard for Ref. 3.3.3.3.7
MSFC-STD-486	Standard, Threaded Fasteners, Torque Limits for Ref. 3.3.2.2.k
MSFC-STD-3029	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments Ref. 3.3.3.1.2

Federal

FED-STD-595	Colors Used in Government Procurement Ref. 3.2.2.4

Military

MIL-STD-129	Military Marking Ref. 5.6

MIL-STD-171	Finishing of Metal and Wood Surfaces Ref. 3.3.3.3.13
MIL-STD-461	Requirements for the Control of Electro-magnetic Interference Characteristics of Subsystems and Equipment Ref. 3.3.4
MIL-STD-889	Dissimilar Metals Ref. 3.3.3.1.3
MIL-STD-1472	Human Engineering Ref. 3.2.6, 3.3.9.1
MIL-STD-2073-1	Standard Practice for Military Packaging Ref. 5.1

2.1.3 Drawings.

John F. Kennedy Space Center (KSC), NASA

79K01010	Cable Identification Marker Tape Ref. 3.3.5.7
79K11622	Advanced Schematic and Selection Guide for Relay and Diode Modules Ref. 3.3.3.2.14
79K19600	Electrical Cable Fabrication Requirements Ref. 3.3.3.3.10, 3.3.5.7

2.1.4 Handbooks.

National Aeronautics and Space Administration (NASA)

NASA-HDBK-1001	Terrestrial Environment (Climatic) Criteria Handbook for Use in Aerospace Vehicle Development Ref. 3.2.5.1
NPG 8715.3	NASA Safety Manual Ref. 3.3.8

John F. Kennedy Space Center (KSC), NASA

KHB 1200.1	Facilities, Systems, and Equipment Management Handbook Ref. 3.3.1.a, 3.3.1.b
KHB 1610.1	KSC Security Handbook Ref. 3.3.10
KHB 1700.7	Space Shuttle Payload Ground Safety Handbook Ref. 3.3.8
KHB 1710.2	Kennedy Space Center Safety Practices Handbook Ref. 3.1.3, 3.2.3, 3.3.2.2.o, 3.3.8
KHB 5310.1	Reliability, Maintainability and Quality Assurance Handbook Ref. 3.2.3, 3.3.3.2.2, 4
KHB 8800.6	KSC Environmental Control Handbook Ref. 3.3.1.d, 3.3.1.2

Spaceport Engineering and Technology Directorate (YA), KSC

KSC-DM-3673	SI (Metric) Handbook Ref. 3.2.2.5

Military

MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures Ref. 3.3.3.1
MIL-HDBK-17	Polymer Matrix Composites Ref. 3.3.3.1
MIL-HDBK-149	Rubber Ref. 3.3.3.1

MIL-HDBK-454	Electronic Equipment, General Guidelines for Ref. 3.3.2.3.3, 3.3.2.3.9, 3.3.3.1.9
MIL-HDBK-695	Rubber Products: Recommended Shelf Life Ref. 3.2.2.1
MIL-HDBK-700	Plastics Ref. 3.3.3.1
MIL-HDBK-5961	List of Standard Semiconductor Devices Ref. 3.3.3.2.2

National Institute of Standards and Technology (NIST)

NIST Handbook 105-1	Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures Ref. 3.3.5.6.f

2.1.5 Technical Manuals and Reports.

Military

TO 31W3-10-22	Telecommunications Engineering, Outside Plant Telephone Ref.3.3.1.5.g
EWR 127-1	Range Safety Requirements Ref. 3.3.8

John F. Kennedy Space Center (KSC), NASA

GP-425	Fluid Fitting Engineering Standards Ref. 3.3.3.2.3
GP-435	Engineering Drawing Practices Ref. 3.3.3, 3.4.1
GP-777	Handbook for Exterior Electrical Enclosures Ref. 3.3.3.2.15

GP-864 Volume IIA	Electrical Cables Handbook Ref. 3.3.2.3.11
GP-1059	Environment and Test Specifications Levels Ground Support Equipment for Space Shuttle System at Launch Complex 39 Volumes I Through IV Ref. 3.2.5.2
KSC-DD-804	Kennedy Space Center Complex Control System (KCCS) Design Guide for A-E Ref. 3.3.1.5.e
KSC-DD-818-TR	Summary of Measurements of KSC Launch-Induced Environmental Effects (STS-1 Through STS-11) Ref. 3.2.5.2
KSC-DM-3649	Lift-off Response Spectra to Launch-Induced Acoustic Pressures Ref. 3.2.5.2
TM-584	Corrosion Control and Treatment Manual Ref. 3.2.2.3, 3.3.1.3.b, 3.3.2.1.e
TM-667	Design Requirements and Practices for Protection From Lightning-Induced Effects Ref. 3.3.2.3.7

2.1.6 Management Instructions.

National Aeronautics and Space Administration (NASA)

NPD 8010.2	Use of the Metric System of Measurement in NASA Programs Ref. 3.2.2.5

John F. Kennedy Space Center (KSC), NASA

KMI 1860.1	KSC Radiation Protection Program Ref. 3.3.8.1

2.1.7 Procedures.

KDP-KSC-P-1535	Design Review Process Ref. 3.3.3
KNPG 8072.1	KSC Materials and Processes (M&P) Control Procedures and Guidelines Ref. 3.3.3, 3.3.3.1, 3.3.3.1.5

2.1.8 Technical Instructions.

KTI-5210	Material Selection List for All Oxygen and Air Services Ref. 3.3.3.1.5.1
KTI-5211	Material Selection List for Reactive Fluid Service Ref. 3.3.3.1.1, 3.3.3.1.5.2
KTI-5212	Material Selection List for Plastic Films, Foams, and Adhesives Ref. 3.3.3.1.10

2.1.9 Other Publications.

John F. Kennedy Space Center (KSC), NASA

K-STSM-14.2.1	KSC Payload Facility Contamination Control Requirements/Plan Ref. 3.3.1.4.d
KSC-DF-107	DE Technical Documentation Style Guide Ref. 3.4.2, 4.2.3

Lyndon B. Johnson Space Center (JSC), NASA

SW-E-0002	Ground Support Equipment General Design Requirements Space Shuttle Ref. Foreword, 3.1.2, 3.2.5.8
SSP 50004	Ground Support Equipment Design Requirements Ref. Foreword, 3.1.2

Federal

Code of Federal Regulations (CFR)

10 CFR 435	Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings Ref. 3.3.1.e
29 CFR 1910	Occupational Safety and Health Standards Ref. 3.3.2.1.d, 3.3.2.2.a, 3.3.8, 3.3.9.2
36 CFR 1190	Minimum Guidelines and Requirements for Accessibility Design Ref. 3.3.1.1.c
40 CFR 355	Emergency Planning and Notification Ref. 3.3.3.1.4
40 CFR 372	Toxic Chemical Release Reporting: Community Right-To-Know Ref. 3.3.3.1.4
49 CFR 171 through 181	Subchapter C, Hazardous Materials Regulations Ref. 3.3.2.2.o
UFAS	Uniform Federal Accessibility Standards for Federal Facilities Ref. 3.3.1.1

State of Florida

7 FAC 15C-1	Anchor and Tie-Down Installation Standards for Mobile/Manufactured Homes and Park Trailers Ref. 3.3.1.3.d

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

2.2 Non-Governmental.

American Institute of Aeronautics and Astronautics (AIAA)

AIAA R-100	Recommended Practice for Parts Management Ref. 3.3.3.2.2

(Application for copies should be addressed to the American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344.)

American National Standards Institute (ANSI)

ANSI A10.8	Safety Requirements for Scaffolding Ref. 3.3.2.1.d
ANSI B30.1	Safety Code for Jacks Ref. 3.3.1.4.c, 3.3.2.2.m

(Applications for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.)

American National Standards Institute/Electronic Industries Alliance (ANSI/EIA)

ANSI/EIA 310	Cabinets, Racks, Panels, and Associated Equipment Ref. 3.3.3.2.16

(Application for copies should be addressed to the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834.)

American National Standards Institute/Electrostatic Discharge Association

ANSI/ESD S20.20	Development of an Electrostatic Discharge Control Program for: Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Ref. 3.3.3.3.11

(Application for copies should be addressed to the Electrostatic Discharge Association, 7900 Turin Road, Bldg. 3, Suite 2, Rome, NY 13440-2079.)

American National Standards Institute/National Conference of Standards Laboratories (ANSI/NCSL)

ANSI/NCSL Z540-1	Calibration Laboratories and Measuring and Test Equipment – General Requirements Ref. 4.2.4

(Application for copies should be addressed to the National Conference of Standards Laboratories, 1800 30th Street, Suite 305B, Boulder, CO 80301-1026.)

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

No number	ASHRAE Handbooks Ref. 3.3.1.4.d

(Application for copies should be addressed to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 1791 Tullie Circle, N.E., Atlanta, GA 30329-2305.)

American Society of Mechanical Engineers (ASME)

ASME B31.3	Process Piping Ref. 3.3.2.2.e
ASME Boiler and Pressure Vessel Code, Section VIII	Rules for Construction of Pressure Vessels Ref. 3.3.2.2.o, 3.3.3.3.1

(Application for copies should be addressed to the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990.)

American Society for Testing and Materials (ASTM)

IEEE/ASTM SI 10	Standard for Use of the International System of Units (SI): The Modern Metric System Ref. 3.2.2.5
ASTM MNL36	Manual for Safe Use of Oxygen and Oxygen Systems – Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation Ref. 3.3.2.2.b

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

American Welding Society, Inc. (AWS)

AWS D1.1	Steel – Structural Welding Code, Standard for Ref. 3.3.3.3.1
AWS D1.2	Structural Welding Code – Aluminum Ref. 3.3.3.3.1
AWS D1.3	Structural Welding Code – Sheet Steel Ref. 3.3.3.3.1
AWS D1.6	Structural Welding Code – Stainless Steel Ref. 3.3.3.3.1

(Application for copies should be addressed to the American Welding Society, Inc., 550 N.W. LeJeune Road, Miami, FL 33126.)

Compressed Gas Association, Inc. (CGA)

CGA C4	Method of Marking Portable Compressed Gas Containers to Identify the Material Contained Ref. 3.3.5.4
CGA C7	Guide to Preparation of Precautionary Labeling and Marking of Compressed Gas Containers Ref. 3.3.5.4

(Application for copies should be addressed to the Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4100.)

Institute of Electrical and Electronics Engineers (IEEE)

IEEE/ASTM SI 10	Standard for Use of the International System of Units (SI): The Modern Metric System Ref. 3.2.2.5

IEEE 141	Electric Power Distribution for Industrial Plants Ref. 3.3.1.5

(Applications for copies should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 3 Park Ave., 17th Floor, New York, NY 10016-5997.)

Institute for Interconnecting and Packaging Electronic Circuits (IPC)

IPC-2221	Generic Standard on Printed Board Design Ref. 3.3.3.2.17
IPC-2222	Sectional Design Standard for Rigid Organic Printed Boards Ref. 3.3.3.2.17

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 2215 Sanders Road, Northbrook, IL 60062-6135.)

International Standards Organization (ISO)

ISO 9001	Quality management systems – Requirements Ref. 4
ISO 14625	Space systems – Ground support equipment for use at launch, landing, or retrieval sites - General requirements Ref. Foreword, 3.1.2
ISO 15389	Space systems – Flight-to-ground umbilicals Ref. 3.3.2.2.j

(Application for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

National Electrical Manufacturers Association (NEMA)

MG 1	Motors and Generators Ref. 3.3.3.2.18

ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More than 2000 Volts AC or 750 Volts DC Ref. 3.3.3.2.18

(Application for copies should be addressed to the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.)

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code Handbook Ref. 3.2.5.6, 3.3.1.5, 3.3.2.3.4, 3.3.3.2.10, 3.3.3.2.18

(Application for copies should be addressed to the National Fire Protection Association, One Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.)

Society of Automotive Engineers (SAE) International

SAE-AMS-H-6088	Heat Treatment of Aluminum Alloys Ref. 3.3.3.3.14
SAE-AMS-H-6875	Heat Treatment of Steel Raw Materials Ref. 3.3.3.3.14
SAE-ARP1247	General Requirements for Aerospace Ground Support Equipment, Motorized and Nonmotorized Ref. 3.3.2.2.n
SAE-AS8090	Mobility, Towed Aerospace Ground Equipment, General Requirements for Ref. 3.3.2.2.n

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

Spring Manufacturers Institute

No number	Handbook for Spring Design Ref. 3.3.2.2.i

(Application for copies should be addressed to the Spring Manufacturers Institute, 2001 Midwest Road, Suite 106, Oak Brook, IL 60523-1335.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

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 regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

The general design requirements and criteria specified herein shall be the minimum requirements necessary to meet the needs and expectations of internal KSC customers (e.g., Safety, Reliability, Maintainability, Quality, Supportability) in a cost-effective manner. In order to meet customer expectations, individual facility, system, and equipment design projects may need requirements that are more stringent than those specified herein. In such cases, requirements that exceed the provisions specified herein shall be determined by the responsible design organization in consultation with its customers (e.g., owner, user, operator).

3.1 Classifications. – For this document, the following classifications for facilities, systems, and equipment shall apply:

3.1.1 Facilities. – The facilities specified in this document shall be classified as conventional and nonconventional facilities of KSC at the Merritt Island Launch Area (MILA), Cape Canaveral Air Force Station (CCAFS), Vandenberg Air Force Base (VAFB), landing and retrieval sites, and any other location where facilities are or will be under KSC operational control.

3.1.1.1 Conventional (Institutional or Support) Facilities. – Conventional facilities are office buildings, laboratory buildings, auditoriums, libraries, warehouses, cafeterias, shops, walkways, utility systems, and other facilities whose structures are characterized by well-established design precedents and loading conditions. The characterization of a facility as conventional does not preclude the use of more stringent standards or specifications for nonconventional structures within the facility.

3.1.1.2 Nonconventional Facilities. – Nonconventional facilities are facilities that are program oriented or experimental in nature and include test stands, launch complexes, operational or research facilities, towers, and similar special-purpose facilities whose structures are characterized by unusual or inadequately defined loading conditions, a lack of established design precedent, or

frequent modifications to support changes in the operational requirements. The characterization of a facility as nonconventional does not preclude the use of other standards or specifications for conventional structures within the facility.

3.1.2 Ground Support Equipment. – GSE designed in accordance with the requirements specified herein satisfies the requirements of SW-E-0002 or SSP 50004, NASA-STD-5005, and ISO 14625. GSE covered by this document shall be classified according to one of the following functional designations.

3.1.2.1 Servicing. – Servicing GSE is required for supplying electrical power or fluids to the flight hardware and/or associated GSE. Typical functions of servicing GSE are those functions of storage, transfer, flushing, purging, pressurizing, conditioning, vapor disposal, and decontamination of propellants and other fluids required by the flight hardware.

3.1.2.2 Checkout and Test. – Checkout and test GSE is defined as equipment required in the test and checkout of flight hardware and/or associated GSE. Typical functions of checkout and test GSE are the functions of stimuli monitoring and evaluation.

3.1.2.3 Handling and Transportation. – Handling and transportation GSE is defined as equipment required for the movement and support of flight hardware and/or associated GSE. Typical equipment in the handling and transportation category are jacks, hoists, slings, dollies, trailers, shipping containers, support stands, strongbacks, and special handling mechanisms (e.g., Payload Ground Handling Mechanism, Vertical Payload Handling Device).

3.1.2.4 Auxiliary. – Auxiliary GSE is defined as equipment that aligns, accesses, protects, and calibrates flight hardware. Auxiliary GSE includes, but is not limited to, protective devices, access stands, platforms, and alignment or calibration hardware.

3.1.2.5 Umbilical. – An umbilical is defined as GSE that interfaces directly with flight hardware in order to transfer fluids, electrical power, or electronic signals to and from the flight vehicle element.

3.1.3 Criticality. – Under each functional designation, GSE (or system) shall be classified by criticality in accordance with KHB 1710.2, Annex H, whereby the GSE:

a. Either physically or functionally interfaces with flight hardware/software.

b. Is classified as safety critical.

c. Generates data used in determining flight worthiness/certification.

The GSE or system is assessed as critical if loss of the GSE or overall system function or improper performance could result in loss of life, loss of flight hardware, or damage to flight hardware.

3.1.4 Configuration Control. – Facilities, systems, and equipment defined herein shall be subject to the configuration control requirements specified in program/project plans and specifications.

3.2 Characteristics.

3.2.1 Performance Characteristics.

3.2.1.1 Operability. – Facilities, systems, and equipment shall meet the flight hardware operational requirements that the GSE is associated with and shall be designed to ensure they do not degrade or contaminate associated flight or ground systems, subsystems, or experiments during use, checkout, servicing, or handling.

3.2.1.2 Interfaces. – Facilities, systems, and equipment shall meet the requirements of all interfaces with new or existing hardware or software. Future system/facility compatibility shall be in accordance with identified interfaces. Facility and GSE hardware shall meet the requirements of the applicable interface control document (ICD).

3.2.1.3 Producibility. – Facility, system, and equipment hardware shall provide for ease of production, manufacture, construction, and inspection. Special care shall be taken to avoid imposing close manufacturing tolerances unless required by design and performance.

3.2.2 Physical Characteristics.

3.2.2.1 Limited Life. – Use of items with a limited life shall be avoided whenever possible. Items with limited life shall be identified. Identified limited-life items shall be controlled from the date of manufacture through operational use, including storage. Provisions will be made for replacement or refurbishment of these items after a specified age or operating time/cycle. Status of limited-life cycle items and waivers on limited-life items shall be maintained. Elapsed time or cycle indicators shall be employed to accumulate operational time or cycles if critical. Age control of elastomeric parts shall be in accordance with MIL-HDBK-695.

3.2.2.2 Useful Life. – Hardware shall be designed for a useful life appropriate to its mission. When a useful life is not identified by program or mission requirements, a goal of 10 years may be used. During this period, normal preventive maintenance, repair, or calibration may be accomplished to maintain specified performance.

3.2.2.3 Corrosion Control. – Protective coating of hardware shall be appropriate to the condition, use, and environment to which the hardware will be exposed during its life cycle. The coating shall minimize corrosion and should indicate its use (see 3.2.2.4). Guidelines for corrosion con-

trol for facilities, systems, and equipment shall be as specified in TM-584. Protective coating of hardware shall be in accordance with NASA-STD-5008.

3.2.2.4 Colors. – The following colors shall be used for the type of GSE indicated. Colors shall be in accordance with FED-STD-595.

Color	Color Chip Number	GSE Type
Gray	26440 or 26251	Electrical/electronic, hydro/pneumatic consoles, racks, and cabinets
Blue	25102	Racks and consoles
Gray	16187 or 16473	Structural steel
Red	11105 or 21105	Remove before flight, safety and protective equipment
White	17875 or 27875	White room or clean room equipment
Black	37038	Panel lettering (or as specified in KSC-STD-E-0015)
Yellow	13538	Handling and transportation equipment

3.2.2.5 Metric System. – New facilities, systems, and equipment shall be designed using the metric system of measurement in accordance with NPD 8010.2. Standard practice for the use of the metric system shall be in accordance with IEEE/ASTM SI 10. Refer to KSC-DM-3673 for a compilation of the metric practices used at KSC.

3.2.2.6 Redundancy. – Redundant systems, subsystems, or components shall be physically separated or otherwise protected to ensure failure of one will not prevent the other from performing the function.

3.2.3 Reliability. – Facilities, systems, and equipment shall be designed to meet system availability and/or dependability requirements. Systems and equipment shall be designed to minimize the probability of system failure and reduce the severity of the failure effect of the system. As a minimum, systems shall be designed to be fail-safe, except for structure and pressure vessels in the rupture mode. Procedures and instructions to perform and document analyses like the Failure

Mode, Effects, and Criticality Analysis (FMECA)/Critical Items List (CIL), reliability diagrams, and in particular cases sneak circuit analysis or an equivalent shall be in accordance with KHB 1710.2, Annex H, and KHB 5310.1.

3.2.4 Maintainability. – Facilities, systems, and equipment shall be designed to minimize the complexity and duration of maintenance, maintenance resources required to keep the system operational, and maintenance downtime. High-failure-rate items should be identified for accessibility concerns. Human engineering criteria shall be used to provide accessibility to failed items. Fault detection and isolation should be considered based on criticality and cost of failures.

3.2.5 Environmental Conditions. – Hardware shall be designed to meet the demands of natural and induced environments to which it will be subjected during its life cycle.

3.2.5.1 Natural Environment. – Hardware to be used or stored in an exterior environment shall be designed so it functions at its respective geographical location after exposure to the natural environment as specified in NASA-HDBK-1001 and as tailored to reflect program-defined risk and exposure times.

3.2.5.2 Launch-Induced Environment. – Hardware designed to function during or after exposure to the Space Shuttle launch-induced environment shall be designed to withstand the environment defined in GP-1059. KSC-DD-818-TR and KSC-DM-3649 may be used in lieu of GP-1059 where actual data is available.

3.2.5.3 Controlled Interior Environment. – Hardware designed to function within a controlled interior environment shall be designed to operate under the following temperature and humidity conditions:

a. Temperature: +15 degrees Celsius (°C) (60 degrees Fahrenheit [°F]) to +27 °C (80 °F) with extremes of an uncontrolled temperature of +10 °C (52 °F) to +40 °C (105 °F) for a maximum of 1 hour.

b. Humidity: nominal 55 percent, with a range of 45 to 70 percent within the above-defined temperature range.

3.2.5.4 Controlled Clean Environment. – Hardware used in a controlled clean environment shall be designed to be operated and maintained at a cleanliness level compatible with the intended use.

3.2.5.5 Uncontrolled Interior Environment. – Hardware used in an uncontrolled interior environment shall be designed to operate in the most severe exterior environmental conditions for temperature and humidity anticipated at the respective geographical locations.

3.2.5.6 Fire/Explosion Environment. – Hardware operated in locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, liquid, gas or solid propellants, etc., as defined by NFPA 70, Article 500, shall be hazardproofed to prevent such hazardous conditions in accordance with the requirements in KSC-STD-E-0002.

3.2.5.7 Environmental Test Methods. – Environmental methods and conditions required for hardware life cycle testing and qualification shall be in accordance with KSC-STD-164.

3.2.5.8 Seismic Environment. – There are no seismic environmental requirements for facilities, systems, and equipment used at KSC. For sites other than KSC, seismic environmental requirements shall be in accordance with SW-E-0002 for GSE.

3.2.5.9 Environmental Compatibility. – All designs shall be reviewed for their impact on both the natural and workplace environment. Closed-loop systems shall be used to the maximum extent possible and, where open-loop systems are necessary, effluent management shall comply with legal requirements.

3.2.6 Transportability. – Hardware design shall take into consideration the mobility and transportability constraints imposed by the deployment and maintenance concepts, handling equipment, and planned modes of transportation (i.e., road, rail, sea, or air). If necessary, hardware shall be capable of being partially dismantled or packed in order to meet the maximum size envelopes of the transportation method to be used. Maximum compatibility with existing procedures, facilities, and equipment, including material handling equipment, shall be a design goal. Equipment to be transported by personnel shall be provided with such handling provisions (e.g., handles, hand holds) necessary to meet operational transportability requirements. Equipment that exceeds the personnel lifting limits of MIL-STD-1472 shall be provided with material handling provisions (e.g., sling, lift points, casters, skid) necessary to meet the operational requirements for installation/removal, maintenance, and use.

3.3 Design and Construction.

3.3.1 Facility Design. – Facility design shall be accomplished in accordance with the requirements specified herein.

a. Facility Siting. New facilities shall be sited or located at KSC in accordance with KHB 1200.1, Section 3, Master Planning. New facilities siting at locations other than KSC shall be in accordance with the siting guidelines of the host complex/area.

b. Real Property. New facilities, additions or expansion of facilities, exterior modification to facilities, or disposal of facilities shall require a change in the real property records of KSC in accordance with KHB 1200.1, Section 5, Real Property Accountability.

c. Cost Estimating. Cost estimates for facility construction shall be compiled in accordance with KSC-SPEC-G-0002.

d. Environmental Impact. The environmental impact of new facilities and addition or expansion of facilities shall be in accordance with KHB 8800.6.

e. Energy Efficiency. Facilities shall be designed to satisfy or exceed the energy conservation requirements and standards set forth in and referenced by 10 CFR 435.

f. Life Cycle Cost. A life cycle cost analysis shall be performed on facility projects to determine the minimum life cycle cost where alternatives are available for comparison. This analysis should include, as a minimum, complete design and construction costs, operations and maintenance costs, energy costs, and an end-of-life-cycle disposal cost of the facility and all support material used over its projected life cycle.

3.3.1.1 Accessibility Design. Accessibility shall be provided in accordance with the Americans With Disabilities Act as required by 36 CFR 1190. Accommodations for the physically handicapped shall be in accordance with Uniform Federal Accessibility Standards (UFAS).

3.3.1.2 Civil Design. – Facility civil design shall be in accordance with the requirements of KHB 8800.6.

3.3.1.3 Structural Design. – Facility structural design shall be in accordance with the following requirements:

a. Structural Steel and Other Structures. The design of facility structures (e.g., steel, aluminum, concrete) shall be in accordance with KSC-STD-Z-0004 and the requirements specified in this document.

b. Corrosion Control. Corrosion control shall be provided for facility structural design in accordance with TM-584.

c. Protective Coating. Protective coating of steel and aluminum shall be provided in accordance with NASA-STD-5008.

d. Trailer/Equipment Tiedowns. Trailer and equipment tiedowns shall be provided in accordance with 7 FAC 15C-1.

e. Foundations. Foundation design shall comply with the requirements specified in KSC-STD-Z-0004.

3.3.1.4 Mechanical Design. – Facility mechanical design shall be in accordance with the following requirements:

a. Fire Protection. Fire protection mechanical design shall be in accordance with NASA-STD-8719.11 and KSC-STD-F-0004.

b. Lifting Devices. Facility lifting device (e.g., cranes, crane girders, lifting slings, hoists) design shall be in accordance with NASA-STD-8719.9.

c. Jacks. The design of jacks shall be in accordance with ANSI B30.1.

d. HVAC. Heating, ventilating, and air-conditioning (HVAC) systems shall be designed in accordance with American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards. The design criteria specified in tables 1 and 2 describe conditions in which HVAC systems must operate. HVAC systems shall be designed to provide the controlled-environment conditions of 3.2.5.3 when operating under conditions in tables 1 and 2. The design criteria specified in table 1 shall be applied when designing noncritical air-conditioning systems such as office spaces and noncritical computer rooms and laboratories. The design conditions specified in table 2 shall be applied when designing process air-conditioning systems such as critical computer rooms, laboratories, and cargo processing levels 1 through 5 clean work areas as identified by K-STSM-14.2.1.

3.3.1.5 Electrical Design. – Facility electrical design shall be in accordance with IEEE 141, NFPA 70, and the following requirements:

a. Lightning Protection. Lightning protection for facilities shall be provided in accordance with KSC-STD-E-0012.

b. Bonding and Grounding. Bonding and grounding for facilities and equipment shall be provided in accordance with KSC-STD-E-0012.

c. Fire Protection. Fire protection electrical design shall be in accordance with NASA-STD-8719.11 and KSC-STD-F-0004.

d. Hazardproofing. Hazardproofing of electrically energized equipment shall be in accordance with KSC-STD-E-0002.

Table 1. Design Conditions for Noncritical Air-Conditioning Systems

	Temperature		Humidity (RH)	
	Summer	Winter	Summer	Winter
Ambient	32 °C (90 °F) DB	-4 °C (25 °F) WB	--	--
	27 °C (80 °F) WB	-12 °C (11°F) DP	--	--
	28 °C (82 °F) WB for cooling towers		--	--
Office spaces:				
Design	23 °C (74 °F) DB	22 °C (72 °F) DB	50%	50%
Operations	26 °C (78 °F) DB	20 °C (68 °F) DB	60% maximum	60% maximum
Computer rooms and laboratories:				
Design	23 °C (74 °F) DB	22 °C (72 °F) DB	40%	40%
Operations	24 ± 1 °C (76 ±2 °F) DB	21 ±1 °C (70 ±2 °F) DB	60% maximum	30% RH minimum with humidification required; 60% maximum
Notes: DB: dry bulb; WB: wet bulb; DP: dew point				

Table 2. Design Conditions for Critical Air-Conditioning Systems

	Temperature		Humidity (RH)	
	Summer	Winter	Summer	Winter
Ambient	36 °C (96 °F) DB	-7 °C (20 °F) WB	--	--
	27 °C (81 °F) WB	-12 °C (11 °F) DP	--	--
	28 °C (82 °F) WB for cooling towers		--	--
Design	22 °C (71 °F) DB	22 °C (71 °F) DB	40%	40%
Operations	22 ±3 °C (71 ±6 °F) DB	22 ±3 °C (71 ±6 °F) DB	30 to 50%	30 to 50% with humidification required

e. Complex Control System. Complex control system design for facilities shall be in accordance with KSC-DD-804.

f. Electrical Power Cables. Installation of electrical power cables shall be in accordance with KSC-SPEC-E-0017.

g. Outside Plant Communications. Outside plant communications cabling shall be designed in accordance with TO 31W3-10-22.

h. Premises Wiring System. Facility premises wiring design shall be in accordance with KSC-STD-E-0021.

3.3.2 GSE Design. – GSE design shall be accomplished in accordance with the requirements specified herein.

3.3.2.1 Structural Design.

a. Structural Steel and Other Structures. The design of GSE structures (e.g., access platforms, support stands) shall be in accordance with KSC-STD-Z-0004 and the requirements specified in this document.

b. Safety Factor. When there is no applicable standard, a minimum safety factor of 2 against yield or permanent deformation and 3 against ultimate failure or collapse shall be used.

c. Flame Deflector. Flame deflector design shall be in accordance with KSC-STD-Z-0012.

d. Scaffolding. Access platforms classified as scaffolding shall be designed in accordance with ANSI A10.8 and 29 CFR 1910. Commercial scaffolding specified in a design shall comply with ANSI A10.8 and 29 CFR 1910.

e. Corrosion Control. Corrosion control shall be provided for facility structural design in accordance with TM-584.

f. Protective Coating. Protective coating of steel and aluminum shall be provided in accordance with NASA-STD-5008.

g. Critical Weld. Critical welds shall be avoided wherever possible. Critical welds shall be identified by the responsible design element on the design drawings by placing a flag note in the tail of the critical weld symbol. The required appropriate nondestructive testing for critical welds shall also be identified by the responsible design organization in the general notes on the design drawings.

h. Quick Release Pins. Quick release pin and pin tether installation shall conform to the requirements of KSC-STD-P-0006.

3.3.2.2 Mechanical Design.

a. Pneumatics. The design of pneumatic (e.g., gaseous nitrogen, helium, oxygen, hydrogen, breathing air, and special oxygen/nitrogen mixtures) servicing systems and equipment shall be in accordance with the requirements of KSC-STD-Z-0005. Vacuum systems or compressed air systems with an operating gage pressure of 1.7 megapascals (MPa) (250 pounds per square inch [psi]) or less shall be designed in accordance with accepted industry standards. Breathing air systems shall conform to 29 CFR 1910 and KSC-STD-Z-0008.

b. Cryogenics. The design of cryogenic (i.e., liquid hydrogen [LH_2], liquid oxygen [LO_2], and liquid nitrogen [LN_2]) servicing systems shall be in accordance with KSC-STD-Z-0009. Oxygen systems shall comply with the guidelines established in ASTM MNL36. The design of cryogenic liquid helium (LHe) servicing systems shall be in accordance with accepted industry standards.

c. Hypergols. The design of the following hypergolic fuel (i.e., monomethylhydrazine [MMH], nitrogen tetroxide [N_2O_4], hydrazine [N_2H_4], and aerozine 50 [A-50]) servicing systems and equipment shall be in accordance with the provisions of KSC-STD-Z-0006.

d. Hydrocarbons. The design of hydrocarbon fuel (i.e., JP-4, JP-5, RP-1, and American Society for Testing and Materials [ASTM] jet fuel A and B) servicing and storage systems and equipment shall be in accordance with KSC-STD-Z-0007.

e. Hydraulics. The design of hydraulic servicing systems and equipment shall be in accordance with ASME B31.3 and in accordance with KSC-STD-Z-0005 as a guide for principles common to both hydraulics and pneumatics.

f. Environmental Control System (ECS) and Coolant Servicing Systems. The design of ECS and coolant servicing systems and equipment used to condition and control the environment within selected space vehicle compartments shall be in accordance with KSC-STD-Z-0010.

g. Life Support. The design of life support systems and equipment used or worn by personnel involved in toxic material operations, emergency rescue operations, and all activities where the possibility of exposure to hazardous atmosphere exists shall be in accordance with KSC-STD-Z-0008.

h. Lifting Devices. The design of lifting devices (e.g., cranes, crane girders, hoists, lifting slings) shall be in accordance with NASA-STD-8719.9.

i. Springs. Spring design shall be in accordance with the Handbook for Spring Design published by the Spring Manufacturers Institute.

j. Umbilical Design. The design of umbilicals shall use ISO 15389 as a guide.

k. Torque Limits. Threaded fasteners that require torquing shall use the torque limit criteria specified in MSFC-STD-486, as a minimum.

l. Tethers. Equipment used in areas where the dropping of hardware could result in injury to personnel or damage to flight hardware shall be tethered.

m. Jacks. The design of jacks shall be in accordance with ANSI B30.1.

n. Transportation Equipment. Transporters and other motorized GSE used for transportation of flight elements shall be designed to system specifications compiled from appropriate sections of SAE-ARP1247B, SAE-AS8090, and other industry and military specifications applicable to the characteristics of the desired end item. GSE requiring mobility shall be designed in accordance with applicable sections of SAE-AS8090.

o. Pressure Vessels. All pressure vessels for use in GSE shall be designed, constructed, tested, and certified in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2, and KHB 1710.2. All ASME code-stamped vessels shall be registered with the National Board of Boiler and Pressure Vessel Inspectors. Pressure vessels utilized for product transportation shall meet the Department of Transportation requirements, 49 CFR 171 through 181.

3.3.2.3 Electronic Design.

3.3.2.3.1 Electrical Control and Monitor Equipment. – The design of electrical control and monitor systems and equipment shall be in accordance with KSC-STD-E-0001.

3.3.2.3.2 Pneumatic and Hydraulic Mechanical Components. – The electrical design for pneumatic and hydraulic mechanical components shall be in accordance with KSC-STD-E-0004.

3.3.2.3.3 Internal Wiring. – The design of internal wiring used for electrical interconnection of components or parts within electronic GSE shall be in accordance with MIL-HDBK-454 and the requirements of KSC-E-165. Wire terminations shall be in accordance with KSC-E-165. Wiring of patchboards shall be in accordance with KSC-W-167.

3.3.2.3.4 Electrical Power. – The design of electrical power for systems and equipment shall be in accordance with NFPA 70.

3.3.2.3.5 Bonding and Grounding. – Bonding and grounding shall be provided in accordance with KSC-STD-E-0012.

3.3.2.3.6 Hazardproofing. – Hazardproofing of electrically energized equipment shall be in accordance with KSC-STD-E-0002.

3.3.2.3.7 Lightning Protection. – Lightning protection for GSE located at KSC at the launch pads, hazardous processing facilities, and other hazardous areas shall be designed in accordance with KSC-STD-E-0012 and TM-667.

3.3.2.3.8 Software. – Software incorporated in the design of GSE shall follow the applicable IEEE software standards and NASA-STD-8719.13.

3.3.2.3.9 Firmware. – Firmware incorporated in the design of GSE shall meet the requirements of the appropriate MIL-PRF-38535 specification and MIL-HDBK-454 requirement.

3.3.2.3.10 Pyrotechnic Systems. – The design of pyrotechnic systems and equipment shall be in accordance with NSTS 08060.

3.3.2.3.11 Electrical Control Cables. – The design of electrical control cables should follow the guidelines in GP 864, Vol. IIA.

3.3.2.4 Cost Estimating. – Cost estimates for GSE fabrication shall be compiled in accordance with KSC-SPEC-G-0003.

3.3.2.5 Life Cycle Cost. – A life cycle cost analysis shall be performed on each project to determine the minimum life cycle cost configuration where alternatives are available for comparison.

This analysis should include, as a minimum, complete design and fabrication costs, operation and maintenance costs, energy costs, and end-of-useful-life disposal costs of the item and all support material used over the projected life cycle.

3.3.3 Materials, Parts, and Processes. – Engineering drawings shall be reviewed for compliance with all applicable materials and processes (M&P) requirements and be approved in accordance with GP-435. The design review process shall include the appropriate M&P assessments in accordance with KDP-KSC-P-1535. Selection of materials and processes shall be in accordance with the KSC materials control program, which is outlined in KNPG 8072.1.

3.3.3.1 Materials. – For establishing properties, MIL-HDBK-5 shall be used for metal, MIL-HDBK-17 shall be used for composites, MIL-HDBK-149 shall be used for rubber, and MIL-HDBK-700 shall be used for plastics. Applications for materials shall be limited to those materials that are adequately described by controlling specifications or standards of a cognizant authority. Any additional qualifying tests and inspections shall be indicated in the engineering documentation. Control documents may be created for proposed materials that lack such documentation. Noncompliance with the material requirements specified herein requires the preparation and approval of a Material Usage Agreement (MUA) in accordance with KNPG 8072.1. Material selection should include an analysis to determine the impact on the environment. Materials that are recyclable at the end of their useful life or are made from recycled material should be given a preference over materials that are not recycled.

3.3.3.1.1 Hydrogen Embrittlement. – Materials subject to hydrogen embrittlement shall not be used in applications where the material could be exposed to hydrogen. Refer to KTI-5211 for a summary of results of various materials tested in hydrogen.

3.3.3.1.2 Stress Corrosion. – Materials shall be selected from alloys that are highly resistant to stress corrosion cracking (SCC) as specified in MSFC-STD-3029.

3.3.3.1.3 Dissimilar Metals. – In accordance with MIL-STD-889, dissimilar metals shall not be used in direct contact with each other. Separation by use of barrier tape, protective coatings, or other methods of isolation shall be used in accordance with MIL-STD-889.

3.3.3.1.4 Toxic Materials or Formulations. – Toxic materials or formulations shall not be specified in facility, systems, or equipment design. Toxic products and formulations shall not be generated by a system or equipment. Typical examples of such toxic materials are mercury in liquid or vapor form, polychlorobiphenyls (PCB's), lead-based paints, chlorofluorocarbons (CFC's), and asbestos. Toxic fluids such as hydrazine (N_2H_4), nitrogen tetroxide (N_2O_4), MMH, and ammonia (NH_3) may only be used when specifically required by a flight vehicle system requirement. The use of such toxic fluids shall comply with the applicable safety regulations. Special attention should be given to eliminate the use of materials specified in 40 CFR 355 and 40 CFR 372.

3.3.3.1.5 Flammability, Odor, and Offgassing. – Materials used in hardware designed for use in direct contact with the flight vehicle element or in close proximity shall be qualified for flammability, odor, and offgassing in accordance with KNPG 8072.1.

3.3.3.1.5.1 Oxygen Service. – Only materials that are compatible with oxygen shall be selected for use in liquid or gaseous oxygen and liquid or gaseous air systems. Refer to KTI-5210 for a summary of oxygen compatibility test results for various materials.

3.3.3.1.5.2 Reactive Fluid Service. – Only materials that are compatible with reactive fluids (i.e., hydrogen, hypergols) shall be used in these systems. Refer to KTI-5211 for a summary of reactive fluids compatibility tests for various materials.

3.3.3.1.6 Refractory Concrete. – Refractory concrete used for heat and blast protection of flame deflectors and other areas of the launch pad shall be in accordance with KSC-SPEC-P-0012.

3.3.3.1.7 Heat and Blast Protection. – Coating materials used for heat and blast protection of hardware shall be in accordance with KSC-SPEC-F-0006.

3.3.3.1.8 Potting and Molding Compound. – Potting and molding compound for electrical connectors shall be in accordance with KSC-SPEC-E-0029, MSFC-SPEC-515, or MSFC-SPEC-222.

3.3.3.1.9 Fungus Resistance. – Materials susceptible to the growth of fungi shall be avoided. When these materials cannot be avoided, the material shall be treated to resist fungus. Refer to MIL-HDBK-454 for fungus-resistant materials.

3.3.3.1.10 Thin Plastic Films and Tape. – Thin plastic films and tape materials used in launch vehicle or payload processing areas shall meet the flame-retardant, antistatic, and hypergolic compatibility requirements.Refer to KTI-5212 for a summary of flammability, antistatic, and hypergolic compatibility tests for various plastic films, foams, and adhesive tapes.

3.3.3.2 Parts. – Selection of parts/components shall be in accordance with AIAA R-100 and as specified herein.

3.3.3.2.1 Use of Commercial Parts. – Commercial off-the-shelf (COTS) equipment, parts, items, or components shall be used to the maximum extent possible when (1) they satisfy the hardware function, (2) they will not degrade the safety or reliability of the flight or ground system, and (3) they provide a cost savings that will exceed possible cost increases due to unique maintenance or logistics requirements, modifications, or an increase in the complexity of the interfacing equipment. In all cases, exact materials of construction and applicable specifications shall be determined for evaluation of material compatibility with requirements. Any additional qualifying tests and inspections shall be indicated in the engineering documentation. Control documents may be created for proposed parts that lack such documentation.

3.3.3.2.2 Electrical, Electronic, and Electromechanical (EEE) Parts. – EEE parts shall be selected from AIAA R-100. Only EEE parts commensurate with the criticality of the application and the life cycle of the hardware shall be used. Determination of the EEE grade shall be based on the specific circuit function and its associated criticality in accordance with KHB 5310.1. MIL-HDBK-5961 should be used in the selection of semiconductor devices in order to control and minimize the variety of devices used by KSC.

3.3.3.2.3 Tubing and Fittings. – Flared tube fittings shall be in accordance with GP-425 and shall be procured in accordance with KSC-F-124. Flared tubing shall be in accordance with KSC-SPEC-Z-0007.

3.3.3.2.4 Fluid System Components. – Where available, fluid system components shall be selected from the 79K80000 series of specification control drawings.

3.3.3.2.5 Electrical Power Receptacles and Plugs. – Electrical power receptacles and plugs for facilities and GSE shall be in accordance with KSC-STD-E-0011.

3.3.3.2.6 Electrical Power Cable. – Sixty-hertz alternating current (ac) power cable shall be in accordance with KSC-STD-E-0014.

3.3.3.2.7 Electrical Cable. – Flexible multiconductor neoprene-jacketed electrical cable shall be in accordance with KSC-SPEC-E-0031.

3.3.3.2.8 Instrumentation and Communication Cable. – Instrumentation and communication cable shall be in accordance with KSC-STD-E-0006.

3.3.3.2.9 Fiber-Optic Cable. – Fiber optic cable shall be in accordance with 79K28125.

3.3.3.2.10 Elevator Traveling Cable. – Electrical traveling cable for elevators shall be in accordance with NFPA 70, Article 620.

3.3.3.2.11 Electrical Hookup Wire. – Electrical hookup wire shall be in accordance with MIL-W-5086, MIL-W-16878, or MIL-W-22759.

3.3.3.2.12 Connectors. – Electrical multiconductor connectors for electrical control and monitor systems and equipment shall be selected from the following basic families of connectors: MIL-C-5015, MIL-C-22992, MIL-C-26482 (inactive for new design), and MIL-DTL-38999.

3.3.3.2.12.1 Coaxial (RF) Connectors. – Coaxial (RF) connectors shall be selected from MIL-PRF-39012/1.

3.3.3.2.12.2 Protective Covers or Caps. – Protective covers or caps shall be specified for all electrical connector plugs and receptacles when they are not connected. Protective covers or caps shall meet the following requirements:

a. Be moistureproof

b. Protect sealings, surfaces, threads, and pins against damage

c. Be resistant to abrasion, chipping, and flaking

d. Comply with cleanliness requirements for plugs and receptacles on which they are used

e. Be made of material that is compatible with the connector materials

f. Be connected to the cable with suitable lanyard, chain, or hinge

g. Be nonstatic producing

3.3.3.2.13 Sensors and Transducers. – Sensors and transducers utilized in the design of Launch Processing System-related GSE at KSC shall be selected from the following list. Deviations from this list shall be approved by the affected NASA organization's director (e.g., Shuttle Operations, Space Station) or the designee.

Specification	Subject
79K03040	Transducer, temperature, platinum resistance
79K03436	Measuring system, flow
79K03437	Discrete valve position indicator
79K03438	Transducer, pressure
79K03439	Resistance temperature bulb signal conditioner
79K03440	Thermocouple signal conditioner with reference junction compensation
79K03441	Low-level thermocouple reference junction
79K03442	Discrete liquid sensor and signal conditioner

79K03444	Strain gage signal conditioner
79K03446	Accelerometer
79K03447	Transducer, pressure, current output
79K03448	Probe, thermocouple, temperature sensing
79K03449	Precision temperature bulb with integral electronics
79K03450	Discrete liquid level sensor with integral electronics
79K03454	Transducer, load cell
79K07981	Hazardous gas detection system (HGDS)
79K08419	Hydrogen leak detection sensors
79K08420	Fixed hypergolic vapor detectors
79K08421	UV fire detector
79K11356	Portable hypergolic vapor detector
79K11357	Portable hypergolic oxidizer vapor detection unit
79K13307	Electronic control module assembly
79K13308	Printed wiring board assembly, electronic control module
79K13513	Flow sensor simulator/monitor assembly
79K13574	Transducer simulator assembly
79K14192	Converter, variable resistance to direct current (dc) voltage
79K14193	Four-channel isolation amplifier
79K14343	ac current sensor
79K14344	dc current sensor

79K18341	Transducer, watt
79K32799	UV/IR fire detector
79K33019	Transducer, mass flow
79K33031	McMillan flow sensor/model 100-6
79K33161	Roton air flow switch
79K33328	Portable hypergolic oxidizer vapor detection unit
79K33329	Portable hypergolic fuel vapor detection unit
79K33395	Transducer voltage
79K33689	Temperature transmitter/relative humidity
79K34313	Portable hypergolic fuel vapor detector at 10 ppb
79K35476	Hypergolic oxidizer (N_2O_4) leak detection transducer
79K35477	Hypergolic fuel (CH_6N_2) leak detection transducer

3.3.3.2.14 Relay and Diode Modules. – Relay and diode modules shall be selected from 79K11622.

3.3.3.2.15 Exterior Electrical Enclosures. – Electrical enclosures used in exterior applications shall be in accordance with GP-777.

3.3.3.2.16 Rack, Panels, and Modular Enclosures. – Electronic racks, panels, and modular enclosures used in interior applications shall be in accordance with ANSI/EIA 310 and KSC-SPEC-E-0002.

3.3.3.2.17 Printed Circuit (PC) Boards. – PC boards shall be designed in accordance with IPC-2221 and IPC-2222. Fabrication shall be in accordance with KSC-E-165. Specifications and standards prepared and published by the Institute of Interconnecting and Packaging Electronic Circuits (IPC) may be used in applications where such use ensures acceptable items.

3.3.3.2.18 Motors. – Motors used in GSE shall be in accordance with National Electrical Manufacturers Association (NEMA) standard MG 1. Starters and controllers shall be in accordance with NEMA standards for industrial control specified in ICS 2 and NFPA 70.

3.3.3.2.19 Threaded Fasteners. – Threaded fasteners shall be limited to those items that are adequately described by controlling specifications or standards of a cognizant authority (e.g., ASTM, NAS, MS, AN). Control documents may be created for proposed fasteners that lack such documentation. Fasteners shall be selected for design utilization based upon the severity of the application. For applications where safety of personnel, damage to flight hardware, or loss of mission is a direct concern, fasteners shall be selected from items of the highest practicable quality. These critical fasteners shall have lot traceability from the manufacturer to the warehouse storage or shall have acceptance testing (chemical and physical properties, where applicable) of fasteners by lot or be proof-loaded prior to use. Other applications shall give primary consideration to reduced cost and schedule requirements.

3.3.3.3 Processes.

3.3.3.3.1 Welding. – Welding shall be in accordance with the following specifications:

Specification	Subject
AWS D1.1	Structural steel for conventional facilities
AWS D1.2	Structural aluminum for conventional facilities
AWS D1.3	Sheet steel
AWS D1.6	Stainless steel
ASME Boiler and Pressure	Pressure vessel welding and brazing Vessel Code, Section VIII
NASA-SPEC-5004	Welding of aerospace GSE and related nonconventional facilities

3.3.3.3.2 Brazing. – Brazing of steel, copper, aluminum, nickel, and magnesium alloys shall be in accordance with KSC-SPEC-Z-0005. Induction brazing shall be in accordance with KSC-SPEC-Z-0006.

3.3.3.3.3 Soldering. – Soldering shall be in accordance with KSC-STD-E-0010.

3.3.3.3.4 Tube Assembly. – Fabrication and installation of flared tube assemblies shall be in accordance with KSC-SPEC-Z-0008.

3.3.3.3.5 Fitting Lubrication. – Lubrication of flared tube fittings shall be in accordance with KSC-SPEC-Z-0009.

3.3.3.3.6 Fluid System Cleaning. – Cleaning of piping, tubing, fittings, and other fluid system components shall be in accordance with KSC-C-123. The cleanliness level and test method shall be specified based upon the application.

3.3.3.3.7 Riveting. – Riveting on facilities and equipment shall be in accordance with MSFC-STD-156.

3.3.3.3.8 Crimping. – Crimping shall be in accordance with 79K22638.

3.3.3.3.9 Potting and Molding. – Potting and molding of electrical connectors shall be in accordance with KSC-STD-132.

3.3.3.3.10 Electrical Cable Fabrication. – Electrical cable fabrication for control and monitor systems and equipment shall be in accordance with 79K19600.

3.3.3.3.11 Electrostatic Discharge (ESD). – All ESD sensitive components and assemblies shall be handled utilizing practices in accordance with ANSI/ESD S20.20.

3.3.3.3.12 Conformal Coating. – Conformal coating on printed circuit assemblies shall be in accordance with QPL-46058-78.

3.3.3.3.13 Metal Treatment and Plating. – Metal treatment (including passivation of stainless steel) and plating shall be in accordance with MIL-STD-171. Cadmium plating shall not be used.

3.3.3.3.14 Heat Treating. – All heat treating of steel shall be performed in accordance with SAE-AMS-H-6875. All heat treating of aluminum shall be performed in accordance with SAE-AMS-H-6088. Heat treating of titanium and titanium alloy parts shall meet the requirements of MIL-H-81200.

3.3.4 Electromagnetic Interference (EMI). – Electrical and electronic systems shall be designed to minimize the generation of and susceptibility to electromagnetic interference in order to eliminate any possible deterioration of performance of the system and surrounding systems. Where applicable, systems and equipment may require compliance with the requirements of MIL-STD-461. EMI characteristics may be measured in accordance with MIL-STD-461.

3.3.5 Identification Marking and Labels.

3.3.5.1 GSE. – GSE shall be identified and marked in accordance with KSC-STD-E-0015.

3.3.5.2 Load Test. – Hardware that has been load-tested satisfactorily shall be identified and marked in accordance with KSC-STD-141.

3.3.5.3 Piping Systems. – Ground piping systems shall be identified and color-coded in accordance with KSC-STD-SF-0004.

3.3.5.4 Compressed Gas Cylinders. – Compressed gas cylinders shall be marked in accordance with CGA C4 and C7.

3.3.5.5 Load Capacity. – Hardware used for hoisting, transportation, handling, and personnel access shall be conspicuously marked to indicate the maximum load capacity.

3.3.5.6 Test Weights. – Prior to first usage, all test weights shall be weighed and marked in accordance with the requirements specified herein.

a. Manufactured or fabricated test weights provided by a vendor shall be weighed and marked by the vendor prior to acceptance by the Government.

b. Marking shall be in accordance with the provisions of KSC-STD-E-0015, unless otherwise specified below.

c. Test weight marking shall be sufficiently large such that the load value is visible to the load test operator at normal working distances up to 6 meters (20 feet). Letters 150 millimeters (6 inches) high are suggested.

d. Square and rectangular test weights shall have the weight value painted in a contrasting color on two opposite sides. Markings shall be placed so they are visible when weights are stacked.

e. Cylindrical test weights shall have the weight value painted in a contrasting color at two points approximately diametrically opposite.

f. Large class F field standard weights up to 4.5 megagrams (10,000 pounds) used as test weights shall conform to the marking requirements of NIST Handbook 105-1, Section 8.

g. After initial marking, test weights shall not be reweighed and remarked unless the test weights are modified or the physical marking is lost. If the test weights are modified in such a way as to significantly change the weight, then they shall not be used until they are reweighed and remarked.

h. The weighing and marking of test weights shall be specified on the engineering drawings.

i. In those special cases where there is no practical method of weighing test weights, the calculated weight shall be used, and the words "calculated weight" shall be noted for weight identification.

j. Test weight fixtures or weight cages used for single or multiple weight tests shall be marked in accordance with this paragraph. The words "fixture weight" shall be noted for weight identification.

3.3.5.7 Electrical Cable Assemblies. – Electrical cable assemblies shall be identified at each end of the cable and labeled in accordance with 79K01010 or 79K19600.

3.3.5.8 Communications Cable Numbering. – Cable numbering for fixed-wire outside plant portions of communications systems shall be in accordance with KSC-STD-E-0009.

3.3.5.9 Serial Numbers. – Serial numbers shall be required on those items, components, or assemblies that contain limited-life parts (e.g., valves, regulators) or require periodic maintenance, servicing, or calibration (e.g., pressure transducers, gages, switches, torque wrench).

3.3.6 Workmanship. – Hardware shall be fabricated and finished so appearance, fit, and adherence to specified dimensions and tolerances are observed and in a manner that ensures reliable operations in accordance with the requirements specified herein. Particular attention shall be given to the neatness and thoroughness of constructions and to the freedom of parts from burrs and sharp edges that might damage associated equipment or cause injury to personnel.

3.3.7 Interchangeability. – Hardware assemblies, components, and parts with the same part number shall be physically and functionally interchangeable.

3.3.8 Safety. – Safety requirements shall be in accordance with EWR 127-1, KHB 1700.7, KHB 1710.2, and 29 CFR 1910. System safety shall be conducted in accordance with Chapter 3 of NPG 8715.3.

3.3.8.1 Radiation Protection. – Facilities, systems, and equipment design that involves radiation hazards (i.e., laser, ultraviolet, infrared, and microwave emitters; radiological sources; or nuclear assemblies) shall be reviewed and approved by the Radiation Protection Committee or Radiation Protection Officer in accordance with KMI 1860.1.

3.3.9 Human Performance. – Design criteria for human performance shall be in accordance with the following requirements.

3.3.9.1 Human Engineering. – MIL-STD-1472 shall be used to establish human engineering criteria for facility, system, and equipment design.

3.3.9.2 Operating Characteristics. – Noise, light, smoke, fumes, heat, and vibration created by equipment shall not exceed the limits defined in the human engineering criteria and 29 CFR 1910.

3.3.9.3 Personnel Lifting Limits. – The human engineering criteria shall be used to determine the maximum weight that one or two men can lift, carry, or handle. Special consideration shall be given to equipment handling adjacent to flight vehicle elements.

3.3.9.4 Propellant Handlers Ensemble (PHE) Operators. – Facilities, systems, and equipment shall be designed to minimize the requirement for operations and maintenance personnel to wear protective clothing such as a PHE (previously called self-contained atmospheric protective ensemble [SCAPE]) during normal operations and maintenance. Valves, gages, levers, bolts, nuts, and any other item required to be moved, turned, manipulated, or monitored by personnel in a PHE shall be sized to facilitate operation by PHE-suited operators. Such items shall be located to optimize access to the item while the PHE-suited operator is in a standing position. Sufficient clearance shall be provided to preclude brushing against other surfaces. Facilities, systems, and equipment shall be designed to avoid requirements for PHE-suited operators to reach into tight areas, stoop to avoid low overhead obstructions, mount supplementary ladders or stairs, touch rough surfaces, or sit, kneel, or lie on the floors or decks. Suitable provisions to prevent damaging the PHE and to prevent fatigue and discomfort of PHE-suited personnel shall be included in the design. Use of expanded surfaces shall be prohibited.

3.3.10 Security. – Security requirements for facilities, systems, and equipment shall be in accordance with KHB 1610.1.

3.3.11 Government-Furnished Property. – Government-furnished property (GFP), in the form of equipment (GFE), software (GFS), information (GFI), or labor (GFL), shall not be incorporated into facilities, systems, and equipment design except where there is a measurably large amount of savings to the Government in cost, schedule, or performance.

3.4 Documentation.

3.4.1 Drawings and Specifications. – Drawings and specifications required for the fabrication, construction, installation, modification, test, operation, maintenance, or utilization of facilities, systems, or equipment shall be prepared in accordance with GP-435.

3.4.2 Technical Documentation. – Technical documentation (e.g., manuals, reports) shall be prepared in accordance with KSC-DF-107.

3.4.3 Operations and Maintenance Documentation (OMD). – Operations and maintenance documentation shall be developed to the extent necessary to permit operations and maintenance personnel to fully utilize, operate, troubleshoot, and otherwise maintain the hardware and software in their charge.

3.5 Logistics. – Facility, system, and equipment design shall accommodate the supply support system for identification and acquisition of sufficient spare parts, components, materials, and items to support construction, fabrication, installation activation, tests, verification, and operation activities that occur during the life cycle of the facility system or equipment. Facility, system, and equipment design shall identify and acquire sufficient spare parts, components, materials, and items to support construction, fabrication, installation, activation, tests, and verification activities that occur prior to the operational readiness date (ORD) of a facility or system.

3.6 Personnel and Training. – Facility, system, and equipment design shall minimize the personnel and training requirements for the operation and maintenance of hardware and software used at KSC. Hardware and software design shall keep the number and skill levels of personnel to a minimum. OMD shall be used as the source documentation in training courses. All facilities, systems, and equipment will be designed assuming operations and maintenance will be performed by appropriately trained and skilled personnel, unless otherwise directed.

The facility, system, or equipment shall be designed for simplicity of use, including redundancy, with controls that are self-explanatory. The design shall provide for appropriate safety and warning devices to alert personnel of impending or existing hazards and shall ensure operations/failures will not affect personnel safety or the safety of the system, equipment, or facility. The design shall limit the number of controls and the data provided to the absolute minimum possible so only those functions needed by an unskilled and untrained operator are available. The design shall provide ease of operation so unskilled and untrained operators do not require training for normal or emergency conditions. Design features shall ensure ease of operation, safety, and economy. The resultant design shall optimize compatibility between equipment and human performance without requiring personnel training.

3.7 Qualification. – Critical systems and other components that have significant failure impact shall be qualified in accordance with the provisions of KSC-STD-G-0003.

4. VERIFICATION

Facility, system, and equipment design shall incorporate program/project technical verification requirements in accordance with ISO 9001. The design shall also include special quality-related requirements, such as special processes, special testing, and any other necessary special requirements that produce a high-quality product.

Quality requirements will be defined in program/project quality and technical requirements documents, specifications, KHB 5310.1, contractual requirements, and other specified documentation.

4.1 Responsibility for Verification. – The concept of quality assurance places primary responsibility for quality of delivered products, materials, or services on the supplier or contractor. The contractor is also responsible for the verifications/quality of subcontractor products. However, where assembly of the facility, system, or equipment is at a Government

where assembly of the facility, system, or equipment is at a Government facility, responsibility for inspection may be split between the Government and the contractor. Accordingly, the supplier's responsibility for inspection shall be clearly stated in the contract documentation, and the Government's role, either as a partner or monitor, shall be specified. A typical statement of responsibility is:

> Responsibility for Inspection. Unless otherwise specified in the contract or order, the supplier is responsible for the performance of all verification requirements specified herein. Except as otherwise specified, the supplier may use its own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the verifications set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.2 Testing. – Testing shall be specified by the engineering documentation and will normally be limited to end-item acceptance testing to verify compliance with the applicable specifications and the ability of the end item to perform its functions.

4.2.1 Load Test. – Unless otherwise required, a load test shall be performed on hardware whenever there is reason to question its safety for the intended use. The minimum test load shall be 125 percent of the design or working load. Lifting devices and equipment shall be load tested in accordance with NASA-STD-8719.9. Hardware that has been successfully load tested shall be identified in accordance with KSC-STD-141.

4.2.2 Nondestructive Test (NDT). – All NDT of base materials shall be performed in accordance with KSC-SPEC-Z-0013. All NDT of welds shall be performed in accordance with the applicable welding specification.

4.2.3 Test Reports. – Test reports shall be prepared in accordance with KSC-DF-107.

4.2.4 Instrumentation Calibration. – Calibration of measuring instruments shall be established and maintained in accordance with ANSI/NCSL Z540-1.

4.3 Quality Conformance Verifications. – All examinations and tests required to verify that all requirements of sections 3 and 5 have been achieved shall be specified in the contract documentation. These examinations shall include:

a. Tests and checks of the performance and reliability requirements

b. A measurement or comparison of specified physical characteristics

c. Verification, with specific criteria, of workmanship

d. Test and inspection methods for ensuring compliance, including environmental conditions for performance

5. PREPARATION FOR DELIVERY

5.1 Preservation and Packaging. – Hardware shall be preserved and packaged in accordance with MIL-STD-2073-1.

5.2 Shipping Containers. – Shipping containers shall be compatible with onsite transportation, handling, and storage methods. For convenient handling and stacking, containers having a gross weight of more than 65 kilograms (150 pounds) shall be provided with integral skids or pallets for shipment. Attach points shall be provided where applicable for crane hoists and tiedowns.

5.3 Height and Size. – The weight and cubic displacement of packaging and packing shall be held to a minimum consistent with the requirement of the item and the method of transportation. Hardware shall be designed so the configuration (i.e., item) may be disassembled as required and packaged for shipment.

5.4 Parts Protection. – There shall be an efficient, reliable, and economical system for the protection of all parts during manufacturing processes and in-plant handling and storage. There shall be standardization of parts protection procedures, methods, materials, and devices, such as carts, boxes, containers, or transportation vehicles necessary to prevent damage to parts.

5.5 Precision Clean Parts. – Precision cleaning levels and packaging shall comply with KSC-C-123.

5.6 Marking. – Containers shall be marked in accordance with the requirements contained in MIL-STD-129.

5.7 Acceleration Recording Instruments. – Shipment of hardware that is sensitive to shock or acceleration shall include instruments that record acceleration along three axes with respect to time. Proof of adequate packaging shall be demonstrated if the use of an acceleration recording instrument is required but is not feasible in a single-item shipment of a small item.

5.8 Transportation and Storage. – The packaging shall protect the hardware during transportation and storage.

6. NOTES

6.1 Intended Use. – This document is intended to be used in the establishment of uniform engineering practices and methods and to ensure the inclusion of essential requirements in the design

of facilities, systems, and equipment used to support the operations of transporting, receiving, handling, assembly, test, checkout, service, launch, and recovery of space vehicles and payloads at KSC.

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

a. Commercial Off-the-Shelf (COTS). Equipment, both hardware and associated software/procedures, that is commercially available from current industry inventory.

b. Critical Weld. A weld whose single failure during any operating condition could result in injury to personnel or damage to property or flight hardware.

c. Ground Support Equipment. Nonflight systems, equipment, or devices necessary to routinely support the operations of transporting, receiving, handling, assembly, test, checkout, servicing, launch, and recovery of a space system (launch vehicle, payload, and experiment) at launch, landing, and retrieval sites.

d. Safety Critical. Any condition, event, operation, process, equipment, or system with a potential for personnel injury, fatality, or damage to or loss of equipment or property.

e. Safety Factor. A ratio of ultimate strength, breaking strength, or yield strength to the maximum material design stress.

f. Safe Working Load. An assigned load, as shown on the identification tag, that is the maximum load, as shown on the identification tag, the device or equipment shall operationally handle and maintain.

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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Preparing Activity:

John F. Kennedy Space Center
Engineering and Science Division
Spaceport Engineering and Technology
Directorate

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER KSC-DE-512-SM, REV. J	2. DOCUMENT DATE October 15, 2002

3. DOCUMENT TITLE
FACILITY, SYSTEM, AND EQUIPMENT GENERAL DESIGN REQUIREMENTS

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

5. REASON FOR RECOMMENDATION

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a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
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8. PREPARING ACTIVITY

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