METRIC/INCH-POUND

KSC-STD-Z-0008
Revision D

DESIGN OF GROUND LIFE SUPPORT SYSTEMS AND EQUIPMENT,

STANDARD FOR

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October 20, 2020

Engineering Directorate

National Aeronautics and
Space Administration

John F. Kennedy Space Center

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DESIGN OF GROUND LIFE SUPPORT SYSTEMS AND EQUIPMENT,

STANDARD FOR

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October 20, 2020

JOHN F. KENNEDY SPACE CENTER, NASA

RECORD OF REVISIONS/CHANGES

REV LTR	CHG NO.	DESCRIPTION	DATE
		Basic issue.	
A		Revision update.	March 1, 1984
B		Revision update.	July 15, 1991
C		Revision update.	October 14, 1996
D		Updated to replace outdated reference documents. Eliminated requirements that are duplicated. Aligned with current design practices and standards.	October 20, 2020

CONTENTS

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

°	degree
ACGIH	American Conference of Governmental Industrial Hygenists
ASME	American Society of Mechanical Engineers
BPVC	Boiler and Pressure Vessel Code
C	Celsius
CCAFS	Cape Canaveral Air Force Station
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
dB	decibel
F	Farenheit
ISO	International Organization for Standardization
KSC	Kennedy Space Center
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
ppm	part per million
psig	pound per square inch gauge
SDS	safety data sheet
TLV	threshold limit value
µ-in	micro-inch

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1. SCOPE

1.1 Purpose

This standard establishes minimum requirements for materials, processes, and engineering practices for the design of ground life support ground systems and equipment for use at KSC and other installations under KSC design responsibility. Where the requirements of this standard do not meet the minimum program or project requirements, those program or project requirements shall take precedence.

1.2 Applicability

a. This standard applies to all fixed, portable, and mobile life support systems and equipment used to provide service or protection for a user who will be working in, escaping from, or resuscitating a victim physically injured within or exposed to one or more of the following environments:

   (1) fuel vapors (hydrazine, monomethylhydrazine, unsymmetrical dimethylhydrazine, Aerozine 50, hydrogen);

   (2) oxidizer vapors (nitrogen tetroxide, inhibited red-fuming nitric acid, hydrogen peroxide);

   (3) smoke;

   (4) oxygen-deficient atmospheres (nitrogen-purged areas, partial vacuum, areas containing fire-extinguishing agents such as carbon dioxide and Halon 1301);

   (5) ammonia.

b. These requirements apply to new equipment that has not been verified to meet requirements of a previous revision of this standard. Equipment designed or fabricated prior to the effective date of this standard may be verified as acceptable for use against the requirements of a previous revision of this standard. Any design changes to such equipment shall meet the requirements of this revision of this standard.

   National Institute for Occupational Safety and Health (NIOSH) approved equipment is exempt from the requirements of this standard.

1.3 Use of Shall, May, Should, and Will

In this standard, “shall” denotes mandatory actions (i.e., requirements) that are verified. “May” denotes discretionary privilege or permission. “Should” denotes a good practice that is recommended but is not required. “Will” denotes an expected outcome, a requirement levied by others, or a requirement that does not have mandated verification. When this standard is placed on a contract, the “will” statements in this standards manual are equivalent to “shall” statements for the purposes of the contract.

2. APPLICABLE DOCUMENTS

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

Copies of the documents are available from the NASA Technical Standards website (http://standards.nasa.gov), any NASA installation library or documentation repository, or from the procuring activity.

2.1 Government Documents

NASA

MPCV 70156	Cross Program Fluid Procurement and Use Control Specification
SSP 30573	Space Station Program Fluid Procurement and Use Control Specification

KSC

KNPR 1820.4	KSC Respiratory Protection Program
KNPR 8715.3-1	KSC Safety Procedural Requirements Volume 1, Safety Procedural Requirements for Civil Servants/NASA Contractors
KSC-DE-512-SM	Ground Systems Development Standard
KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies, Specification for
KSC-STD-Z-0005	Pneumatic Ground Systems Development Standard
PRO-P-0001	KSC/CCAFS Propellants/Pressurants Sampling Plan

CFR

29 CFR	Code of Federal Regulations Title 29: Labor Part 1910: Occupational Safety and Health Standards
42 CFR	Code of Federal Regulations Title 42: Public Health Part 84: Approval of Respiratory Protective Devices

49 CFR	Code of Federal Regulations Title 49: Transportation Parts 171 through 180: Hazardous Materials Regulations

2.2 Non-Government Documents

ASME

ASME B40.100	Pressure Gauges and Gauge Attachments
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME BPVC-VIII	ASME Boiler & Pressure Vessel Code, Section VIII

ASTM

ASTM F739-12	Standard Test Method for Permeation of Liquids and Gases through Protective Clothing Materials under Conditions of Continuous Contact

CGA

CGA G-7.1	Commodity Specification for Air

ISO

ISO 15859	Space Systems – Fluid Characteristics, Sampling, and Test Methods Part 1: Oxygen Part 13: Breathing Air

3. DEFINITIONS

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

Aerozine 50: a 50/50 mixture by weight of hydrazine and unsymmetrical dimethylhydrazine.

fixed equipment: equipment that is designed to remain in place, attached to permanent foundations.

Halon 1301: common name of bromotrifluoromethane ($CBrF_3$), also knowns as R13B1 or Halon 13B1.

mobile equipment: equipment that is designed to be moved from place to place on wheels, skids, or other specialized handling equipment.

portable equipment: equipment that is designed to be carried by one individual.

supplied air respirator: a respirator that makes use of a hose to deliver air from a stationary source.

4. SYSTEM REQUIREMENTS

4.1 Design Requirements

a. In addition to the requirements in this standard, life support systems and equipment shall comply with KSC-STD-Z-0005.

b. Life support systems and equipment will comply with 29 CFR 1910 and 42 CFR Part 84.

c. Mobile life support systems and equipment will comply with 49 CFR Parts 171 through 180.

4.2 Operating Media

a. Life support systems and equipment shall use liquid air, gaseous air, or gaseous oxygen in accordance with program or project requirements.

PRO-P-0001 contains the specifications required by the International Space Station (SSP 30573) and Space Launch System (MPCV 70156) programs, as well as industry standard specifications (ISO 15859-1, -13).

b. Oxygen shall not be used in systems previously designed for air.

c. Oxygen shall not be used with supplied air respirators.

d. Liquid air use concentration shall not exceed 30% oxygen by mass.

Liquid air is an unstable mixture and its composition is constantly changing during use. The limiting values given in this standard are for the purpose of one-time acceptance of liquid air for procurement only.

4.3 Interior Surfaces

a. Interior (wetted) surfaces should have a surface roughness not to exceed a nominal roughness grade of 63 μ-in in accordance with ASME B46.1.

b. Paint or other surface coatings shall not be applied to interior surfaces.

c. All interior surfaces shall initially be cleaned to level 300A or better in accordance with KSC-DE-512-SM. From that point, respirators will be maintained visually clean as defined by the respirator manufacturer or the KSC Engineering Technical Authority.

4.4 Welding, Brazing, and Soldering

a. Welding shall be in accordance with KSC-DE-512-SM and KSC-SPEC-Z-0008.

b. Brazing shall be in accordance with KSC-DE-512-SM.

c. Soldering shall not be used on life support systems and equipment.

4.5 Material Compatibility

Life support systems and equipment shall be designed and evaluated for material compatibility in accordance with KSC-DE-512-SM.

4.6 Allowable Leakage and Permeation

a. Leakage for portable gaseous air or portable gaseous oxygen supply systems shall not exceed:

(1) 0.004% of usable compressed cylinder volume per hour between the cylinder and primary shutoff valve, with the primary shutoff valve closed;

(2) 0.16% of usable compressed cylinder volume per hour for components between the primary shutoff valve and second-stage regulator or resuscitator head, with the primary shutoff valve open and second-stage regulator closed.

b. Reverse leakage of hazardous vapors through a facemask seal shall not exceed the occupational exposure limit defined in KNPR 1820.4.

c. Permeability of hazardous vapors through protective clothing or equipment, as defined by ASTM F739-12, shall not exceed the occupational exposure limit defined in KNPR 1820.4.

4.7 Acceptance Testing and Acceptance Data Packages

Life support systems and equipment shall meet the acceptance testing and acceptance data package requirements of KSC-STD-Z-0005.

4.8 Packaging, Handling, and Transportation

a. Packaging, handling, and transportation of life support systems and equipment shall be in accordance with KSC-DE-512-SM.

b. Prior to transportation, life support systems and equipment shall be pressurized to 20 ± 5 psig with gaseous air in accordance with CGA G-7.1, Type 1, Grade E, to prevent contamination intrusion.

5. COMPONENT REQUIREMENTS

Fluid components shall be in accordance with KSC-STD-Z-0005 in addition to the requirements specified herein.

5.1 Pressure Vessels

All pressure vessels shall be in accordance KSC-DE-512-SM.

5.2 Fusible Plug/Burst Disc Assembly

a. A fusible plug/burst disc assembly, venting to atmosphere, shall be incorporated when a portable pressure vessel is used.
b. No functional components shall be installed between the pressure vessel and the assembly.
c. The burst disc shall meet the requirements of ASME BPVC-VIII.1 for fixed and portable life support systems and equipment, or 49 CFR for mobile life support systems and equipment.
d. The fusible plug shall melt at 98-105°C (208-220°F).
e. The discharge flow rate, upon rupture of the burst disc, shall not be less than the flow rate of the nearest downstream relief valve.
f. The configuration shall be designed to prevent impingement of the discharge gas on adjacent parts or on operating personnel.
g. The fusible plug/burst disc assembly shall be accessible for easy removal and replacement.

5.3 Flexible Hoses and Tubes

Flexible hoses and tubes shall be selected, installed, and inspected in accordance with KSC-DE-512-SM and KNPR 8715.3-1.

5.4 Filters

A 10- to 30-micron (absolute rating) filter shall be incorporated upstream of each pressure regulator.

5.5 Quick-Disconnect Couplings

a. Quick disconnect coupling seats and seals shall be nonmetallic and replaceable.
b. Both halves of the coupling shall incorporate automatic closure upon separation.
c. Supplied air couplings shall be incompatible with facility outlets of other gas systems to prevent inadvertent connection of supplied air respirators with non-respirable gases or oxygen.
d. With the exception of systems that interface with astronaut suit or rescue equipment, couplings used in breathing air systems at KSC or Cape Canaveral Air Force Station shall be 9.5 mm (3/8 in) Hansen quick coupling or KSC Engineering-approved equal.

5.6 Pressure Regulators

a. Pressure regulators shall be used where pressure lower than the air or oxygen source pressure is needed.

b. The regulator outlet pressure shall be greater than or equal to 2% of the supply pressure.

c. The pressure regulator shall maintain the specified outlet set pressure to within ±10% of the set pressure across the entire specified supply pressure range.

d. The pressure regulator shall be designed to fail in the closed position without damage to any other components in the system.

5.7 Shutoff Valves

a. Shutoff valves shall be of the angle, globe, or metering (needle) type.

b. The valve stem seal shall not be subjected to the supply pressure when the valve is in the closed position.

c. Valves shall have replaceable non-metallic seats.

d. The valve shall be designed and constructed to prevent removal of the stem from the valve body during normal use to avoid sudden release of pressure when the valve is opened.

5.8 Inhalation Valves

Inhalation valves on facemasks and facepieces shall be protected against distortion and accidental damage.

5.9 Exhalation Valves

Exhalation valves on facemasks and facepieces shall be designed and constructed to prevent inward leakage of contaminated air to the extent that the air or oxygen inside the facemask or full facepiece remains within specification requirements.

5.10 Check Valves

Check valves shall be spring-loaded with replaceable non-metallic seats.

5.11 Relief Valves

a. relief valve shall be installed immediately downstream of each pressure regulator.

b. The relief valve flow capacity shall be greater than or equal to the flow capacity of the fully-open upstream pressure regulator.

c. The relief valve spring shall be outside of the fluid flow path.

d. Relief valves shall have replaceable non-metallic seats.

5.12 Facemasks and Full Facepieces

a. A facemask used for medical purposes (e.g., on a resuscitator) shall be transparent to permit viewing of the mouth and nasal passages.

b. A full facepiece (i.e., used to cover the entire face and provide panoramic vision) will comply with 42 CFR Part 84.

5.13 Head Harnesses and Carrying Cases

a. Head harnesses attached to a facemask or full facepiece shall provide adequate tension for sealing purposes, and evenly-distributed pressure over the area of contact between the facemask or full facepiece and the face.

b. Flexible head harnesses shall provide elasticity for at least partial self-adjustment, and for easy detachment from the facemask or full facepiece and subsequent reattachment.

c. Rigid head harnesses shall provide adjustment features for widely varying head sizes and shapes, and quick-don capability of the facemask or full facepiece to the face.

d. When a carrying case is used, the case shall hold all items firmly in place when oriented in any position, and protect items from damage when dropped in any orientation from a height of 5 feet onto a concrete floor.

5.14 Pressure Gauges

a. On fixed and mobile life support systems and equipment, pressure gauges shall be installed before and after each regulator and shall conform to ASME B40.100.

b. On portable life support systems and equipment, pressure gauges shall be of the dial type and shall conform to 42 CFR, Part 84.

5.15 Flow Meters

Flow meters shall be the volumetric measuring type with an accuracy within ±5% of the reading.

5.16 Warning Devices

a. Warning devices shall be of the audible type as specified in 29 CFR 1910.134.

b. Additional visual warning devices (e.g., lights) shall be installed in areas subject to high noise levels, where hearing protection is required or where remote compressor equipment cannot be heard.

c. On fixed life support systems and equipment, an end-of-service-life (i.e., depletion of operating medium) warning device shall be installed on all pneumatic supply sources and compressor systems to indicate:

(1) compressor failure, located on the compressor;

(2) compressor overheating, located on the compressor;

(3) carbon monoxide levels greater than 10 parts per million (ppm), located within the first 3 feet of piping or tubing exiting the compressor;

(4) oxygen concentration less than 19.5%, located within the first 3 feet of piping or tubing exiting the compressor.

d. On mobile and portable liquid life support systems and equipment monitored by operating personnel, depletion of operating medium shall be monitored with pressure gauges.

e. On mobile and portable liquid life support systems and equipment not monitored by operating personnel, an audible end-of-service-life warning device shall be installed to:

(1) operate in any orientation;

(2) indicate a minimum of 20% of remaining useful life, taking into account any air or oxygen vented to the atmosphere as a result of operation of the warning device;

(3) produce 50-60 decibels (dB) when intended for use in a quiet environment (e.g., hospital room), or otherwise produce 75-85 dB.

5.17 Piping, Tubing, and Fittings

a. Piping, tubing, and fittings in fixed and mobile life support systems and equipment shall be in accordance with KSC-STD-Z-0005.

b. Piping, tubing, and fittings in portable life support systems and equipment shall be in accordance with KSC-STD-Z-0005 or standard commercial practices.

c. Flared tube assemblies in fixed and mobile life support systems and equipment shall be fabricated and installed in accordance with KSC-SPEC-Z-0008.

6. NOTES

6.1 Intended Use

This standard defines the requirements for design of life support ground systems and does not constitute a specification for the procurement, fabrication, or installation of the system or components.

6.2 Citation Data

Contract documents should cite this standard by number, title, and date. Drawings should cite this specification by number in a general note.

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