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5) KSC-STD-Z-0010A, (September 1, 1983), Design of Environmental Control Systems, Ground Coolant Systems, Coolant Servicing Systems, and Ground Support Equipment, Standard For.	*YesN*	*o*	*SBU Reviewer's Signature*	*Date*
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NASA Export Control Program

KSC-STD-Z-0010A
September 1, 1983

DESIGN OF ENVIRONMENTAL CONTROL SYSTEMS, GROUND COOLANT SYSTEMS, COOLANT SERVICING SYSTEMS, AND GROUND SUPPORT EQUIPMENT, STANDARD FOR

ENGINEERING DEVELOPMENT DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center

KSC FORM 16-12 (REV. 6/76)

KSC-STD-Z-0010A
September 1, 1983

DESIGN OF ENVIRONMENTAL CONTROL SYSTEMS, GROUND COOLANT SYSTEMS, COOLANT SERVICING SYSTEMS, AND GROUND SUPPORT EQUIPMENT, STANDARD FOR

PREPARED BY
PLANNING RESEARCH CORPORATION
Systems Services Company
for
ENGINEERING DEVELOPMENT
JOHN F. KENNEDY SPACE CENTER, NASA

PRC CONTROL NUMBER: 310–1282

Approved:

Peter A. Minderman
Director of Engineering Development

This Revision Supersedes All Previous Editions of This Standard

JOHN F. KENNEDY SPACE CENTER, NASA

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ABBREVIATIONS AND ACRONYMS

ac	alternating current
a.m.	morning
AFBMA	Anti-friction Bearing Manufacturers Association
AMCA	Air Movement and Control Association (Air Conditioning)
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
Btu/ft^2	British thermal unit per square foot
CTI	Cooling Tower Institute
db	dry bulb
ECS	environmental control system
F	Fahrenheit
FED	Federal
GN_2	gaseous nitrogen
GP	general publication
GSE	ground support equipment
HEPA	high-efficiency particulate air (filter)
HI	Hydraulic Institute
hp	horsepower
Hz	hertz
IEEE	Institute of Electrical and Electronic Engineers
JSC	Lyndon B. Johnson Space Center
KMI	Kennedy management instruction
KSC	John F. Kennedy Space Center
MIL	military
NASA	National Aeronautics and Space Administration
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NHB	NASA handbook
no.	number
O_2	gaseous oxygen
p.m.	post meridian
psig	pound per square inch gage
rh	relative humidity
rms	root mean square
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SP	special publication
SPEC	specification
STD	standard
TEFC	totally enclosed fan-cooled

ABBREVIATIONS AND ACRONYMS (cont)

TEMA	Tubular Exchanger Manufacturers Association
TM	technical manual
UL	Underwriters Laboratories
V	volt
wb	wet bulb

JOHN F. KENNEDY SPACE CENTER

DESIGN OF

ENVIRONMENTAL CONTROL SYSTEMS, GROUND COOLANT SYSTEMS, COOLANT SERVICING SYSTEMS, AND GROUND SUPPORT EQUIPMENT, STANDARD FOR

1. SCOPE

This standard has been approved by the Engineering Development Directorate of the John F. Kennedy Space Center (KSC) and is mandatory for use by KSC and associated contractors.

This standard establishes the requirements for specifying the design of new ground support equipment (GSE) for use in environmental control systems (ECS), ground coolant systems, and coolant servicing systems or parts thereof. This standard was written to support KSC-DE-512-SM and is applicable to the specification for all new environmental control system, ground coolant system, and coolant servicing system GSE designs used at KSC.

2. APPLICABLE DOCUMENTS

The following documents of the issue in effect on date of invitation for bids or request for proposals form a part of the standard to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this standard, the contents of this standard shall be considered a superseding requirement.

2.1 Governmental.

2.1.1 Specifications.

John F. Kennedy Space Center (KSC), NASA

KSC-C-123	Surface Cleanliness of Fluid Systems

KSC-SPEC-F-0006	Heat and Blast Protection Coating Materials, Specification for
KSC-SPEC-Z-0002	Welding, Aluminum Alloy Pipe, Tubing and Associated Fittings, Specification for
KSC-SPEC-Z-0003	Welding, Stainless Steel and Invar 36 Pipe, Tubing and Associated Fittings, Specification for
KSC-SPEC-Z-0004	Welding of Structural Carbon Steel, Low-Alloy Steel, Stainless Steel, and Aluminum Alloys, Specification for
KSC-SPEC-Z-0005	Brazing, Steel, Copper, Aluminum, Nickel, and Magnesium Alloys, Specification for
KSC-SPEC-Z-0006	Induction Brazing, Aerospace Tubing, Fittings, Specification for
KSC-SPEC-Z-0007	Tubing, Steel, Corrosion Resistant, Types 304 and 316, Seamless, Specification for
KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies, Specification for
KSC-SPEC-Z-0011	Application of Silicone Rubber Ablative Material to Ground Support Equipment, Specification for
KSC-SPEC-Z-0013	Penetrant, Magnetic Particle and Ultrasonic Inspection, Requirements for, Specification for

Lyndon B. Johnson Space Center (JSC), NASA

SE-S-0073	Space Shuttle Fluid Procurement and Use
SW-E-0002	General Design Requirements, Ground Support Equipment, Space Shuttle Program

Federal

L-P-535	Plastic Sheet (Sheeting), Plastic Strip, Vinyl Chloride Polymer and Vinyl Chloride Vinyl Acetate Copolymer, Rigid

BB-F-1421	Fluorocarbon Refrigerants
CC-M-1807	Motor, Alternating Current, Fractional and Integral Horsepower (500 HP and Smaller)
HH-I-551	Insulation Block and Boards, Thermal (Cellular Glass)

Military

MIL-P-27401	Propellant Pressurizing Agent, Nitrogen
MIL-M-8090	Mobility, Towed Aerospace Ground Equipment, General Requirements Test

2.1.2 Standards.

John F. Kennedy Space Center (KSC), NASA

KSC-STD-C-0001	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures and Ground Support Equipment, Standard for
KSC-STD-E-0002	Hazard Proofing of Electrically Energized Equipment, Standard for
KSC-STD-E-0012	Bonding and Grounding, Standard for
KSC-STD-E-0013	Lightning Protection, Standard for
KSC-STD-E-0015	Marking of Ground Support Equipment, Standard for
KSC-STD-SF-0004	Safety Standard for Ground Piping, Systems Color Coding and Identification
KSC-STD-Z-0004	Design of Structural Steel Buildings and Framework

Federal

FED-STD-209	Clean Room and Work Station Requirements, Controlled Environment

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-454	Standard General Requirements for Electronic Equipment

MIL-STD-810	Environmental Test Methods
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities

2.1.3 Drawings.

John F. Kennedy Space Center (KSC), NASA

79K07614	ECS Flexible Duct
79K08152	ECS Dust Cap
79K08260	Flex Hose Assembly
79K09457	ECS Flex Duct Dust Cap, Internal
79K11948	Material Selection List for Type J Fluid Services, MSL-Type J
79K14740	Material Usage Code
79K18243	ECS Flexible Dual Size Duct

2.1.4 Other Documents.

National Aeronautics and Space Administration (NASA)

NHB 5300.4(1B)	Quality Program Provisions for Aeronautical and Space System Contractors
NHB 5300.4(1C)	Inspection System Provisions for Aeronautical and Space System Materials, Parts, Components, and Services
NHB 6000.1	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems Equipment and Associated Components
NHB 8060.1	Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments That Support Combustion
TM-82473	Terrestrial Environmental (Climatic) Criteria Guidelines for Use in Space Vehicle Development

John F. Kennedy Space Center (KSC), NASA

GP-359	Liquid Propellants Safety Handbook
GP-425	Engineering Standards
GP-1098	Ground Safety Plan
KSC-DD-404	Survey of Polyphase Induction Motors for Energy Savings
KMI 1710.1D	The KSC Safety Program and Reliability and Quality Assurance Program
KMI 1810.1D	KSC Occupational Medicine Environmental Health Program
SP-4-38	Acoustic and Vibration Environment and Test Specification Levels, Launch Complex 39 Ground Support Equipment
TM-584	Corrosion Control and Treatment Manual

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

2.2 Non-Governmental.

Air-Conditioning and Refrigeration Institute (ARI)

ARI Standard 210	Unitary Air Conditioning Equipment, Standard for
ARI Standard 260	Application, Installation, and Servicing of Unitary Equipment, Standard for
ARI Standard 410	Forced Circulation Air-Cooling and Air-Heating Coils, Standard for
ARI Standard 450	Water-Cooled Refrigerant Condensers, Remote Type, Standard for
ARI Standard 480	Refrigerant-Cooled, Liquid Coolers, Remote Type, Standard for
ARI Standard 495	Refrigerant Liquid Receivers, Standard for
ARI Standard 520	Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units, Standard for

ARI Standard 550	Centrifugal or Rotary Liquid-Chilling Packages, Standard for
ARI Standard 590	Reciprocating Water Chilling Packages, Standard for
ARI Standard 710	Liquid-Line Driers, Standard for

(Application for copies should be addressed to the Air Conditioning and Refrigeration Institute, 1815 North Ft. Myer Drive, Arlington, Virginia 22209.)

Air Movement and Control Association (Air Conditioning) (AMCA)

AMCA Bulletin 99	Standards Handbook
AMCA Bulletin 210	Test Code for Air Moving Devices
AMCA Bulletin 300	Test Code for Sound Rating Air Moving Devices

[Application for copies should be addressed to the Air Movement and Control Association (Air Conditioning), 30 West University Drive, Arlington Heights, Illinois 60004.]

American National Standards Institute (ANSI)

ANSI A58.1	Minimum Design Loads in Buildings and Other Structures, Building Code Requirements for
ANSI B31.5	Refrigeration Piping
ANSI S1.21	Methods for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, New York 10018.)

American Society for Testing and Materials (ASTM)

ASTM C 534	Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Specification for
ASTM C 552	Cellular Glass Block and Pipe Thermal Insulation, Specification for

ASTM E 84	Surface Burning Characteristics of Building Materials, Test for
ASTM F 25	Sizing and Counting Airborne Particulate Contamination in Clean Rooms and Other Dust-Controlled Areas Designed for Electronic and Similar Applications, Method for
ASTM F 50	Continuous Sizing and Counting of Airborne Particles in Dust-Controlled Areas Using Instruments Based Upon Light-Scattering Principles, Test Method for

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

<u>American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)</u>

ASHRAE Fundamentals Handbook	ASHRAE Handbook 1981 Fundamentals
ASHRAE Standard 14	Methods of Testing for Rating for Rating Position Displacement Condensing Units
ASHRAE Standard 15	Safety Code for Mechanical Refrigeration
ASHRAE Standard 17	Method of Testing for Capacity Rating of Thermostatic Refrigerant Expansion Valves
ASHRAE Standard 20	Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ASHRAE Standard 22	Methods of Testing for Rating Water-Cooled Refrigerant Condensers
ASHRAE Standard 23	Methods of Testing for Rating Positive Displacement Refrigerant Compressors
ASHRAE Standard 24	Methods of Testing for Rating Liquid Coolers
ASHRAE Standard 25	Methods of Testing Forced Convection and Natural Convection Air Coolers for Refrigeration
ASHRAE Standard 28	Method of Testing Flow Capacity of Refrigerant Capillary Tubes

ASHRAE Standard 33	Methods of Testing Forced Circulation Air-Cooling and Air-Heating Coils
ASHRAE Standard 34	Number Designation of Refrigerants
ASHRAE Standard 35	Method of Testing Desiccants for Refrigerant Drying,
ASHRAE Standard 37	Methods of Testing for Rating Unitary Air-Conditioning and Heat Pump Equipment
ASHRAE Standard 63	Method of Testing Liquid-Line, Refrigerant Driers

(Application for copies should be addressed to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 345 East 47th Street, New York, New York 10017.)

American Society of Mechanical Engineers (ASME)

ASME Section VIII	Pressure Vessels, ASME Boiler and Pressure Vessel Code
ASME PTC-10	Performance Test Code, Compressors and Exhausters

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.)

Anti-Friction Bearing Manufacturers Association (AFBMA)

AFBMA 10	Balls, Terminology, Definitions and Tolerances for Metal Balls

(Application for copies should be addressed to the Anti-Friction Bearing Manufacturers Association, 2341 Jefferson Davis Highway, Suite 1015, Arlington, Virginia 22202.)

Cooling Tower Institute (CTI)

CTI ATC-105	Acceptance Test Code for Water Cooling Towers, Mechanical Draft Industrial Type

(Application for copies should be addressed to the Cooling Tower Institute, 9030 IH-45 North, Room 216, Gulfbank Road Exit, Houston, Texas 77037.)

Hydraulic Institute (HI)

HI Standard	Hydraulic Institute Standards, 13th Edition (1975)

(Application for copies should be addressed to the Hydraulic Institute, c/o A. P. Wherry and Associates, 712 Lakewood Center N., 14600 Detroit Avenue, Cleveland, Ohio 44107.)

Institute of Electrical and Electronic Engineers (IEEE)

IEEE No. 119	IEEE Recommended Practice for General Principles of Temperature Measurement as Applied to Electrical Apparatus

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, New York 10017.)

National Electrical Manufacturers Association (NEMA)

NEMA DC-12	Hot-Water Immersion Controls
NEMA MG-1	Motors and Generators

(Application for copies should be addressed to the National Electrical Manufacturers Association, 2101 L Street N.W., Washington, D.C. 20037.)

National Fire Protection Association (NFPA)

NFPA No. 70	National Electrical Code (NEC)
NFPA No. 90A	Installation of Air-Conditioning and Ventilating Systems Standard for the
NFPA No. 214	Water-Cooling Towers, Standard for

(Application for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.)

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

SMACNA 1975-4	High Pressure Duct Construction Standards
SMACNA 1976-1	Low Pressure Duct Construction Standards
SMACNA 1975-2	Duct Liner Application Standard

(Application for copies should be addressed to the Sheet Metal and Air Conditioning Contractors National Association, 8224 Old Courthouse Road, Vienna, Virginia 22180.)

b. System power shall be designed to operate and maintain specified performance from power sources supplying the following alternating current (ac) voltages:

(1) 120/240 V root mean square (rms), 60 hertz (Hz), single phase

(2) 240/480 V rms, 60 Hz, three phase

c. System controls shall be designed to operate and maintain specified temperatures from local or remote locations using either of the following:

(1) Pneumatic pressure, 20 pounds per square inch gage (psig), maximum

(2) Electricity, 28 V dc or 110 V ac, nominal

3.1.2 Natural Environment. - The natural environmental parameters not specifically defined for the Eastern Space and Missile Center in this standard shall be obtained from TM-82473.

3.1.2.1 Wind Profile. - The minimum design pressure for wind profile is presented in terms of velocity pressure in paragraph 3.6.2 of KSC-STD-Z-0004 and in terms of design pressures (velocity pressure multiplied by the shape factor 1.3) for that shape in ANSI A58.1. Peak pressures shall be used as loads in making static analyses. Steady-state pressure in conjunction with peak pressures shall be used in making dynamic analyses. Design pressure referenced in ANSI A58.1 for structures 30 feet in height is 125 miles per hour peak wind velocity, 30.8 pounds per square foot steady-state pressure, and 52 pounds per square foot peak pressure.

3.1.2.2 Ground Thermal Environment.

a. Temperature

(1) Minimum: 20 degrees F saturated

(2) Maximum: 103 degrees F db, 81 degrees F wb

b. Maximum solar radiation

(1) Low design (diffuse): 30 Btu/ft^2; hours 10 a.m. to 2 p.m.

(2) High design (normal incidence): 360 Btu/ft^2; hours 11 a.m. to 3 p.m.

Tubular Exchanger Manufacturers Association (TEMA)

TEMA Standard	Standard for Tubular Exchanger Manufacturers Association

(Application for copies should be addressed to the Tubular Exchanger Manufacturers Association, 25 N. Broadway, Tarrytown, New York 10591.)

Underwriters Laboratories (UL)

UL 207	Refrigerant-Containing Components and Accessories, Nonelectrical
UL 873	Temperature-Indicating and Regulating Equipment

(Application for copies should be addressed to the Underwriters Laboratories, 333 Pfingsten Road, Northbrook, Illinois 60062.)

3. REQUIREMENTS

Systems, subsystems, and components designed for use as a part of, or in conjunction with, GSE for ECS, ground coolant systems, and coolant servicing systems shall conform to the requirements of this standard and SW-E-0002.

3.1 System Requirements. - The ECS, ground coolant systems, and coolant servicing systems covered by this standard are divided into the following four categories:

a. General requirements

b. Coolant (refrigerant) requirements

c. Coolant (liquid) requirements

d. Cooling (air side) requirements

3.1.1 General Requirements.

a. System design standard conditions shall be as follows:

(1) Outside: 92 degrees F dry bulb (db), 80 degrees F wet bulb (wb), 60 percent relative humidity (rh)

(2) Inside: 75 degrees db, 61 degrees F wb, 45 percent rh

3.1.2.3 Humidity. - Design shall provide for a minimum of 30 percent rh up to a maximum of 100 percent where an electrical potential (static electricity) may damage equipment.

3.1.2.4 Moisture and Fungus. - Design shall consider moisture as water vapor content of the atmosphere expressed as absolute humidity and relative humidity. Fungus shall include saprophytic and parasitic lower plants, including molds, mildews, and dark masses of spores.

3.1.2.5 Equipment Environment. - Mechanical equipment shall be designed to withstand unlimited exposure to the environment at KSC without being enclosed in a cabinet that requires protective measures, such as dry purges or heaters.

3.1.3 Induced Environment. - The ECS, ground coolant systems, and coolant servicing systems shall be designed to withstand launch-induced conditions of acid precipitation.

3.1.3.1 Vibration and Shock. - Random vibration accelerations for the GSE shall not exceed the levels specified in SP-4-38-D. Design shall provide vibration isolators on all rotating equipment and physical or geographical protection for equipment.

3.1.3.2 Acoustics. - The lift-off overall sound pressure levels experienced by GSE shall not exceed the values presented in SP-4-38-D.

3.1.3.3 Thermal. - The thermal environment induced after lift-off shall not exceed the values presented in SP-4-38-D. Design shall provide for protection of equipment where excessive temperatuares may be encountered.

3.1.4 Mobility. - ECS and GSE that require mobility shall be designed in accordance with MIL-M-8090 in addition to the requirements of this standard.

3.1.5 Safety. - GSE and related structural supports shall be designed in compliance with KMI 1710.1D and KMI 1810.1D to preclude failures or hazards that would jeopardize personnel safety or damage or degrade the vehicle.

3.1.5.1 Safety Factors. - The following GSE safety factors as minimum values shall be applicable to the design of structural and fluid subsystems:

a. Minimum values for permanent structures and GSE transporters shall be in accordance with KSC-STD-Z-0004

b. Pressure vessels, valves, fittings, transfer piping, fill and vent lines, hoses, etc shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII and shall have the following safety factors:

   (1) Proof pressure = 1.5 times maximum working pressure by hydrostatic test

(2) Burst pressure = 4.0 times maximum working pressure

c. GSE transporters and workstands shall have a minimum structural design factor of safety against overturning of 2.0.

d. GSE structural design shall be based upon the intended use of the equipment and the type of loads expected, with a safety factor of 2 applied to the yield strength of the structure.

3.1.5.2 Human Engineering. - GSE shall be engineered for accessibility, maintainability, and safety in conformance with design criteria presented in MIL-STD-1472.

3.1.5.3 Gaseous Nitrogen (GN_2) Isolation. - Design of ECS shall provide for personnel safety and protection where gaseous nitrogen is introduced in any duct system. The minimum purge for personnel protection shall be a full fresh air purge capability of the duct system. System isolation between high-pressure gaseous nitrogen and supply air shall be made using two valves in series in the GN_2 supply piping.

3.1.5.4 Gaseous Oxygen (O_2) Meters. - Where ECS or GSE pass through or supply an environment of gaseous nitrogen to a room, design shall include the capability of monitoring the oxygen content of the air in that room. O_2 sensors shall be located in the contaminated area which shall actuate an audible alarm(s) and visible flashing light(s) within the room and also an audible alarm(s) and visible flashing light(s) upon approach to the room.

3.2 Materials. - Materials and processes used in the design of GSE for ECS, ground coolant systems, and coolant servicing systems shall be capable of meeting the physical and chemical requirements and tests set forth in this standard and applicable specifications.

3.2.1 Selection. - Selection of parts/components and materials for environmental control system, ground coolant system, and coolant servicing system GSE shall be in accordance with 79K11948 and 79K14740.

3.2.2 Oxygen Compatibility. - Application of materials in the presence of oxygen or possible presence of oxygen shall be governed by NHB 8060.1.

3.2.3 Corrosion Resistance. - All metals shall be corrosion resistant or treated to provide corrosion resistance in accordance with TM-584. Corrosion-resistant metals shall be used, wherever possible.

3.2.4 Corrosion Protection. The minimum protective coating, including sealants and calking, for all material used for ECS, coolant systems, and GSE shall be in accordance with KSC-STD-C-0001.

3.2.5 Moisture and Fungus Resistance. - Fungus non-nutrient materials as defined in MIL-STD-810, method 508, shall be used. Fungus inert materials are listed in MIL-STD-454. Fungus nutrient materials shall be hermetically sealed or treated to prevent fungus growth for a period of 10 years. Materials not meeting any of the above requirements shall be identified, and inspection, maintenance, or replacement periods shall be specified.

3.3 Hazard-Proofing.

3.3.1 Ignition-Proofing. - Equipment containing electrically energized devices located in hazardous areas shall be hazard-proofed by purging in compliance with KSC-STD-E-0002.

3.3.2 Heat and Blast Protection. - Equipment located in blast areas shall be protected in accordance with KSC-SPEC-F-0006 and KSC-SPEC-Z-0011.

3.3.3 Toxic Vapor Protection. - Equipment located in areas where toxic vapors might accumulate shall be either sealed, blast-proofed, or purged. Intakes to air distribution systems shall be located in compliance with appropriate sections of GP-359 remote from areas where normal toxic vapor venting occurs or where accidental spillage could result in contamination of breathing or vehicle air supplies.

3.3.4 Bonding and Grounding. - GSE shall comply with KSC-STD-E-0012 and KSC-STD-E-0013. Design shall provide a physical ground for discharge of static electricity for all equipment, stationary or mobile, per KSC-STD-E-0012.

3.3.5 Identification. - All GSE components shall be identified by markings applied in accordance with KSC-STD-E-0015. The piping and tubing runs shall be color-coded in compliance with KSC-STD-SF-0004.

3.3.6 Flight-Line Hazards. - GSE design shall provide for the protection of personnel during hazardous landing and safing operations in accordance with GP-1098.

3.4 Contamination Control. - GSE and fluid media shall conform to required levels of cleanliness and purity.

3.4.1 GSE Contamination. - System components shall be cleaned and maintained to the required level of cleanliness as specified in KSC-C-123.

a. Level 150 cleanliness is required for all fluid distribution systems interfacing with the launch vehicle or payload.

b. Level 300 cleanliness is required for all fluid distribution systems not interfacing with the vehicle or for vent and return fluid distribution systems.

3.4.2 Fluid Media Contamination. - Fluid media (air) purity and cleanliness shall comply with the specific requirements of the controlled area.

3.4.2.1 Particulate. - The particulate matter that contaminates drying and preservation gases shall be sized and counted in accordance with SE-S-0073 and MIL-P-27401. Gases used to supply requirements for controlled environment areas shall be particle sized and counted in accordance with FED-STD-209 and ASTM F 25 and F 50.

3.4.2.2 Moisture. - The moisture content of gases shall not exceed system requirements as tested in accordance with SE-S-0073 and MIL-P-27401.

3.4.2.3 Impurities. - Total hydrocarbon content of gases shall meet system requirements when tested in accordance with SE-S-0073 and MIL-P-27401 by use of activated charcoal filters.

3.5 Welding. - All welding shall be in accordance with the following applicable specifications:

a. KSC-SPEC-Z-0002. - Pipe, tubing, and fittings; aluminum alloy

b. KSC-SPEC-Z-0003. - Pipe, tubing, and fittings; stainless steel and Invar 36

c. KSC-SPEC-Z-0004. - Structural; carbon steel, stainless steel, low alloy steel, and aluminum alloy

d. KSC-SPEC-Z-0005. - Brazing; steel, copper, aluminum, nickel, and mag ensium alloys

e. KSC-SPEC-Z-0006. - Induction-brazing aerospace tubing and fittings

3.6 Inspection. - Requirements for penetrant, magnetic particle, and ultrasonic inspection of welds shall be in accordance with KSC-SPEC-Z-0013.

3.7 Radiographic Inspection. - All pressure welds, which require radiographic inspection, shall be 100-percent radiographed in accordance with the requirements of the above applicable welding specifications. All radiographs shall be submitted to the design agency having jurisdiction for approval and retention prior to acceptance of components.

3.8 Refrigeration Systems. - This section provides requirements for the standardization of specifications for the design of refrigeration systems, subsystems, and components that are used in the ECS, ground coolant system, and coolant servicing system GSE. These refrigeration systems shall conform to pressure relief requirements of ASHRAE Standard 15.

3.8.1 Refrigerants. - The fluorocarbon refrigerants employed in the system shall conform to BB-F-1421 and shall be designated in accordance with ASHRAE Standard 34 and shall be compatible with the compressor and design temperature. The refrigerants shall have a normal boiling point between minus 150 degrees F and plus 120 degrees F.

3.8.2 Air-Conditioners. - Unitary air-conditioners shall conform to ARI Standard 210 in design requirements and ARI Standard 260 in application and installation requirements. The unitary air-conditioners shall be tested and rated in conformance with ASHRAE Standard 37. Condensing coil shall be in accordance with 3.8.5.

3.8.3 Gas-Cooler Evaporators. - The gas-cooler evaporator shall be designed to be compatible with the refrigerant specified and the gas being conditioned. The evaporator coil shall conform to ARI Standard 410 when rated and tested by methods presented in ASHRAE Standard 33.

3.8.4 Liquid-Cooler Evaporators. - The evaporator for liquid cooling shall have a shell constructed of seamless steel pipe with internal heat transfer surface constructed from seamless copper tubing. The evaporator shall conform to applicable portions of ASME Pressure Vessel Code Section VIII, ARI Standard 480, and the TEMA Standard. The liquid cooler shall be rated and tested in accordance with ASHRAE Standard 24.

3.8.5 Air-Cooled Condenser. - The air-cooled condenser shall be either an integral part of the refrigeration unit or remote type. The condenser shall be rated in accordance with ASHRAE Standard 20 or 14. The condenser coil shall be an extended-surface fin-and-tube type and shall be constructed of seamless copper tubes and copper fins and end plates. The fins shall be mechanically bonded to the tubes. The condenser shall be designed for pressures specified in ASHRAE Standard 15 for the type of refrigerant employed in the system. Each condenser shall have a receiver with a capacity of 1.25 times the system capacity and shall be at the lowest point in the refrigeration system.

3.8.6 Water-Cooled Condenser. - The water-cooled condenser shall be either an integral part of the refrigeration unit or remote type. The condenser shall be a shell-and-tube type with shell of seamless steel pipe and tubes of seamless copper. The condenser shall conform to applicable portions of ASME Pressure Vessel Code, Section VIII and ARI Standard 450 when tested and rated in accordance with ASHRAE Standard 22.

3.8.7 Receivers. - Liquid receivers shall be the through type, designed, fitted, and rated in accordance with the recommendations of ARI Standard 495. The receiver shall be constructed and tested in accordance with the requirements of ASME Pressure Vessel Code, Section VIII. Each receiver shall be equipped with inlet, outlet drop pipe, drain plug, purging valve, dual safety valve, and liquid level sight glass. The receiver shall have a storage capacity of 125 percent of that required for the fully charged system and shall be located lower than the condensing coil.

3.8.8 Compressors. - Refrigerant compressors shall be of the open, semi, full hermetic reciprocating or centrifugal type and shall be provided with one or more of the following protective devices in order to comply with applicable portions of NFPA No. 70, UL 207, UL 873, and ASHRAE Standard 15:

a. Overcurrent protection

b. High-pressure protection cutout or relief device

c. High-temperature control against motor overheating and oil breakdown

d. Low-pressure protective switch for minimum refrigerant suction pressure

e. Low oil pressure and low oil level protection devices

f. Time delay restart or manual reset lockouts to prevent rapid cycling of compressor

g. Crankcase heater

3.8.8.1 Centrifugal Compressors. - The design specification for centrifugal compressors used with liquid and water chilling packages shall conform to ARI Standard 550. In addition to applicable safety controls in 3.8.8, the centrifugal compressor liquid chilling packages shall include the following safety controls:

a. Load-limiting control with capacity control override

b. Evaporator safety relief valves

c. Low evaporator chilled liquid temperature cutout

d. Low chilled water flow cutout

3.8.8.2 Reciprocating Compressors. - The design specification for reciprocating compressors shall be in accordance with applicable portions of ARI Standards 520 and 590. Testing and rating of the reciprocating compressors shall comply as applicable to ASHRAE Standard 23.

3.8.9 Expansion Devices. - The expansion device specified for use with refrigerant systems shall be sized to minimize cycling. Expansion valves shall be tested and rated to the particular refrigeration unit in accordance with ASHRAE Standard 17. ASHRAE Standard 28 shall be applied to testing and rating capillary tube expansion devices.

3.8.10 Controls and Instrumentation. - All electrical controls and instrumentation shall be in conformance with applicable portions of NFPA No. 70; NEMA DC-12; UL 873; and IEEE No. 119 and shall be selected and matched with the location and equipment.

3.8.11 Motors. - The design specification of motors for refrigerant systems shall comply with NFPA No. 70 for definition of maximum current. The design of motors shall require that insulating materials, operating temperatures, breakdown torque, starting torque, and starting current requirements be specified and conform to NEMA motor and generator standards. Motors 1/3 horsepower (hp) and smaller shall be single-phase capacitor start type. Motors of 1/2 hp and larger shall be three-phase, induction squirrel-cage type, NEMA design B having normal starting torque and low starting current. All motors shall have class B insulation or better and shall be thermally protected. Motors shall conform to NEMA MG 1. All motors 3 hp or greater shall be totally enclosed, fan-cooled (TEFC) construction for NEMA design B and shall meet KSC-DD-404 recommendations for new motors.

3.8.12 Moisture and Contaminant Control. - The design of refrigeration units shall specify the application of refrigerant filter driers or purge units as required to remove moisture from the refrigerant. Refrigerant liquid-line driers shall conform to ARI Standard 710 when tested and rated in accordance with ASHRAE Standards 35 and 63. The purge unit shall be designed to remove moisture and permanent gases from the condenser vapor and return the purged liquid refrigerant to the evaporator. The filter driers shall be piped with a by-pass and an isolation valve.

3.8.13 Refrigerant Piping. - The design specifications for refrigerant piping, fittings, and line components shall conform to all applicable portions of ANSI B31.5.

3.8.14 Thermal Insulation and Water Vapor Barriers. - The low-temperature portions of the refrigerant system shall be insulated to prevent heat gain and the formation of condensation. This includes piping, tubing, fittings, valves, and other components in the lines. High-temperature equipment that may be a personnel or fire hazard shall be insulated. All insulation shall be of type, class, and composition suitable for the application. All plastic foam insulation shall be nonburning.

3.8.15 Cooling Towers. - The cooling tower shall be a factory-fabricated, field-erected, atmospheric type complete with basin, spray nozzles, piping, frame, louvers, float assembly, drain, and overflow. The tower shall be designed for the natural environmental conditions set forth in 3.1.2 and shall conform to NFPA No. 214. The design specification shall require conformance with applicable portions of CTI ATC-105 for cooling towers when tested in accordance with CTI ATC-105.

3.8.16 Noise Control. - Sound power level shall be controlled to acceptable ratings for the particular application. Measurement of sound power radiated from refrigerating and air-conditioning equipment shall conform to criteria for testing presented in ANSI S1.21.

3.9 Refrigerant (Liquid) Requirements. - This section provides criteria for standardizing the design specification of liquid secondary coolant systems, subsystems, or components for use with the environmental control system, ground coolant system, and coolant servicing system GSE. These coolants are normally liquid or a solution with no flash point or a flash point above 150 degrees F and a freezing point compatible with lowest of operating temperature.

3.9.1 Coolant Media. - The liquid coolant is defined as any liquid used for the transmission of heat without a change in state. Types of coolants are Freon 21, Freon 114, ammonia, coolant water, and fuel cell cooling fluid (FC-40). The properties that secondary coolants should have are low freezing point, low viscosity, nonflammability, stability, high boiling point, noncorrosive, high specific heat, and high thermal conductivity factor. Specification of coolant media to manufacturer's specification (except as follows) is permitted where fluid properties are compatible with ground support and vehicle coolant circuits. Water glycol shall be specified in accordance with SE-S-0073.

3.9.2 Heat Exchangers. - The specification of the design of heat exchangers for liquid-to-liquid and gas-to-liquid heat transfer requirements shall be in accordance with ARI Standards 480 and 410 and tested in compliance with ASHRAE Standards 24 and 25, respectively. The coil design shall conform to the TEMA Standard. Each heat exchanger shall have an adjustable flow setting device on the return side and shall have isolation valves on supply and return piping. A pressure relief valve shall be designed into each heat exchanger.

3.9.3 Pumps. - The liquid coolant circulation pump shall be centrifugal design and may be positioned horizontal or vertical to meet coolant system requirements. The pump shall conform to applicable portions of the HI Standard.

3.9.4 Motors. - Pump motors shall be designed and sized in conformance with 3.1.1 and 3.8.11 of this standard and the system head pressure and capacity.

3.9.5 Pipe, Tube, and Fittings. - Pipe and fittings shall be specified to conform to ANSI B31.5. Tubing for coolant mass transfer (other than tubular heat exchangers or coils) shall be specified for design in accordance with KSC-SPEC-Z-0007 and for installation in conformance with KSC-SPEC-Z-0008. Tube fittings for coolant mass transfer shall conform to GP-425. All process piping shall be cleaned to KSC-C-123 level IV cleanliness.

3.9.6 Insulation and Vapor Barrier. - The design of the air or water distribution system for low temperatures shall include molded rigid urethane foam pipe insulation with thermal conductivity of 0.015 Btu.in/h.ft^2.degrees F and having a flame spread of 25 or less and a smoke development of 50 or less when tested in accordance with ASTM E 84. The external vapor barrier shall be a companion two-part compound composed of resins, solvents, and fillers that are UL listed or shall be a vinyl type jacket conforming to L-P-535, Composition A, Type I, Class 2. In addition, an internal vapor barrier shall be created by applying a band of adhesive every 12 inches of length. An end seal and vapor barrier shall be made with a heavy bodied lap seal adhesive. All circumferential and longitudinal overlaps shall be sealed with a mastic.

The design of air or water distribution systems for high temperatures shall include pipe insulation of cellular glass with internal and external vapor barriers as specified for low-temperature systems and shall conform to ASTM C 552 and HH-I-551.

The insulation of refrigeration systems using fluorocarbon shall be either closed cell sheet or tubing insulation conforming to ASTM C 534, Type I for severe design conditions or rigid urethane foam conforming to the burning and smoke characteristics specified above for low temperature systems. Design shall require clean, dry surfaces for application of bonding adhesive.

3.9.7 Flex Hose Assemblies. - Flex hose assemblies shall be in accordance with 79K08260.

3.10 Cooling (Airside) Requirements. - This section applies to the requirements for design of gas distribution systems used to condition, ventilate, or purge GSE and vehicle spaces or to cool liquid secondary coolants. These coolants are permanent gases or a gas mixture with normal boiling point below minus 150 degrees F.

3.10.1 Air-Conditioning and Ventilation. - The design of air distribution systems shall comply with NFPA No. 90A and the ASHRAE Fundamentals Handbook. The air handling units shall be fan coil or built-up units.

3.10.1.1 Blowers and Fans. - Air-moving equipment for low-pressure systems shall comply with AMCA Bulletin 99 when tested to AMCA Bulletin 210.

3.10.1.2 Turbocompressor. - Air-moving equipment for high-pressure systems shall comply with ASME power test code PTC-10. Bearings shall be designed for a minimum life of 5 years per AFBMA 10. Noise measurements shall be made in accordance with AMCA Bulletin 300. Design shall make turbo compressor accessible for balancing without disassembly.

3.10.1.3 Motors. - Motors for blowers, fans, turbocompressors, and pumps shall meet all requirements of NEMA motor and generator standards and consider the recommendations of KSC-DD-404. The motors shall be squirrel-cage induction type with NEMA design B starting and torque characteristics and class B insulation. All motors 3 hp or greater shall be totally enclosed, fan-cooled construction.

3.10.1.4 Plenums. - Intake, heating, cooling, and filter plenums shall be designed to attenuate sound, prevent condensation, provide thermal insulation, and absorb vibration. Plenum thermal insulation and adhesives shall comply with NFPA No. 90A. Where design shows filters in the plenum, such filters shall be in accordance with 3.10.1.9.

3.10.1.5 Rigid Ducts. - Rigid air ducts shall conform to the following requirements:

a. High-pressure-rated ducts shall be designed to SMACNA 1975-4 standards for high-velocity duct construction with materials of construction compatible with intended use. Inner ducts shall be aluminum.

b. Low-pressure-rated ducts shall be designed to SMACNA 1976-1 standards for low-velocity duct construction using fiberglass, galvanized sheet metal, aluminum, or stainless steel.

c. The recommended design and application practices in the ASHRAE Fundamentals Handbook for insulation and water vapor barriers installation shall apply.

d. Environmental control system dust caps shall be in accordance with 79K08152.

3.10.1.6 Flexible Ducts. - Flexible air ducts and components shall conform to 79K07614, 79K18243, and 79K09457.

3.10.1.7 Air Coolers/Dehumidifiers. - Air coolers shall be designed with respect to the intended application and tested in accordance with ASHRAE Standard 33. Coil design shall comply with the TEMA Standard. Plenum design shall conform to applicable standards in 3.10.1.4.

3.10.1.8 Air Heaters. - Heating and reheat applications shall be in accordance with UL construction requirements and NEC installation standards. Electric duct heaters shall have a minimum of 2 feet of metal ducting downstream of the heater in accordance with SMACNA 1975-2.

3.10.1.9 Filters. - Filters shall be designed into all ECS and GSE systems to meet the level of cleanliness required and to provide protection for the equipment. Electrostatic or medium efficiency type filters, in conjunction with prefilters of the ordinary efficiency type shall ordinarily be used. High-efficiency particulate air (HEPA) filters with preflters shall be used where extremely clean air is required.

Filters shall be installed immediately upstream of all interfaces where control of particulate matter is critical and at other appropriate points as required for particulate control. Selection of the equipment shall be based upon the performance requirements to ensure maximum protection with least performance penalty (pressure drop). Filters shall be compatible with the intended application.

a. Prefilters shall be used to prevent excessive loading of the primary filter and shall be either the throwaway spun glass mat or individual type. Prefilters shall be used in fresh air intakes and prior to primary filters. Cleanable type filters shall not be used.

b. Primary filters shall be medium efficiency filters used to clean supply air.

c. Final filters shall be HEPA type where extremely clean air is required for clean rooms and facilities handling bacteriological and high toxic materials. Minimum efficiency of 99.97 percent on 0.3 micron or larger particles based on the dioctylphthalate smoke and a maximum gage pressure drop of 1.0 inch of water when operated at rated flow. All HEPA filters shall be UL listed as fire resistive type and shall have prefilters of Group II or Group III as specified in FED-STD-209.

d. Activated carbon filters shall be used where odor producing gases and vaporized impurities are to be removed. All carbon filters shall be downstream of a high-efficiency filter of 85 or 95 percent.

3.10.2 <u>Environmental Control Systems, Ground Coolant Systems, and Coolant Servicing Systems for Clean Rooms.</u> - Clean room specification of design requirements shall conform to FED-STD-209.

3.10.2.1 <u>Air Cleanliness Classes.</u> - Air shall be classified as to cleanliness level in accordance with FED-STD-209. Air shall conform to the requirements of 3.4.2.5. A class 100 clean room particle count shall not exceed a total of 100 particles per cubic foot of 0.5 micron or larger.

3.10.2.2 <u>Standard Clean Room.</u> - Design of the room, anterooms, entryways, furnishings, and air distribution/conditioning systems shall be in accordance with FED-STD-209, appendix paragraphs 40 and 50.

Laminar airflow design shall be used to meet any or all classes of cleanliness per class 100, 10,000 and 100,000 clean rooms. Nonlaminar airflow design shall not be used for class 100 level cleanliness but may be used in conjunction with laminar flow for class 10,000 and may be used exclusively for class 100,000 air.

3.10.2.3 <u>Laminar-Flow Clean Room or Work Areas.</u> - Design of the room, anterooms, entryways, furnishings, and air distribution/conditioning systems shall be in accordance with FED-STD-209, appendix paragraphs 40.2 and 50.1 for laminar-flow and class 100 air.

4. QUALITY ASSURANCE PROVISIONS

4.1 Design and Development Controls. - The designer shall ensure that the following are specified as required to assure quality and to fulfill the design intent:

a. Inspection and test criteria (including specific nondestructive test methods, test equipment, environmental conditions, and sample size)

b. Identification and data retrieval requirements

c. Identification of critical hardware characteristics necessary for procurement and fabrication

d. Performance and/or tolerance limits

e. Applicable process specifications for cleanliness/contamination control

f. Applicable process specifications, standards, and procedures

g. Limited-life requirements

h. Acceptance/rejection criteria

i. Handling, storage, preservation, marking, labeling, packaging, packing, and shipping requirements

j. Equipment to be placed under integrity control

k. Packaging, handling, and transportation

l. Marking for shipment

4.2 Contractual Requirements. - When this standard is invoked in a contract, the statement of work shall invoke the applicable provisions of NHB 5300.4 (1C) or NHB 5300.4(1B), or both.

5. PREPARATION FOR DELIVERY

5.1 Packaging, Handling, and Transportation. - The packaging, handling, and transportation of ECS, ground coolant system, and coolant servicing system GSE elements shall be in accordance with NHB 6000.1. Packaging, handling, and transportation requirements specific to certain GSE shall become part of the individual element detailed specification.

5.2 Marking for Shipment. - All containers shall be marked in accordance with MIL-STD-129. Hazardous materials shall be marked in accordance with applicable Freight Tariffs.

6. NOTES

This standard defines the requirements for the design of ECS, ground coolant system, and coolant servicing system GSE and does not constitute a specification for the procurement, fabrication, or installation of the systems or elements.

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