MAN-SYSTEMS INTEGRATION STANDARDS

NASA-STD-3000
VOLUME II

REVISION B
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NASA
National Aeronautics and
Space Administration

FOREWORD

This is Volume II of the Man-Systems Integration Standards (MSIS) prepared for the National Aeronautics and Space Administration (NASA) The MSIS consists of a family of documents with a video tape as an adjunct . Each document volume has a specific purpose, as stated below, and each has been assembled from the data contained in Volume I.

The title and scope of each current volume are given below:

Volume I - Man Systems Integration Standards

This document contains man-systems integration design considerations, design requirements, and example design solutions for development of manned space systems. This is a NASA-level standards document applicable to all manned space programs including NASA, military, and commercial programs.

Volume II - Man-Systems Integration Standards - Appendices

This volume contains the appendices which pertain to the MSIS, and is organized as follows:

Appendix A	Bibliography
Appendix B	Paragraph References
Appendix C	Glossary
Appendix D	Abbreviations and Acronyms
Appendix E	Units of Measure and Conversion Factors
Appendix F	Not Applicable
Appendix G	Acceleration Regime Applicability
Appendix H	Video Tape User's Guide
Appendix I	Not Applicable
Appendix J	Keywords
Appendix K	MSIS Recipients Listing

Volume III - Man-Systems Integration Standards - Design Handbook

This volume is a condensed field guide of pertinent quantitative data extracted from Volume I.

Chapters of the MSIS family of documents are as follows:

1. Introduction
2. General Requirements
3. Anthropometry and Biomechanics
4. Human Performance Capabilities
5. Natural and Induced Environments
6. Crew Safety

7. Health Management
8. Architecture
9. Work stations
10. Activity Centers
11. Hardware and Equipment
12. Maintainability
13. Facility Management
14. Extravehicular Activity

Volume IV - Space Station Man-Systems Integration Standards

This volume underwent many changes as we phased into the International Space Station Alpha (ISSA) program. A smaller volume was developed from Volume IV and published as an ISSA document entitled **International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)** with ISSA document number **SSP-50005**. This document will be maintained by the ISSA publishing operations in Interleaf format. The contents of the SSP-50005 document will be monitored and controlled by the ISSA Flight Crew Support and Integration Team.

Volume V - STS Man-Tended Payload Man-Systems Integration Standards

Deleted.

Volume VI - Assured Crew Return Vehicle Man-Systems Integration Standards

This document served as the Assured Crew Return Vehicle (ACRV) project man-systems integration design requirements. The data in this document is a subset of the data found in Volume I and defines the requirements which were pertinent to the ACRV as defined in the ACRV documentation. Additional data and guidelines were provided to assist in the design. The data contained in this volume which is pertinent to the International Space Station Alpha (ISSA) has been incorporated into ISSA document SSP-50005.

The original MSIS document was assembled for NASA by the Boeing Aerospace Company (BAC), Kent, Washington, in conjunction with subcontractors Lockheed Missiles and Space Company (LMSC), Sunnyvale, California; Essex Corporation, Huntsville, Alabama; and CAMUS, Inc., Springdale, Arkansas. The contractor team leaders and section authors for this effort are listed in Figure F-1. Subsequent iterations to the MSIS will be developed for NASA by the custodial organization at JSC.

A Government\Industry Advisory Group (GIAG), composed of a panel of "Experts" and "Users", met four times to review the technical content as it was being developed.

The six GIAG Experts were as follows:

Julien M Christensen (PhD) - Chief Scientist, Human Factors, Universal Energy Systems, Inc., Dayton, Ohio.

James W. McBarron - Chief, Shuttle Support Branch, Crew Systems Division, NASA-Johnson Space Center, Houston, Texas.

John T. McConville (PhD) - President, Anthropology Research Project, Inc, Yellow Springs, Ohio.

William R. Pogue - Ex-Skylab astronaut, CAMUS, Inc., Springdale, Arkansas.

Robert C. Williges (PhD) - Prof. of Industrial Engineering and Operations Research/Prof. of Psychology, Virginia Polytechnic Institute, Blacksburg, Virginia.

Wesley E. Woodson - President and Research Director, Man-Factors, Inc., El Cajon, California.

The GIAG User group was composed of invited representatives form all of the prime aerospace contractors, support contractors, NASA centers and Headquarters, other Government agencies, and some non-aerospace contractors. The GIAG Users who participated in at least one of the GIAG meetings are listed in Figure F-2.

The technical content of these documents has been thoroughly reviewed by the GIAG participants. The data can be used with confidence that all known relevant human engineering requirements applicable to the space environment have been documented and are as technically valid as it is possible to determine. Iterations to the MSIS will be developed as physiological and technical knowledge and requirements dictate.

Comments from any user are welcome and will be considered for updating the database and the documentation. A Recommendations and Comments form appears at the end of this volume to facilitate user inputs.

Figure F-1

Contractor Team and Topic Assignments		
BOEING AEROSPACE COMPANY		
Charles W. Geer	Program Manager	
Keith H. Miller	Technical Leader/Editor-in-Chief	
	1.0	Introduction
	2.0	General Requirements
	6.0	Crew Safety
(Robert Horne)	11.0	Hardware and Equipment
	13.0	Facility Management
	Vol. 2	Appendix
Eric Liening/Han Peters	5.1	Atmosphere
	5.8	Thermal Environment
Patrick Cornelius/Keith Miller	5.2	Microgravity
	5.3	Acceleration
	5.9	Combined Environmental E
Charles Wright	5.4	Acoustics
	5.5	Vibrations
Eugene Normand	5.7	Radiation
Ethel E. Erickson		SDMS Data Entry and Proofreading
LOCKHEED MISSILES & SPACE COMPANY		
Dr. David Regal	Subcontract Technical Leader	
	4.0	Human Performance Capabilities
	9.0	Workstations
Barry Tillman	3.0	Anthropometry and Biomechanics
	7.0	Health Management
	8.0	Architecture
	10.0	Activity Centers
Stuart Parsons/David Regal	12.0	Design for Maintainability
ESSEX CORPORATION		
Nicholas Shields	Subcontract Technical Leader	
	14.0	Extravehicular Activity (EVA)

Figure F-2

Government/Industry Advisory Group
User Group
(Attended One or More of the GIAG Meetings)

Cletis Booher	NASA - Johnson Space Center
Gerald Carr	CAMUS, Inc
Gerald Chaikin	Chief, HEL Detachment, MICOM
Bryant Cramer	NASA Headquarters
T. Lee Doolittle	University of Washington
Capt. Vance Gilstrap	USAF Space Division
Rob Gray	ILC Dover
Richard F. Haines	NASA - Ames Research Center
Lt. Cdr. Steve Harris	Naval Air Test Center
Marion Hix	NASA - Goddard Space Flight Center
Capt. David Hoerr	NASA - Johnson Space Center
Marshall W. Horton	NASA - Johnson Space Center
Gary A. Johnson	McDonnell Douglas Astronautics Company
Neil A. Johnson	United Airlines Aircrew Training Center, Inc.
Rod Jones	NASA - Johnson Space Center
Joseph P. Joyce	NASA - Lewis Research Center
Mary M. Jurmain	Technology Inc.
Robert Kain	NASA - Johnson Space Center
Robert Kerle	Grumman Aerospace Corp.
Dave Kissinger	NASA - Johnson Space Center
Joseph J. Kosmo	NASA - Johnson Space Center
Ronald V. Kruk	CAE Electronics Ltd.
Lynn L. Lally	Lockheed Emsco
Pieter Lammers	European Space Agency
William A. Langdoc	NASA - Johnson Space Center
John Lauffer	Rocketdyne Corp.
Joel H. Leet	NASA - Kennedy Space Center
Charles M. Lewis	NASA - Marshall Space Flight Center
James L. Lewis	NASA - Johnson Space Flight Center
James S. Logan M.D.	NASA - Johnson Space Center

Figure F-2 (Continued)

Government/Industry Advisory Group

User Group
(Attended One or More of the GIAG Review Meetings)

Mike Lounge	NASA - Johnson Space Center
Don B. Morris	Rockwell International
Debra Muratore	Mitre Corporation
Melinda H. Naderi	NASA - Marshall Space Flight Center
D. C. Nagel	NASA - Ames Research Center
George Nelson	NASA - Johnson Space Center
Bob Overmyer	Martin Marietta Corp.
Stuart Parsons	Lockheed Missiles and Space Company
Virgil A. Paull	Martin Marietta Corp.
Maj. John C. Pellosie	USAF AAMRL/HEG
Martín Pollack	Grumman Aerospace Corp.
Larry Price	McDonnell Douglas Astronautics
A. M. Lex Ray	Martin Marietta
John A. Roebuck	Rockwell International
Dane Russo	Northrup Services
Patricia Santy, M.D.	NASA - Johnson Space Center
Richard Sauer	NASA - Johnson Space Center
R. W. Scarlata	General Electric
Gerald Shinkle	NASA - Johnson Space Center
Daniel H. Spoor, M.D.	Technology Inc.
Jack Stokes	NASA - Marshall Space Flight Center
Earl Switzer	Arinc Research Corp.
Allen B. Thompson	Martin Marietta - Denver
Robert Trevino	NASA - Johnson Space Center
Conway Underwood	Boeing Aerospace Company
Frank Welman	Arinc Research Corp.
Charles Wheelwright	NASA - Johnson Space Center
H. Eugene Winkler	NASA - Johnson Space Center
Harry L. Wolbers	McDonnell Douglas Astronautics Company
Maj. Lynn Woolard	NASA - Kennedy Space Center
Barbara Woolford	NASA - Johnson Space Center

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APPENDIX A

BIBLIOGRAPHY

USER'S GUIDE

This bibliography includes all of the human engineering standards, data books, and technical documents that were reviewed to obtain the man-systems integration design considerations, requirements, and examples given in this document. The references that are cited as source documents for either the text or figures are noted by having an asterisk located after the reference number. Those references that are not so notated were given due consideration but found not to have data appropriate for these standards.

In the following listing, the reference citation is as follows:

Reference No.
Document No.
Used by Originator
Author (if cited)
Document Title
(Document Title Line 2, if required)
Prepared by
Published by
Publication Date

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APPENDIX C

MSIS GLOSSARY LIST

5th Percentile Oriental Female

Oriental females falling at the 5th percentile based on the size of the oriental female population. The smallest human size considered for design purposes.

95th Percentile Caucasian Male

Caucasian males falling at the 95th percentile based on the size of the Caucasian male population. The largest size considered for design purposes.

Abduction

The movement of a body segment away from the midline of the body or body part to which it is attached.

Acceleration

The time rate of change of velocity.

Acidosis

Reduction of alkali reserve due to excess of acid metabolites.

Actuation force

The force required to operate a mechanical device such as a tool, access door, or fastener.

Acute $C0_2$ Toxicity

Condition of exposure to high-level concentrations of carbon dioxide; associated physiological response.

Adaptive Response

Change in structure, form, or behavior of an organism to suit a new environment.

Adduction

The movement of a body segment or segment combination toward the midline of the body or body part to which it is attached.

Aerobic Power

Aerobic power is the total amount of power an individual generates. It is related to useable power output by an efficiency factor which varies with the task and the individual.

Alveolar Pressure

Gas pressure existing within alveoli.

Alveoli

The air sacs of the lung.

Anatomical Position

A baseline posture for measuring joint motion range. The posture is standing upright, head facing forward, arms hanging down with the palms facing forward.

Annoyance

The sense of being troubled, irritated, or disturbed by unwanted noise

Anoxia

Total lack of oxygen.

Anthropometry

Anthropometry is the application of scientific physical measurement methods to human subjects for the development of engineering design standards and specific requirements and for evaluation of engineering drawings, mock-ups, and manufactured products for the purpose of assuring suitability of these products for the intended user population.

Anxiety

Nervous or fear reaction to perception of danger.

Astigmatism

A defect of an optical system in consequence of which rays from a point fail to meet in a focal point resulting in a blurred and imperfect image.

Atelactasis

Collapsed or airless state of all or part of the lung.

Atmosphere

1) The mixture of gasses surrounding the Earth or filling the habitable volume of a spacecraft.

2) The pressure exerted by a column of mercury 760 mm high at 1 G, equal to 101.329 kilopascals.

Beats

A periodic sound resulting from the interaction of two or more sounds of different frequencies.

Bends

Common symptom of decompression sickness. Caused by gas bubbles in blood stream. Characterized by pain, poorly localized but tending to occur in joints.

Binary Number System

A base 2 number system using only 1's and 0's. Well suited for electronic logic where the 1's and 0's can be represented by signal present and signal absent.

Binaural

Of, relating to, or involving both ears.

Biomechanics

Biomechanics is the interdisciplinary science (comprising mainly anthropometry, mechanics, physiology, and engineering) of the mechanical structure and behavior of biological materials. It concerns primarily the dimensions, composition, and mass properties of body segments; the joints linking the body segments together; the mobility in the joints; the mechanical reactions of the body to force fields, vibrations, and impacts; the voluntary actions of the body in bringing about controlled movements, in applying forces, torques, energy and power to external objects like controls, tools, and other equipment.

Bit-Mapped Graphics

The data that defines the pixel color which is behind the screen pixel.

Blackout

(see Graying of Vision)

Body Envelope

The volume envelope which just encloses the body and body motions during an activity.

Bolus

Used in this document to designate mass of fecal discharge.

Bremsstrahulung

Gamma radiation emitted by an electron when it is deflected by the Coulomb field of an atomic nucleus of charge Z; the fraction of energy radiated as photons by an electron of initial energy E (Mev) is approximated numerically by ZE/1000.

Brightness

The amount of light emitted or reflected from a surface.

Brightness Ratio

The ratio of the luminance of two areas or surfaces.

British Thermal Unit (Btu)

The amount of heat required to raise 1 lb of water 60 degrees F, 1 degree F.

Cabinet

A structural housing into which drawers and shelves are installed. Generally, there is no utility connections between the cabinet and the items installed within it. (See: Housing).

Carcinogenesis

Origin or production of cancer

Cardiac Arrythmias

Periodic irregular heartbeat

Cardiovascular System

Pertaining to the heart and blood vessels.

Cartwheeling

Vernacular descriptive of inertial resultant of human body to rotational acceleration around the x-axis. (Refer to Figure 5.3.1-1.)

Cataractogenesis

Causing the formation of cataracts

Central Acuity

Center part of the visual field.

Cerebral Hemodynamic Effects

Blood circulation and pressure effects in the head.

Chassis Leakage Currents

Currents generated by such internal sources as filter capacitors terminated to accessible parts or ground, and capacitive and inductive coupling to accessible parts or ground. These currents can be conveyed form accessible parts and subsequently applied to a crew member.

Chokes

Syndrome of chest pain, cough, and respiratory distress.

Chronic CO_2 Toxicity

Condition of exposure to long-term, low-level excess concentrations of carbon dioxide, associated physiological response.

Circadian Rhythms

Bodily functions rhythmically fluctuating with time. These functions include heart rate, blood pressure, body temperature, and respiratory volume. Generally, these metabolic functions slow for a period of time once during a 24 hour period. The most important activity geared to circadian rhythms is sleep.

CO_2 Withdrawal

Symptoms arising from cessation of exposure to excess CO_2.

Color Saturation

Saturation is the extent to which an object has more or less color. Saturation is, therefore, relative colorfulness.

Coma

Unconsciousness from which an individual cannot be aroused.

Command Language (command set)

A set of terms, each with a precise function, used to control the operations of a computer.

Contaminants

Unwanted material or bacteria.

Continuous Noise

A noise with negligibly small fluctuations of level within the period of observation

Contrast

The difference between the luminance of an object or figure $C = [(Lc + Lr) - (Ld + Lr)] / (Lc + Ld + 2Lr)$ and its immediate background.

C = Contrast

Lc = Object luminance

Ld = Background luminance

Lr = Reflected luminance

Control

A manually operated hardware item used to operate or change the performance of a machine or system.

Core-Shell Concept

Concept of representing a human as a heat-producing core surrounded by a shell (skin) through which heat exchange with the environment takes place.

Coronary Occlusion

Occlusion of a branch of the arterial system that supplies blood to the heart muscle.

Coulomb Friction

Sliding or kinetic Friction.

Crew Station

Any location where a task or activity is performed. There are two basic types of crew stations: workstation and activity center.

Critical Flicker Fusion Frequency

The frequency at which a flashing light will appear as a steady state light - approximately 65 Hz.

Cyanosis

Bluish tinge in mucous membranes and skin due to excessively reduced hemoglobin In capillaries.

Dark Adaptation

Dark adaptation is the state of being adapted (sensitive) to low levels of ambient luminance (brightness). At any one time the visual system operates well within only a limited range of luminance levels. This range is centered about a particular adaptation level that is determined by the prevailing luminance. As the prevailing luminance changes the adaptation level will also change. The adaptation level shifts more quickly to higher than lower luminance levels.

Dead-Faced

An electrically conductive surface incapable of supplying sufficient energy under normal conditions to present a hazard (e.g., the output of a solid-state switch when in the "STANDBY" state).

Decompression Sickness

Collective term for symptoms caused by gas bubbles formed in body tissues and blood from exposure to rapid decrease in barometric pressure.

Default Values

A value or option automatically provided by the computer system for use in processing when no alternative has been specified by the operator.

Delirium

A condition of mental confusion, often with hallucinations.

Denitrogenation

The act of reducing dissolved nitrogen concentration in tissues, usually by breathing mixture devoid of nitrogen.

Dependent Elbow

The elbow being engorged with blood during acceleration.

Design Eye Volume

That volume of space in front of a workstation within which a user's head and eyes should be located to guarantee visual access to all display information. The design of displays and display layout may be guided by a specified design eye volume.

Desquamation

Shedding, peeling, casting off

Diluent Gas

Physiologically inert component of an atmosphere, purpose of which is to reduce oxygen partial pressure-

Direct Contact

The personal contact of a crewmember to electrically powered surfaces.

Direct Glare

Glare produced by a light source located within a person's field-of-view.

Display

Hardware item used to present system information needed by the operator to make decisions for controlling the system.

Door

Used in Section 8.0, Architecture, to denote a full opening body passageway. A door opening is closed with a door cover. A door cannot be sealed against a differential pressure.

Double Insulated Enclosure/Chassis

An enclosure/chassis which incorporates an insulation system comprised of basic insulation and supplementary insulation with the two insulations physically separated and so arrancged that they are not subject to the same deteriorating influences (e.g., temperature, contaminants, and the like) to the same degree.

Drawer

A hardware element designed to slide in and out of a cabinet, rack, or housing. (See: Equipment drawer, Storage drawer)

Dry Bulb Temperature

Air temperature measured by a common thermometer.

Dysbarism

Condition arising from differential pressures between gas pockets in body and ambient. In this document, considered to indicate greater pressure within body cavities.

Dyskinesia

Impaired or abnormal motion of voluntary or involuntary muscles

Dysmetria

Impaired ability to estimate distance in muscular action.

Dyspnea

Difficult or labored breathing.

Ear Clearing

Act of equalizing pressure between inner ear and ambient.

Ebullism

Vaporization of body fluids at body temperature and low barometric pressure.

Edematous Eyelids

Excessive accumulation of fluid in eyelids due to the disturbances of fluid exchange.

Effective Temperature

Empirical sensory index accounting for temperature, humidity and air movement.

Electrical Shock

Sudden stimulation of the nerves and convulsive constriction of the muscles caused by the discharge of electricity through the body.

Emboli

Abnormal particles such as air bubbles circulating in the blood

Embolism

Occlusion of a blood vessel. In the case of gas embolism, by a bubble of gas.

Enclosure/Chassis

The outer casing of an electrical/electronic device.

Enhancement Coding

Any of a variety of techniques used to enhance, or increase the salience of selected items of information (e.g., color coding. It is well suited for interactive computer applications.

Environmental Control

Control of ambient conditions to produce habitable environments.

Equipment Drawer

A drawer used to house subsystem components. The installed components are generally attached to the drawer using fasteners which require tools for attachment/disattachment. It has utility connections to its housing's utility distribution system.

Erythema

Skin reddening (e.g., sun burn)

EVA (Extravehicular Activity)

Activities performed by a space-suited crewmember in an unpressurized or space environment.

EVA Restraint

A means of stabilizing the EVA crewmember which requires physical ingress and egress by the crewmember.

EVA Workstation

Any area at which an EVA task is performed.

Exchange Rate

The increase in sound level (dBA) for which permissible exposure time is halved

Exposure Limit

Maximum safe acceleration exposure limit as a function of vibration frequency and exposure time.

Extension

Straightening or increasing the angle between the parts of the body.

Extravehicular Mobility Unit

An independent anthropometric space suit system that provides crewmembers with environmental protection, life support, mobility, communications, and visibility while performing various EVAs.

Eyeballs Down

Vernacular descriptive of inertial resultant of human body to linear acceleration in the upward + Gz vector. (Refer to Figure 5.3.1-1).

Eyeballs In

Vernacular descriptive of inertial resultant of human body to linear acceleration in the forward -Gx vector. (Refer to Figure 5.3.1-1.)

Eyeballs Left

Vernacular descriptive of inertial resultant of human body to linear acceleration in the left yaw +Gy vector. (Refer to Figure 5.3.1-1.)

Eyeballs Out

Vernacular descriptive of inertial resultant of human body to linear acceleration in the backward +Gx vector. (Refer to Figure 5.3.1-1.)

Eyeballs Right

Vernacular descriptive of inertial resultant of human body to linear acceleration in the right yaw -Gy vector. (Refer to Figure 5.3.1-1.

Eyeballs Up

Vernacular descriptive of inertial resultant of human body to linear acceleration in the downward -Gz vector. (Refer to Figure 5.3.1-1.)

Facility

Equipment or equipment and the area dedicated to a specific crew activity. Similar to the term "Center," but "Facility" can refer to only equipment without specifying an area of use. Examples: Shaving Facilities, Recreation Facility.

Fatigue Decreased Proficiency Boundary

Acceleration boundaries as a function of vibration and exposure time for the preservation of working efficiency.

Flexion

Bending or decreasing the angle between the parts of the body.

Follower

The visual movable indicator on a computer video screen that points to or marks the current position at which a character may be entered.

Foot Restraint

A restraint which stabilizes a crewmember by providing a platform for immobilizing the feet.

Gas Exchange

The flow of gas through a membrane in the small air sacs in the lungs to the blood stream and vice versa.

Gas Tension

The partial pressure exerted by a gas.

Glare

A consequence of bright light sources in the visual field that cause discomfort and/or a decrease in visual functioning. The effect is worse the closer the light source is to the line of gaze. The amount of light scattering within the eye (which varies between individuals effects susceptibility to glare.

Globe Temperature

Physical composite of dry bulb temperature, radiation, and wind effects measured by placing a temperature sensing device in the center of a blackened sphere.

Glottis

Opening between the free margins of the vocal folds.

Graying of Vision

Due to the draining of blood from the occipital region of the brain during acceleration, the vision begins to narrow (tunnel vision) and things appear less bright.

Grayout

(see Graying of Vision)

Grounded Enclosure/Chassis

An enclosure/chassis electrically connected to the ground return.

Gustatory Sensations

Pertaining to the sense of taste.

Habitable Volume

Habitable volume is defined as free, pressurized volume, excluding the space required for equipment, fixtures,

Handhold

A handle or grasp area which is slightly larger than the hand and is used as a mobility aid, hand restraint, or as a hardware mounting surface.

Handrail

A handle or grasp area which is several times longer' than the hand that is used as a mobility aid, hand restraint, or as a hardware mounting surface.

Harmonic

An overtone having a frequency that is an integral multiple of a given primary tone.

Hatch

Used in this document to denote a full body passageway. A hatch opening is closed with a hatch cover. A hatch can be sealed against a differential pressure

Heart Arrhythmia

Lack of rhythm in heart action.

Heat Exhaustion

(Also known as heat prostration) - A syndrome resulting from exposure to high temperatures; characterized by a moist, cold skin, poor circulation, a normal temperature but elevated rectal temperature, restlessness and anxiety.

Heat Stroke

The body temperature rises because of faulty heat dissipation due to high environmental temperature and humidity. Rectal temperatures may go from 106 - 100 deg F.

Hematopoietic

Blood producing

Hemoglobin

Oxygen carrying cells of the blood.

Hemorrhage

Escape of blood from vessels.

Hexadecimal Number System

A base 16 number system used by computers in which each digit represents a power of sixteen. For each digit of a hexadecimal number four digits (24=16) of binary logic are required.

Hierarchical Menu

A set of embedded menus such that entries in all but the lowest level menu will produce another menu when selected.

Housing

A structure into which equipment is installed. (See: Cabinet, Rack)

Hyperbaric

Dealing with ambient pressures which are greater than the gas pressures in the body.

Hyperoxia

Oxygen excess condition arising when greater than normal oxygen partial pressures are encountered.

Hypobaric

Dealing with ambient pressures which are less than the gas pressures within the body.

Hypotension

Low blood pressure

Hypothermia

Subnormal temperature of the body.

Hypoxia

Oxygen deficiency.

Icon

A symbol that graphically resembles its intended meaning (e.g., a schematic drawing or a headlight on the control that is used to control an automobile's headlights).

Illumination

The amount of light (luminance flux) falling on a surface. Measured in lumen/m2 lux = 0.093 ft-c. Illumination decreases with the square of the distance from a point source.

Impact Acceleration

Pulsed or short-duration accelerations of less than 1 sec. duration.

Impact Noise

See Impulse Noise

Impulse Noise

A noise consisting of one or more bursts of sound energy, each of a duration less than about one second

Inaccessible area

Any area with an opening that will accept a loose and floating object of 10mm (0.4in.) diameter and cannot be retrieved or captured by using a retrieval tool and/or crewmember reaching their hand and forearm into the area.

Inclusions

Tiny particles of foreign matter or air bubbles entrained in glass.

Incontinence

Inability to control the natural evacuation of the feces or urine; specifically, involuntary evacuation due to organic causes.

Infrasonic

Sound at frequencies below the audio range, f 20 Hz

Indirect Contact

The contact of a crewmember to electrically powered surfaces through an electrically conducting medium (e.g., probe, rod).

In-Line Circuit Leakage Currents

Unintentional currents which can flow in a conductor. These currents may result from the inability of solid-state electronics to reach an "infinite" impedance "OFF" state, as is the ability of a mechanical switch. The solid-state electronic device has a finite impedance which undesirably completes the input/output circuit thus providing a means for current to flow. Connections to in-line circuits are normally isolated from crewmember inadvertent contact by barriers and may be considered a hazard if accessible to inadvertent crewmember contact. In-line circuits with leakage currents are referred to as in "STANDBY" when placed in the high impedance state since a complete disconnect is not possible and the circuit output is still energized.

Intermittent Noise

A noise whose level suddenly drops to the level of the background noise several times during the period of observation, the time during which the level remains at a constant value, different from that of the ambient being of the order of magnitude of one second or more

Ischial Tuberoscities

Two bony protuberances in the hip structure. These bones support a major portion of the seated body weight in 1-G conditions.

Isolated Patient Contact

A direct or indirect patient contact that is deliberately separated from the supply circuit and ground by virtue of spacings, insulation, protective impedance, or a combination thereof (e.g. intra-aortic pressure monitor).

Isometric Joystick

The isometric joystick, often referred to as a force joystick or a pressure joystick, is a lever that doesn't move. The output of the isometric joystick is a function of the amount of force applied to it.

Isotonic Joystick

The isotonic joystick, often referred to as a displacement joystick, provides an output which is proportional to the displacement of the joystick from the center.

Keystone Effect

A distortion in the shape of a projected image resulting from the film plane and screen plane not being parallel. Usually, magnification will vary from top to bottom or right to left.

Kinesthetic System

Sensations originating in the sense organs of the muscles, tendons, and joints that provide us with a sense of relative body segment movement and position.

Lacrimation

Crying. tear production.

Lateral Rotation

The turning away from the midline of the body.

Leakage Currents

Unconditional currents which can be applied to a crewmember.

Level Equivalent or L_{eq}

Equivalent sound level or time-average sound level in dB. The level of steady sound which, in a stated time period and at a stated location, has the same A-weighted sound in dB energy as the time-varying sound.

Leukopenia

Lack of white blood cells

Light scatter fraction

The ratio of scattered light to specular reflected light.

Line of sight

The optical axis extending from the observers eyes to the target viewed.

Line of sight deviation

The angle which the line of sight is redirected into the eye due to intervening optically refractive material (e.g., prism).

Linear Acceleration

The rate of change of velocity of a mass; the direction of movement of which is kept constant.

Local Vertical

Local vertical is achieved by a consistent arrangement of vertical cues within a given visual field to provide an definable demarcation at the crew station boundary within the visual field. A consistent local vertical within modules is highly desirable.

Long Term Mission

Any mission in which crewmembers are away from earth for a period greater than two weeks.

Luminance

The photometric equivalent of the brightness of an area as viewed from a given direction. More technically, luminance flux per unit of projected area per unit solid angle. Measured in candela per square meter (cd/m2), footlamberts (ft-L, or millilamberts (mL). 1.0 cd/m2 0.31 mL = 0.29 ft-L. The luminance of a surface does not vary with the distance of the observer from the surface being viewed.

Luminance Ratio

The difference between the luminance of an object and its surroundings.

Masking Noise

A background noise or signal with dynamic range in frequency and level sufficient to obscure another noise or signal from aural awareness

Mean Perception

A mild shock perceived by 50% of the population.

Medial Rotation

The toning toward the midline of the body.

Mediastinal Emphysema

Accumulation of gas in the tissues of the mediastinum.

Menu

A method for inputting information to a computer. The menu is a list of the available input options that may be selected.

Meridional

A line or a plane which is normal to the line of sight.

Metabolism

Physiological activity involving utilization of foodstuffs and oxygen to produce tissues and provide for production of energy.

Micturition

Urinary discharge.

Minification

An image that is smaller than actual size.

Minimal Passageway

A minimal passageway is a translation path which is only large enough to permit passage of a space suited crewmember with his or her long axis in the direction of travel.

Mobility Aid

A device (such as a handle) or a surface (padding which facilitates translation in a microgravity environment.

Narcosis

A state of profound stupor, produced by toxic effect of certain substances, in diluent gas narcosis, by excessive partial pressure of diluent.

Narrow Band Noise

A simple or complex tone having intense and steady state frequency components, relative to wideband noise components, in a very narrow band (1, of the octave band or 5Hz, whichever is less) and is heard as a musical sound either harmonic or discordant.

Nausea

Discomfort in stomach with aversion to food and tendency to vomit.

Neurocirculatory System

Concerned with both nervous and vascular systems.

Neutral Body Posture

The characteristic posture that the relaxed human body assumes in microgravity.

No Sensation

The level of perception only perceived by a fractional percentage of the population.

Noise Cancelling

A technique to delete, neutralize, or counteract any unwanted electrical signal within a communication system that interferes with the sound or image being communicated.

Noise Shields

The physical coverings or shells used to protect or screen any unwanted electrical signal within a communication system that interferes with the sound or image being communicated.

Non-adaptive Response

Pathological response to a new environment which presents conditions beyond an organisms ability to adapt to.

Normoxic

Having a normal level of oxygen.

Nuerocirculatory collapse

R psychosomatic disorder characterized by dyspnea, palpitation, vertigo, faintness, fatigue. Tremor, caused by stress, fear, and violent exercise.

Octal Number System

A base 8 number system in which each digit represents a power of eight. For each digit of an octal number three digits (23 = 8 of binary logic are required.

Octave Band

The band of frequencies where the highest frequency is twice that of the lowest frequency

One-Third Octave Band

The band of frequencies In which the ratio of the extreme frequencies is equal to the cubic root of 2: i.e. fn/fe 1.260, where fn and fe are the highest and lowest cutoff frequencies of the band.

Orbital Replacement Unit (ORU)

A piece of equipment (a single item or module containing an assembly of components) which is designed for removal and replacement as a unit.

Ordinary Patient Connection

A direct patient contact that does not have the spacing, insulation, or protective impedance associated with an isolated patient connection (e.g., blood pressure cuff).

Orthostatic Intolerance

Difficulty in standing erect in a l-G environment. This could be due to any number of effects of exposure to microgravity (cardiovascular, muscular, skeletal, or coordination.

ORU Chassis Leakage Currents

Currents generated by such internal sources as filter capacitors terminated to accessible parts or ground, and capacitive and inductive coupling to accessible parts or ground. These currents can be conveyed from accessible parts to ground or other accessible parts and subsequently applied to a crewmember.

Overall SPL

Overall SPL (Sound Pressure Level) is interpreted as including all noise within the frequency range from 22.4 to 11,200 Hz.

Oxygen Atelectasis

Collapsed or airless state of all or part of a lung.

Oxygen Toxicity

Toxic effects of excess oxygen partial pressure.

Parallax Error

The perceived change in relative position of objects at different distances from an observer when viewed from different positions. Can cause errors in the reading of some instruments.

Paresthesias

A sensation of tingling, crawling, or burning of the skin.

Paroxysm

A sudden increase in the appearance or intensity of symptoms.

Pass-Through

A pass-through is a translation path which is only large enough to permit passage by an IVA clothed crewmember with his or her long axis in the direction of travel.

Passageway

A pass-through area between non-adjacent modules or spaces.

Patient

A crewmember instrumented with electrical/electronic equipment.

Patient Connection Leakage Current

Leakage currents measured between patient leads at the patient interface, or between patient leads at the patient interface and ground.

Pattern Coding

A perceptual indicator used to differentiate areas of interest to the observer, or reduce operator search time.

Peak Pressure Level

Peak sound pressure for any specified time interval is the maximum absolute value of the instantaneous sound pressure in that interval.

Percentile

A point on a scale indicating the percentage of persons within a population who have a body dimension of a certain size or smaller. The value of the statistical variable that marks the boundary between the consecutive intervals in a distribution of 100 intervals, each containing one percent of the total population.

Perception

A mild shock.

Perfusional changes

Changes in the flaw rate of blood in blood vessels 21

Petechial Hemorrhages

A minute, rounded spot of hemorrhage on a surf ace such as skin, mucous membrane, serous membrane, or on a cross-sectional surf ace of an organ.

Photokeraratoconjunctivitis

The action of light that causes an Inflammation of the conjuctiva of the cornea of the eye.

Photokeratitis

Inflammation of the cornea.

Physiologically Inert

Substance that does not Interact chemically with the body.

Physiology

The functions of living organisms.

Pixel Addressability

The capability to store or retrieve from, a specific location in memory, the basic unit or picture element that makes up the image displayed in a video screen.

Pleura

Membrane enveloping the lung and lining the thoracic cavity.

Pneumothorax

The presence of gas in a pleural cavity.

Postrun Headache

Headache that occurs after an event.

Predicted Four-hour Sweat Rate

Empirical index incorporating environment, work and clothing to predict sweat production.

Pre-Emphasis

The intentional alteration of the relative strengths of signals at different frequencies (as in radio and in disc recording) to reduce adverse effects (as noise) in the following parts of the system.

Primary Passageway

A primary passageway is a translation path which accommodates a space suited crewmember in an upright working position or neutral body posture.

Prompt

A message or other signal displayed on a computer generated display advising the operator that he or she is expected to provide some specific response.

Pronation

The rotation of the forearm so that the palm faces downward.

Proxemics

The study of the nature, degree, and effect of the spatial separation individuals naturally maintain (as in various social and interpersonal situations) and of how this separation relates to environmental and cultural factors.

Proximity Operations

Any space module related activity that is performed outside the space module and within a specified boundary.

R value

Ratio of initial nitrogen partial pressure to the final total pressure.

Rack

A structure into which equipment drawers or other types of equipment mounting hardware is installed. A rack generally has a built-in utility distribution system that provides interfaces far connecting the installed equipment's utilities.

Random Noise

A sound whose instantaneous amplitudes occur, as a function of time, according to a normal (Gaussian) distribution curve. Random noise need not have a uniform frequency spectrum.

Reaction Time

The time between the presentation of a stimulus and the beginning of a response to that stimulus.

Reduced Comfort Boundary

Acceleration boundaries as a function of vibration and exposure time for the preservation of comfort.

Remote Operation

An operation which permits personnel to send and receive information or commands to a distant environment.

Replacement Unit

General term that includes Orbital replacement units (ORU), Line replacement units (LRU), and Shop replacement units (SRU).

Respiration

The series of actions resulting in the supply of oxygen to tissues of the body.

Response Time

The time interval during which the actual response to the stimulus is accomplished.

Restraint

A mechanism for restricting unwanted movements of an object or a person in microgravity environments. Restraints can be mechanical (such as a strap) or non-mechanical (magnetism or vacuum.

Reverberation Time

Time required for the average sound energy density in an enclosure to decrease to -60 d B of the initial value after the source has stopped.

Roentgen Equivalents, Man

The absorbed dose of any ionizing radiation which produces the same biological effects in crewmembers as those resulting from the absorption of 1 roentgen of x-rays.

Rotational Acceleration

The rate of change of the direction of a mass, the velocity of which is kept constant. In this regard, the rotational acceleration is directly proportional to the square of the velocity and inversely proportional to the radius of the turn.

Sacrificial surfaces

A protective surf ace placed over a delicate surface which will absorb environmental damage.

Scrolling

An operation or facility of a VDT in which display elements make a continuous bottom-to-top vertical movement across the screen (or window) under control of the operator, with display lines appearing at the bottom edge and dropping off at the top.

Segment

A body segment is the largest dimensional mass which when moved will maintain a constant geometry.

Shock

Physical or emotional trauma; clinical manifestations of inadequate amount of circulating blood. (also see Impact Acceleration)

Shock - Electrical

See Electrical Shock

Shock Load

See Impulse Acceleration

Signal-To-Noise Ratio

The ratio of the amplitude of the signal transmitted through an instrumentation system to the amplitude of the noise generated within the system.

Somersaulting

Vernacular descriptive of inertial resultant of human body to rotational acceleration around the y-axis. (Refer to figure 5.3.1-1.)

Sonic

Sound at frequencies within the range of hearing 20 Hz 20KHz

Space Module

An inhabited establishment away from the earth.

Space Motion Sickness

A malady occurring in approximately 50, of people initially exposed to microgravity. Symptoms are similar to that of motion sickness and last 2-4 days. To date, susceptibility to space motion sickness has not been predictable from responses In a l-G environment. Only limited success has been achieved in controlling space motion sickness.

Specularar Glare

Glare which is created by the image of a light source reflecting off a surface within a person's field-of-view.

Specular Reflection

The reflected image of the light source corresponds very closely in size and shape to the original light source.

Speech Interference Level

The background or sound noise level in dB at frequencies between 150 and 7500 Hz that will result in the loss of intelligibility conversation.

Squeeze

Condition arising when gas pocket is compressed to a smaller size than its normal residual volume.

Standby

A high impedance state of an electronic device, usually to minimize the amount of energy consumed or supplied (e.g., the off state of an electronic switch).

Standard Passageway

A standard passageway is a translation path which accommodates an IVA clothed crewmember in an upright working position or neutral body posture.

Stroke

Common term for apoplexy; hemorrhage into the brain, causing sudden onset of coma and neurological signs.

Subcutaneous Emphysema

Accumulation of gas under the surface of the skin.

Suffusion

A spreading or flow of any fluid of the body into surrounding tissue; an extensive superficial extravasation of blood.

Supination

The rotation of the forearm so that the palm faces upward.

Symbol

A character or graphic that stands for or represents something else such as operations, quantities, elements, relations, or qualities.

Syncope

Sudden loss of strength, fainting.

Teleoperator

A remotely controlled mobility module which incorporates sensory and manipulative subsystems for the purpose of extending the human operator's skills and cognitive capabilities into hostile or remote environments.

Tether

A hook and lanyard which is used to attach a crewmember or a piece of hardware to a piece of hardware.

Thermal Comfort

That condition of mind which expresses satisfaction with the thermal environment. Specifically, when the core temperature is normal, and the rate of body heat storage is zero.

Thermogenesis

Muscular heat production by shivering.

Thermogenesis

Production of heat.

Thermoregulation

Regulation of temperature, particularly self-regulation of body temperature.

Thrombocytopenia

Lack of blood platelets

Tinnitus

Ringing in one or both ears.

Tissue

An aggregation of similar cells and associated with intercellular substance.

Touch Temperature

Temperature of objects in direct physical contact.

Toxicity

The quality of poison; the kind and amount of poison produced by a microorganism

Tracheal Pressure

Gas pressure existing within the trachea (wind pipe).

Translation

To move from one place to another by use of reaction power.

Transmissivity

The proportion of luminous flux which passes completely through a window to the eyes or sensor to the amount of luminous flux incident upon the outside of the window.

Troland

Retinal illuminance resulting from viewing a surface with a luminance of 1 cd/m^2 through an artificial pupil with an area of 1mm^2.

Tunnel

A passageway which allows the crewmember to move only along his/her longitudinal axis.

Twist

Vernacular descriptive of inertial resultant of human body to rotational acceleration around the z-axis. (Refer to Figure 5.3.1-1.)

Ultrasonic

Sound at frequencies above the audio range, f 20 KHz.

Urethra

The canal that carries urine from the bladder.

Vasoconstriction

Decrease of size of blood vessels to decrease blood flow to the skin to preserve body heat

Vasodialation (Vasodilatation)

Increase of size of blood vessels to allow increased blood flow to the skin to promote heat loss.

Vestibular System

Located in the inner ear, the vestibular system is responsible for the sense of balance (and relative position of the body with respect to the environment). The vestibular system senses acceleration and direction of gravity.

Viewport

A transparency located such that an observer can see from one compartment into another.

Visual acuity

The smallest resolvable detail an observer can see.

Visual Angle

The angle formed at the eye by two imaginary lines drawn to either side of the object in question.

Visual Clutter

Visual clutter results when the quantity of information in a visual display becomes great enough so that it starts to result in information overload. Accuracy and speed of performance will decline as visual clutter increases.

Visual Display Terminal

An electronic device used to present visual information that is usually computer generated. They are used in conjunction width both the Input and output of information. Examples include: cathode ray tub (CRT), liquid crystal diode (LCD, light emitting diode (LED), plasma, and electro-luminescent (EL).

Wavefront Deviation

Any change in the reflected wavefront of a set of rays as compared with the incident wavefront of the same set.

Wet Bulb Glove Temperature

Calculated refinement of globe temperature by weighting dry bulb and wet bulb temperatures with the standard globe temperature.

Wet/Dry Index

Calculated prediction of human stress temperature accounting for wet and dry bulb temperatures.

Wing Tab Connector

An electrical utilities or other connector with two opposed radial tabs to facilitate EVA connect or disconnect.

X-axis

Pack to chest (anatomical)

Y-axis

Right to left side (anatomical)

Z-axis

Foot (or buttocks to head (anatomical).

APPENDIX D

ABBREVIATIONS AND ACRONYMS

USER'S GUIDE

This appendix contains an alphabetized listing of the abbreviations and acronyms used in the text and figures of Volumes I and IV. In the text, these were italicized the first time the abbreviation or acronym was used within a topical section. In most cases, the definition was shown adjacent to this first use.

Additional References for Abbreviations and Acronyms

Users are referred to the following references for official lists of abbreviations and acronyms that are used by NASA and the DOD:

34
MIL-STD-12D, Abbreviations for Use on Drawings, Specifications, and Standards

65
MSFC-STD-350A, Abbreviations for Use in Drawings

93
USAS Y1O.3-1968, Letter Symbols for Quantities Used in Mechanics

ACRONYM	DEFINITION
+Gx	Forward acceleration (see Figure 5.3.1-1)
+Gy	Right yaw acceleration (see Figure 5.3.1-1)
+Gz	Upward acceleration (see Figure 5.3.1-1)
+Rx	Left roll velocity (see Figure 5.3.1-1)
+Ry	Forward pitch down velocity (see Figure 5.3.1-1)
+Rz	Right yaw velocity
- Gx	Backward acceleration (see Figure 5.3.1-1)
- Gy	Left yaw acceleration (see Figure 5.3.1-1)
- Gz	Downward acceleration (&ee Figure 5.3.1-1)
- Rx	Right roll velocity (see Figure 5.3.1-1)
- Ry	Backward pitch up velocity (see Figure 5.3.1-1)
- Rz	Left yaw velocity
1/3 OB	One-third octave band
ACGIH	American Conference of Governmental Industrial Hygienists
ADS	Altitude decompression sickness
AFSC	Air Force Space Command
AI	Articulation index
ALARA	As low as reasonably achievable
AMU	Atomic Mass Unit
ANSI	American National Standards Institute
Ar	Argon
ASHRAE	Amer. Soc.of Heating, Refrig., and Air Conditioning Engrs
ATA	Atmospheres, absolute
a_x	x-axis acceleration
a_y	y-axis acceleration
a_z	z-axis acceleration
BHS	Body heat storage
BIB	Built-in breathing
BITE	Built-in test equipment
BTPS	Body temperature and pressure saturated with water
Btu	British thermal unit
CCTV	Closed circuit television
CFU	Colony forming units
CO_2	Carbon dioxide
CRS	Cosmic ray source
CRT	Cathode ray tube
CWS	Control and warning system
D	Absorbed dose
DACT	Disposable absorbent containment trunk
dB	Decibels
DO	Dry bulb temperature
DCS	Decompression sickness
DE	Dose equivalent
DIPS	Dynamic isotope power system
DOD	Department of Defense

ACRONYM	DEFINITION
e	Electron
ECG	Electrocardiogram
ECLSS	Environmental control and life support system
ED10	10% of pop. showing phsysiolgical response to ionizing rad.
EDK	Electric dynamic katathermometer
EEG	Electroencephalograph
EKG	Electrocardiogram
EL	Exposure limits
ELF	Extremely low frequencies
EM	Electromagnetic
EMU	Extravehicular mobility unit
ET	Effective temperature
ev	Electron volts
EVA	Extravehicular activity
FDA	Food and Drug Administration
FDP	Fatigue decreased proficiency
Fe	Iron
FMEA	Failure modes and effects analysis
FSW	Feet of seawater (33 FSW =1 Atmosphere)
G	Gravitational acceleration
GC/MS	Gas chromatograph/mass spectrometer
GCR	Galactic cosmic radiation
GEO	Geosyncronous Earth orbit
GIAG	Government Industry Advisory Group
GT	Globe temperature
g_x	Vibrational acceleration in the direction of the x-axis
g_y	Vibrational acceleration in the direction of the y-axis
Gy	Gray (radiation dosage unit of measure)
g_z	Vibrational acceleration in the direction of the z-axis
H	Hydrogen
He	Helium
HUT	Hard upper torso
Hx	Diatonic hydrogen
Hz	Hertz (cycles per second)
HZE	Ultra heavy nuclear particles
Icl	Insulation value of clothing
IDB	In-suit drink bag
IEEE	International Electronics and Electrical Engineers
INIRC	International Non-ionizing Radiation Committee
IR	Infrared
IRPA	International Radiation Protection Association
ISO	International Standards Organization
IVA	Intravehicular Activity
JSC	Johnson Space Center
kcal	Kilocalories (1000 calories)
kp	Kilo pascal

ACRONYM	DEFINITION
Kr	Krypton
KSC	Kennedy Space Center
LBNP	Lower body negative pressure
LCVG	Liquid cooling ventilation garment
LD50	Lethal dose of ionizing radiation for 50% of population
LED	Light emitting diode
LEO	Low Earth orbit
L_{eq}	Equivalent level in dB
LET	Linear energy transfer
LOS	Line of sight
LTA	Lower torso assembly
MeV	Millions of electron volts
MFR	Manipulator foot restraint
MIL	Military
mmHg	Millimeters of mercury - used to indicate pressure level
MMU	Manned maneuvering unit
MSFC	Marshall Space Flight Center
MSIS	Man-Systems Integration Standards
MTBF	Mean time between failure
MW	Microwave
N_2	Nitrogen
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
Nc	Convective heat transfer coefficient
NC (Curve)	Noise criteria curve
NCRP	National Council on Radiation Protection and Measurements
Ne	Neon
NIR	Non-ionizing radiation
nm	Nanometer (1E-9 meters); (also) nautical miles
NTU	Nethlometric tubidity units
O_2	Diatonic oxygen
O_2	Oxygen
OASPL	Overall sound pressure level
OB	Octave band
OBS	Operational bioinstrumentation system
ORU	Orbital replacement unit
OSHA	Occupational Safety and Health Administration
OTC	Over the counter
p	Proton
P4SR	Predicted 4-hour sweat rate
PB	Phonetically Balanced
PEO	Polar Earth orbit
PFR	Portable foot restraint
pH	Measure of acidity
PLSS	Primary life support system
PSIL	Preferred speech interference level

ACRONYM	DEFINITION
Pt/Co	Platimun/cobalt color measurement
PTS	Permanent threshold shift
Q	Quality factor
qs	Body heat storage index
Ra	Radium
rads	Radiation dose absorbed by tissue
RBE	Relative biological effectiveness
Rcl	Total heat transfer resistance
RDA	Recommended dietary allowance
REM, rem	Roentgen equivalent man
RF	Radio frequency
RFPG	Radiofrequency protection guides
rms	Root -mean -square
RMS	Remote manipulator system
RTG	Radioisotope thermoelectric generator
SAA	South Atlantic anomaly
SAE	Society of Automotive Engineers
SAR	Specif ic absorption rate
SCR	Solar cosmic radiation
SDMS	Standards Database Management System
SEP	Solar energetic particles
SIL	Speech interference level
SMF	Space medical facility
SPE	Solar particle event
SPF	Specific pathogen free
SPL	Sound pressure level
Sr	Strontium
SSA	Space suit assembly
STD	Standard
STP	Standard temperature and pressure
STS	Space Transportation System
Sv	Sievert (radiation dose unit of measure)
tb	Weighted mean body temperatures
TBT	Total body temperature
tc	Core temperature
TLV	Threshold limit values
TMG	Thermal micrometeoroid garment
Tmrt	Mean radiant temperature
TOC	Total organic carbon
TON	Threshold odor number
tr	Skin temperature
TTN	Threshold taste number
TTS	Temporary threshold shift (hearing)
TTS2	Temporary threshold shift measured 2 minutes after exposure
UCD	Urine collection device
UV	Ultraviolet

ACRONYM	DEFINITION
UVR	Ultraviolet radiation
VDT	Visual display terminal
WB	Wet bulb temperature
WBGT	Wet bulb globe temperature
WD	Wet/dry index
WFI	Water for Injection
WYSIWYG	What you see is what you get
Xe	Xenon
Z	Ultra heavy nuclei

APPENDIX E

UNITS OF MEASURE AND CONVERSION FACTORS

This section presents definitions, physical constants and conversion factors that are used in the text and may be useful as reference data.

ATMOSPHERE (atm):

The pressure exerted by 76 cm mercury with a density of 13.5951 gm/cm^3 at 1g (the standard barometric pressure at sea level).

1 atm = 1.01325 x 10^6 $dynes/cm^2$
= 1033.2 gm/cm^2
= 760 mm Hg
= 14.696 psi
= 101.329 kPa (kilo Pascals)

BRITISH THERMAL UNIT (Btu):

1 Btu = 1.0559 x 10^{10} ergs
= 1055.9 joules
= 251.995 gm-cal
= 778.77 ft-lbs
= 0.25199 kcal

1 Btu/hr = 0.1667 Btu/min
= 0.04199 kcal/min
= 0.2932 watt

1 Btu/min = 0.25199 kcal\min
= 0.23599 hp
= 17.595 watts

1 Btu/ft^2, hr = 2.7125 $kcal/m^2$ hr
Btu/hr to joules, 1 Btu/hr = 1.05435 x 10^3 joule/hr
800 Btu/hr x 1054.35 = 843480 joule/hr

CANDELA (cd):

1 cd = 1.018 candle

CANDLE (c):

The unit of luminous intensity.
1 c = 1 lumen/steradian

CENTIMETER (cm):

1 cm = 0.03280 ft
= 0.3937 in
= 0.01 m
= 10mm
= $1 \times 10^4 \mu$ (micron)

(See also Square Centimeter, Cubic Centimeter).

CENTIMETER-CANDLE (phot):

1 phot = 1×10^4 lux

CENTIMETERS PER SECOND PER SECOND:

1 cm/sec^2 = 0.0328 ft/sec^2

CLO (clo):

The unit of insulation resistance for clothing.
1 clo = 0.18°C m^{2}hr/kcal
= 0.88°F ft^{2}hr/Btu

CUBIC CENTIMETER (cc or cm^3):

1 CC = 3.531×10^{-5} ft^3
= 0.061023 in^3
= 1×10^{-6} m^3
= 1000 mm^3
= 2.6417×10^{-4} gal (US fluid)
= 0.0338 oz (US fluid)

= 2.113×10^{-3} pint (US fluid)

1 cc/sec = $0.0021186\ ft^3/min$

CUBIC FOOT

1 ft^3 = 1728 in^3

= 28.32 liters

= 0.02832 m^3

1 ft^3/min = 472.0 cc/sec

= 0.4720 liter/sec

= 62.43 lbs H_2O/min

1 ft^3/sec = 1699.3 liters/min

CUBIC INCH:

1 in^3 = $5.787 \times 10^{-4}\ ft^3$

= 1.639×10^{2} liter

= $1.639 \times 10^{-5}\ m^3$

CUBIC METER:

1 m^3 = 35.3144 ft^3

= $6.1023 \times 10^{4}\ in^3$

= 999.973 liters

DECIBEL (db):

Used for comparing power levels, acoustical or electrical.

1 db = 10 $\log_{10}$ P/PO where P is the power to be compared to a reference power PO

= 1 bel = increase in power (P) by a factor of 10

(See also Sound Pressure Level).

DEGREE (ANGULAR) (deg):

1 deg = 60 minutes

= 0.01745 radian

= 3600 seconds

1 deg = 3.0462×10^{-2} steradian

DEGREES TO RADIANS:

$1^{o} = \pi/180$ rad

$60^{o} \times \pi/180 = 1.0472 = 1$ rad

DEGREES CENTIGRADE (^{o}C):

$^{o}C = 5/9\ (^{o}F - 32)$

DEGREES FARENHEIT (^{o}F):

$^{o}F = (9/5 \times {}^{o}C) + 32$

DEGREES PER SECOND:

1 deg/sec = 0.017453 radian/sec
= 0.1667 rpm

DYNE (dyne):

1 dyne = 1.0197×10^{-6} kg
= 2.2481×10^{-6} lb

1 dyne-cm = 1 erg

DYNE PER SQUARE CENTIMETER

1 dyne/cm^2 = 9.8692×10^{-7} atm
= 0.0010197 gm/cm^2
= 4.0148×10^{-4} in H_2O
= 7.5006×10^{-4} mm Hg
= 1.4504×10^{-5} psi

ERG (erg):

1 erg = 9.4805×10^{-11} Btu
= 7.3756×10^{-8} ft-lb
= 2.3889×10^{-11} kcal
= 8.8510×10^{-7} lb-in
= 1 dyne-cm

FOOT (ft):

1 ft = 30.48 cm
= 12 in
= 0.3048 m
(See also Square Foot, Cubic Foot).

FOOT-CANDLE (fc):

1 ft-c = 1 lumen/ft^2
= 10.764 lumen/m^2
= 10.75 lux

FOOT-LAMBERT (ft-L):

1 ft-L = 1.0764 millilamberts
= 0.32 decibles with respect to 1 mL

FOOT PER MINUTE:

1 ft/min = 0.3048 m/min
= 0.005080 m/sec
= 0.011364 mph

FOOT PER SECOND:

1 ft/sec = 1.0973 km/hr
= 0.5921 knot
= 0.6818 mph

FOOT-POUND (ft-lb):

1 ft-lb = 0.001285 Btu
= 1.3558 x 10^7 ergs
= 3.2389 x 10^{-4} kcal
1 ft-lb/min = 3.0303 x 10^{-5} hp
= 0.01667 ft-lb/sec
= 0.022597 watt
1 ft-lb/sec = 0.001818 hp
= 0.01943 kcal/min
= 1.3558 watts

G(g):

The acceleration of gravity (also the acceleration of a vehicle).

1 g = 32.174 ft/sec^2
= 980.665 cm/sec^2

GRAM (gm):

1 gm = 0.001 kg
= 1000 mg
= 0.03527 oz
= 0.0022046 lb
1 gm/cm^3 = 62.428 lbs/ft^3
1 gm/hr = 0.540 lb/day
= 0.0003757 lb/min
1 gm/liter = 0.062427 lb/ft^3
1 gm/cm^2 = 9.6784 x 10^{-4} atm
= 980.665 dynes/cm^2
= 0.9356 mm Hg
= 0.014223 psi
1 gm/m^2/hr = 2.78 x 10^{-5} gm/cm^2/sec
= 0.7448 lb/ft^2/hr

GRAM-CALORIE (gm-cal):

1 gm-cal = 30874 ft-lbs
= 0.001 kcal

GRAY (Gy)):

The SI unit for the amount of ionizing radiation energy absorbed by tissue.

1 Gy = 100 rads

HORSEPOWER (hp):

1 hp = 3.300 x 10^4 ft-lbs/min
= 550 ft-lbs/sec
= 10.688 kcal/min
= 745.7 watts

INCH (in):

1 in = 2.540 cm
= 0.0833 ft
= 25.40 mm
(See also Cubic Inch, Square Inch)

INCH OF WATER (in H_2O):

1 in H_2O = 0.002458 atm
(at 4^{o}C) = 2490.82 dynes/cm^2
= 0.0361 psi
= 1.868 mm Hg

JOULE (joule):

1 joule = 1 watt-sec

KILOGRAM(kg):

1 kg = 1000 gm
= 2.205 lb
= 35.28 oz

KILOGRAM-CALORIE (kcal or large Calorie):

1 kcal = 3.9683 Btu
= 4.186 x 10^{10} ergs
= 1000 gm-cal
= 3087 ft-lbs
1 kcal/hr = 0.0661 Btu/min
= 0.857 ft-lbs/sec
= 0.1667 kcal/min
= 1.161 watts

1 $kcal/m^2hr$ = 0.3687 Btu/ft^2hr

1 kcal/min = 3.9685 Btu/min
= 51.457 ft-lbs/sec
= 0.093557 hp
= 69.767 watts

KILOGRAM-CENTIMETER SQUARED:

1 $kg\text{-}cm^2$ = 0.3417 $lb\text{-}in^2$

KILOGRAM-METER PER SECOND:

1 kg-m/sec = 7.2330 ft-lb/sec
= 9.80665 watts

KILOMETER (km):

1 km = 10^5 cm
= 3281 ft
= 10^3 meters, m
= 0.6214 statute miles, mi
= 0.54 nautical miles, nm

KILOPASCAL:

1kPa = 6.895 psi
= 4.754×10^5 $dynes/cm^2$
1 psi = 0.145 kPa

KILOMETERS PER HOUR:

1 km/hr = 0.9113 ft/sec
= 0.5396 knot
= 0.6214 mph

KNOT (nautical mile per hour):

1 knot = 1.689 ft/sec
= 1.853 km/hr
= 1.1516 mph

LAMBERT (L):

Unit of surface brightness.
1L = 0.3183 c/cm^2
= 2.0536 c/in^2
= 1 $lumen/cm^2$

LITER (l):

1 liter = 0.03531 ft^3
= 61.02 in^3
= 1000 ml
1 liter/min = 5.886×10^{-4} ft^3/sec
1 liter/sec = 2.12 ft^3/min

LUMEN (lumen):

1 lumen = 0.001496 watt
= 0.07958 spherical candle power
1 $lumen/ft^2$ = 1 ft-c
= 10.764 $lumen/m^2$

LUMENS PER SQ. METER TO FT CANDLES

1 $lumen/m^2$ = 0.0929 ft. candle

LUX

1 lux = 0.093 ft-c (see meter-candle)

METER (m):

1m = 100 cm
= 3.281 ft

= 39.37 in

(See also Cubic Meter).

METER-CANDLE (lux):

1 lux = 1 lumen/m^2

= 0.092903 ft-c

METER PER SECOND (m/sec):

1 m/sec = 3.281 ft/sec

= 3.600 km/hr

= 2.2369 mph

MICRON (or mu):

A unit of length equal to one-millionth of a meter or one-thousandth of a millimeter, usually called micrometer.

1 μ = 10^{-6} meter

= 3.937×10^{-5} in

= 0.001 mm

MIL (mil):

1 mil = 0.001 in

= 0.0254 mm

= 25.40μ (microns)

MILES (statute) (mi):

1 mi = $1{,}609 \times 10^5$ cm

= 5,280 ft

= 1.609 km

MILES PER HOUR (mph)

1 mph = 88 ft/min
= 1.4667 ft/sec
= 1.6093 km/hr
= 0.8684 knot

MILLIGRAM (mg):

1 mg = 0.001 gm
= 3.5274×10^{-5} oz
= 2.2046×10^{-6} lb
1 mg/m^3 = 6.243×10^{-4} lb/ft^3

MILLILAMBERT (ml):

1 mL = 0.929 lumen/ft^2
(perfectly diffused light)

MILLILITER (ml):

1 ml = 1.000028 cc
= 0.061025 in^3
= 0.001 liter
= 0.0338 oz (US fluid)

MILLILITERS PER HOUR:

1 ml/hr = 0.06102 in^3/hr

MILLIMETER (mm):

1mm = 0.10 cm
= 0.03937 in
= 1000 μ
(See also Square Millimeter).

MILLIMETER OF MERCURY (mm Hg):

1mm Hg = 0.0013158 atm

(at 0^oC) = 1333.22 $dyne/cm^2$
= 1.3595 gm/cm^2
= 0.019337 psi
= 0.535 in H_2O
= 0.1333 kPa

MILLISECONDS (msec):

1 msec = 0.001 sec

NAUTICAL MILES (nm):

1 nm = 0.87 statute miles
= 1.85 kilometers

NEWTON (N):

The unit of force in the mks system equal to 0.2248 lbf.

NEWTONS TO POUNDS:

1 N = 0.22507 lbf

NEWTON CENTIMETERS TO INCH OUNCES:

1 N-cm = 1/.706 in oz
70N-cm x 1/.706 = 99.15 = 100 in oz

NEWTON METERS TO FOOT POUNDS:

1Nm = 1/1.356 ft lb
15Nm x 1/1.356 = 11.06 = 11 ft lb

NEWTON METERS TO INCH POUNDS:

1 Nm = 1/.11298 in lb
4 Nm x 1/.11298 = 35.4 = 3 5 in lb

NIT:

Unit of luminence equal to the luminence provided by one candle of radiant flux emited per square meter of surface
Candela per square meter (Cd m^2)

OUNCE (oz):

1 oz = 28.3495 gm
= 0.0625 lb

PASCALS (Pa)

Pa = 4.75389 dynes/cm^2
= 6.895×10^{-3} psi

PARTS PER MILLION (ppm).

1 ppm = 1.0 mg/liter of H_2O
= 8.345 lbs/million gallons

PHON (phon):

1 phon unit = SPL of a 1000 cycle/sec tone

PHOT:

(See Centimeter Candle).

POISE:

Unit of viscosity.
1 poise = 1 dyne/sec, cm^2
= 1 gm/cm, sec
= 0.067196 lb/ft, sec

POUND (lb):

1 lb = 453.5924 gm

= 0.45359 kg
= 16 oz
= 4.448 N
1 lb/day = 18.89 gm/hr
1 lb/hr = 0.7559 gm/min
= 10.886 kg/day

POUND-INCH (lb-in):

1 lb-in = 1.1298×10^6 dyne/cm

POUND-INCH SQUARED:

Unit of moment of inertia.
1 lb-in^2 = 2.9264 kg-cm^2

POUND OF WATER PER MINUTE (lb H_2O/min):

1 lb H_2O/min = 0.01603 ft^3/min
= 2.670×10^{-4} ft^3/sec

POUND PER CUBIC FOOT (lb/ft^3):

1 lb/ ft^3 = 0.01602 gm/ cm^3

POUNDS PER SQUARE INCH (psi):

1 psi = 0.06805 atm
= 6.8947×10^4 dyne/cm^2
= 70.307 gm/cm^2
= 51.715 mmHg
= 27.7 in H_2O
= 145.03 Pa

POUNDS PER SQUARE INCH ABSOLUTE (psia):

Absolute pressure, where 0 psia = vacuum
= 0.1449 kpascals

POUND WEIGHT (1 wt):

1 lb wt = 4.4482×10^5 dynes
= 453.59 gm wt
= 16 oz

RAD (rad):

Radiation absorbed dose.
1 rad = 100 ergs/gm of irradiated material

RADIAN (rad):

1 radian = $1/2\pi$ circumference revolution (0.15915)
= 57.296 deg
1 radian/sec = 57.296 deg/sec
= 9.549 rpm
1 radian/sec^2 = 572.96 rpm^2

REVOLUTIONS PER MINUTE (rpm):

1 rpm = 6 deg/sec
= 0.10472 radian/sec
1 rpm^2 = 0.001745 radian/sec^2

ROENTGEN (r):

1 r = ionization by x-rays or gamma-rays producing 1 electrostatic unit of charge in 1 cm^3 of air (STP)
= 83.0 ergs/gm

SIEVIERT (Sv):

Sv is the SI unit for ionizing radiation dose equivalent
1 Sv = 100 rem = (Gy) (Q)
(Refer to Figure 5.7.2.1.3.1-1 for definition of Q values)

SOUND PRESSURE LEVEL (SPL):

SPL is sound pressure related logarithmically to a reference level of pressure (P_0), which by convention is 0.0002 dynes/cm^2. The defining equation is:

$$SPL = 20 \log_{10} P/PO \text{ in decibels}$$

SQUARE CENTIMETER (cm^2):

1 cm^2 = 1.076 x 10^{-3} ft^2
= 0.1550 in^2
= 100 mm^2

SQUARE FOOT (ft^2):

1 ft^2 = 929.0 m^2
= 144 in^2

SQUARE INCH (in^2):

1 in^2 = 6.4516 cm^2
= 0.006944 ft^2
= 645.1626 mm^2

SQUARE MILLIMETER (mm^2):

1 mm^2 = 0.01 cm^2
= 0.001550 in^2

STERADIAN:

The solid angle which encloses a surface on a sphere equal to the square of the radius.

USEFUL PHYSICAL CONSTANTS

Acceleration of gravity (g) = 32.17 ft/sec2
= 980.6 cm/sec^2

Velocity of sound in dry air @0^{o}C = 33,136 cm/second and 1 atmos. = 1,089 feet/second

Heat of fusion of water @1.0 atmos.	= 79.7 calories/gram = 144 Btu/pound
Heat of vaporization of water @ 1.0 atmos.	= 540 calories/gram = 970 Btu/pound
Specific heat of air	= Cp = 0.238 cal/gram (^{o}C)
Density of water @ $0^{o}C$	= .099984 grams/cm^3
Density of air @ $0^{o}C$ and 760 mm Hg	= 0.0012929 grams/cm^3(0.0807 lb/ft^3)
Velocity of light (c)	= 2.99792458 x 10^{10} cm/sec
Avogradro's number (N)	= 6.0221367 x 10^{23} molecules/gram-mole
Pi(π)	= 3.14159265
Naperian-logarithm base	= 2.71828183

APPENDIX F

UNRESOLVED DATA PROBLEMS AND ISSUES

(This appendix has been deleted from this volume)

APPENDIX G

ACCELERATION REGIME APPICABILITY

USER'S GUIDE

One of the unique features of the MSIS data base is that every paragraph has been coded as to the acceleration regimes that are applicable. Immediately following each paragraph number and title, a notation is made in brackets { } with one or two of the following codes:

O = Orbital

= the zero-g and near zero-g acceleration environments encountered in orbital and very low acceleration transorbital operations

L = Launch/Re-Entry

= the multi-g launch, re-entry, and abort acceleration environments.

P = Planetary

= the g-loads encountered on the moon and Mars. Long term, low-level accelerations encountered in some transorbital flight operations may also be applicable. An artificial gravity system may also fall into this regime.

A = All

=this regime includes all of the above plus the 1-g acceleration environment.

(blank)

=none of the above apply.

This appendix of a relational data base searching function in the Standards Relational Data base System (SDMS) can be used to locate all of the applicable MSIS data for a hardware program's specific acceleration regimes.

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
1.0	X			
1.1	X			
1.2	X			
1.3	X			
1.4	X			
1.4.1	X			
1.4.2	X			
1.4.3	X			
1.4.3.1	X			
1.4.3.2	X			
1.4.3.3	X			
1.4.3.4	X			
1.4.3.5	X			
1.4.4	X			
1.5	X			
2.0	X			
2.1	X			
2.2	X			
2.2.1	X			
2.2.2	X			
2.3	X			
2.3.1	X			
2.3.2	X			
3.0	X			
3.1	X			
3.1.1	X			
3.1.2	X			
3.2	X			
3.2.1	X			
3.2.2	X			
3.2.3	X			
3.2.3.1		X		
3.2.3.2	X			
3.2.3.3	X			
3.3	X			
3.3.1	X			
3.3.1.1	X			
3.3.1.2	X			
3.3.1.3	X			
3.3.2	X			
3.3.2.1	X			
3.3.2.2	X			
3.3.2.2.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
3.3.2.2.2	X			
3.3.2.2.3	X			
3.3.2.3	X			
3.3.2.3.1	X			
3.3.2.3.2	X			
3.3.3	X			
3.3.3.1	X			
3.3.3.2	X			
3.3.3.2.1	X			
3.3.3.2.2	X			
3.3.3.2.3	X			
3.3.3.2.4	X			
3.3.3.2.5	X			
3.3.3.2.6	X			
3.3.3.3	X			
3.3.3.3.1	X			
3.3.3.3.2			X	
3.3.4		X		
3.3.4.1		X		
3.3.4.2		X		
3.3.4.3	X			
3.3.5	X			
3.3.5.1	X			
3.3.5.2	X			
3.3.5.3	X			
3.3.6	X			
3.3.6.1	X			
3.3.6.2	X			
3.3.6.3	X			
3.3.6.3.1	X			
3.3.6.3.2	X			
3.3.7	X			
3.3.7.1	X			
3.3.7.2	X			
3.3.7.3	X			
3.3.7.3.1	X			
3.3.7.3.1.1	X			
3.3.7.3.1.2	X			
3.3.7.3.2	X			
3.3.7.3.2.1	X			
3.3.7.3.2.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
3.3.7.3.3	X			
3.3.7.3.3.1	X			
3.3.7.3.3.2	X			
4.0	X			
4.1	X			
4.2	X			
4.2.1	X			
4.2.2	X			
4.3	X			
4.3.1	X			
4.3.2	X			
4.3.2.1	X			
4.3.2.2	X			
4.4	X			
4.4.1	X			
4.4.2	X			
4.4.2.1	X			
4.4.2.2	X			
4.5	X			
4.5.1	X			
4.5.2		X		
4.5.2.1		X		
4.5.2.2		X		
4.6	X			
4.6.1	X			
4.6.2		X		
4.7	X			
4.7.1	X			
4.7.2		X		
4.8		X		
4.8.1		X		
4.8.2		X		
4.9	X			
4.9.1	X			
4.9.2		X		
4.9.3		X		
4.10	X			
4.10.2	X			
4.11	X			
4.11.1	X			
4.11.2	X			
4.11.3	X			
5.0	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
5.1	X			
5.1.1	X			
5.1.2	X			
5.1.2.1	X			
5.1.2.1.1	X			
5.1.2.1.2	X			
5.1.2.1.3	X			
5.1.2.1.4	X			
5.1.2.1.4.1	X			
5.1.2.1.4.2	X			
5.1.2.1.4.3	X			
5.1.2.2	X			
5.1.2.2.1	X			
5.1.2.2.1.1	X			
5.1.2.2.1.2	X			
5.1.2.2.1.3	X			
5.1.2.2.1.4	X			
5.1.2.2.1.5	X			
5.1.2.2.1.6	X			
5.1.2.2.1.7	X			
5.1.2.2.1.7.1	X			
5.1.2.2.1.7.2	X			
5.1.2.2.1.7.3	X			
5.1.2.3.	X			
5.1.2.3.1	X			
5.1.2 3.2	X			
5.1.2.3.3	X			
5.1.3	X			
5.1.3.1	X			
5.1.3.2	X			
5.1.3.3	X			
5.1.3.4	X			
5.1.3.4.1	X			
5.1.3.4.2	X			
5.1.3.4.3		X	X	X
5.2		X		
5.2.1		X		
5.2.2		X		
5.2.2.1		X		
5.2.2.2.		X		
5.2.3		X		
5.3	X			
5.3.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
5.3.2	X			
5.3.2.1	X			
5.3.2.1.1	X			
5.3.2.1.2	X			
5.3.2.1.3	X			
5.3.2.2	X			
5.3.2.2.1	X			
5.3.2.2.2	X			
5.3.2.2.3	X			
5.3.2.3	X			
5.3.2.4	X			
5.3.3	X			
5.3.3.1	X			
5.3.3.1.1	X			
5.3.3.2	X			
5.3.3.3	X			
5.4	X			
5.4.1	X			
5.4.2	X			
5.4.2.1	X			
5.4.2.1.1			X	
5.4.2.1.2		X		
5.4.2.1.3			X	
5.4.2.2	X			
5.4.2.3	X			
5.4.2.3.1	X			
5.4.2.3.2	X			
5.4.2.3.3	X			
5.4.2.4	X			
5.4.2.4.1	X			
5.4.2.4.1.1	X			
5.4.2.4.1.1.1	X			
5.4.2.4.1.1.2	X			
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5.4.2.4.2	X			
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5.4.2.4.2.2	X			
5.4.2.4.3	X			
5.4.2.4.3.1	X			
5.4.2.4.3.2	X			
5.4.3	X			
5.4.3.1	X			
5.4.3.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
5.4.3.2.1	X			
5.4.3.2.1.1	X			
5.4.3.2.1.2	X			
5.4.3.2.1.3	X			
5.4.3.2.1.4	X			
5.4.3.2.1.5	X			
5.4.3.2.2	X			
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5.4.3.2.2.2	X			
5.4.3.2.3	X			
5.4.3.2.3.1	X			
5.4.3.2.3.2	X			
5.4.3.2.3.3	X			
5.4.3.2.3.4	X			
5.4.3.2.4	X			
5.4.3.2.5	X			
5.4.4	X			
5.4.4.1	X			
5.4.4.2	X			
5.4.4.3	X			
5.5	X			
5.5.1	X			
5.5.2	X			
5.5.2.1	X			
5.5.2.1.1			X	
5.5.2.1.2		X		X
5.5.2.1.3			X	
5.5.2.2	X			
5.5.2.3	X			
5.5.2.3.1	X			
5.5.2.3.2	X			
5.5.2.3.3	X			
5.5.2.4	X			
5.5.2.4.1	X			
5.5.2.4.2	X			
5.5.2.4.3	X			
5.5.2.4.4	X			
5.5.3	X			
5.5.3.1	X			
5.5.3.2	X			
5.5.3.2.1	X			
5.5.3.2.2	X			
5.5.3.2.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
5.5.3.2.4	X			
5.5.3.2.5	X			
5.5.3.3	X			
5.5.3.3.1			X	
5.5.3.3.2	X			
5.5.3.3.3	X			
5.5.3.3.4	X			
5.5.4	X			
5.5.4.1	X			
5.5.4.2	X			
5.5.4.3	X			
5.6	X			
5.7	X			
5.7.1	X			
5.7.2	X			
5.7.2.1	X			
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5.7.2.1.2	X			
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5.7.2.1.2.4	X			
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5.7.2.1.3.1	X			
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5.7.2.1.3.3.1	X			
5.7.2.1.3.3.2	X			
5.7.2.1.3.3.3	X			
5.7.2.1.3.3.4	X			
5.7.2.1.3.3.5	X			
5.7.3.1.3.3.6	X			
5.7.2.1.3.4	X			
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5.7.2.1.4.2	X			
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5.7.2.1.4.4	X			
5.7.2.1.4.5	X			
5.7.2.1.4.6	X			
5.7.2.1.5	X			
5.7.2.2	X			
5.7.2.2.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
5.7.2.2.2	X			
5.7.2.2.3	X			
5.7.2.2.4	X			
5.7.3	X			
5.7.3.1	X			
5.7.3.1.1	X			
5.7.3.1.2	X			
5.7.3.1.3	X			
5.7.3.1.4	X			
5.7.3.2	X			
5.7.3.2.1	X			
5.7.3.2.2	X			
5.8	X			
5.8.1	X			
5.8.2	X			
5.8.2.1	X			
5.8.2.2	X			
5.8.2.2.1	X			
5.8.2.2.2	X			
5.8.2.2.2.1	X			
5.8.2.2.3	X			
5.8.2.2.4	X			
5.8.2.2.5	X			
5.8.3	X			
5.8.3.1	X			
5.8.3.2	X			
5.9	X			
5.9.1	X			
5.9.2	X			
6.0	X			
6.1	X			
6.2	X			
6.2.1	X			
6.2.2	X			
6.2.2.1	X			
6.2.2.2	X			
6.2.3	X			
6.3	X			
6.3.1	X			
6.3.2	X			
6.3.3	X			
6.3.3.1	X			
6.3.3.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
6.3.3.3	X			
6.3.3.4	X			
6.3.3.5	X			
6.3.3.6	X			
6.3.3.7	X			
6.3.3.8	X			
6.3.3.9	X			
6.3.3.10	X			
6.3.3.11	X			
6.3.4	X			
6.4	X			
6.4.1	X			
6.4.2	X			
6.4.2.1	X			
6.4.2.1.1	X			
6.4.2.2	X			
6.4.2.2.1	X			
6.4.2.3	X			
6.4.2.4	X			
6.4.3	X			
6.4.3.1	X			
6.4.3.1.1	X			
6.4.3.2	X			
6.4.3.3	X			
6.4.3.4	X			
6.4.3.5	X			
6.4.3.6	X			
6.4.3.7	X			
6.4.3.8	X			
6.4.3.9	X			
6.4.3.10	X			
6.4.3.11	X			
6.4.3.12	X			
6.4.3.13	X			
6.4.3.13.1	X			
6.4.3.14	X			
6.4.3.15	X			
6.4.3.15.1	X			
6.4.3.16	X			
6.4.3.17	X			
6.4.3.18	X			
6.4.3.18.1	X			
6.4.3.18.1.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
6.4.3.18.1.2	X			
6.4.3.18.2	X			
6.4.3.18.2.1	X			
6.4.3.18.2.2	X			
6.4.3.18.2.3	X			
6.4.3.18.2.4	X			
6.4.3.18.2.5	X			
6.4.3.19	X			
6.5	X			
6.5.1	X			
6.5.2	X			
6.5.3	X			
6.6	X			
6.6.1	X			
6.6.2	X			
6.6.3	X			
6.6.3.1	X			
6.6.3.1.1	X			
6.6.3.1.2	X			
6.6.3.2	X			
6.6.3.2.1	X			
6.6.3.2.2	X			
6.6.3.2.3	X			
6.6.3.3	X			
6.6.3.4	X			
6.7	X			
6.7.1	X			
6.7.2	X			
6.7.3	X			
6.7.4	X			
6.7.5	X			
7.0		X		X
7.1	X			
7.2	X			
7.2.1	X			
7.2.2	X			
7.2.2.1	X			
7.2.2.2	X			
7.2.2.2.1	X			
7.2.2.2.2	X			
7.2.2.2.3	X			
7.2.2.3	X			
7.2.2.3.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
7.2.2.3.2	X			
7.2.2.4		X		X
7.2.3		X		X
7.2.3.1		X		X
7.2.3.2		X		X
7.2.3.3		X		X
7.2.3.3.1		X		X
7.2.3.3.2		X		X
7.2.3.3.2.1		X		X
7.2.3.3.2.2		X		X
7.2.3.3.3		X		X
7.2.3.4		X		X
7.2.3.4.1		X		X
7.2.3.4.2		X		X
7.2.3.4.3		X		X
7.2.4	X			
7.2.4.1	X			
7.2.4.2	X			
7.2.4.3	X			
7.2.5	X			
7.2.5.1	X			
7.2.5.2	X			
7.2.5.1	X			
7.2.5.2	X			
7.2.5.3	X			
7.2.5.3.1	X			
7.2.5.3.2	X			
7.2.5.3.3	X			
7.2.5.3.4	X			
7.2.5.3.5	X			
7.2.5.3.6	X			
7.2.6	X			
7.2.6.1	X			
7.2.6.2	X			
7.2.6.3	X			
7.2.7	X			
7.2.7.1	X			
7.2.7.2	X			
7.2.7.2.1	X			
7.2.7.2.2	X			
7.2.7.2.2.1	X			
7.2.7.2.2.2	X			
7.2.7.2.2.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
7.2.7.3	X			
7.2.7.3.1	X			
7.2.7.3.2	X			
7.2.7.3.2.1	X			
7.2.7.3.2.2	X			
7.2.7.3.2.3	X			
7.2.7.3.2.4	X			
7.2.7.3.3	X			
7.2.8	X			
7.3	X			
7.3.1	X			
7.3.2	X			
7.3.2.1	X			
7.3.2.2	X			
7.3.2.3	X			
7.3.3	X			
7.3.3.1	X			
7.3.3.2	X			
7.3.3.3	X			
7.3.3.4	X			
7.4	X			
7.4.1	X			
7.4.2	X			
7.4.3	X			
7.4.3.1	X			
7.4.3.2	X			
8.0	X			
8.1	X			
8.2	X			
8.2.1	X			
8.2.2	X			
8.2.2.1		X		
8.2.2.2	X			
8.2.2.3	X			
8.2.2.4	X			
8.2.2.5	X			
8.2.2.6	X			
8.2.2.7	X			
8.2.2.8	X			
8.2.3	X			
8.2.3.1	X			
8.2.3.2	X			
8.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
8.3.1	X			
8.3.2	X			
8.3.2.1	X			
8.3.2.2	X			
8.3.3	X			
8.3.3.1	X			
8.3.3.2	X			
8.4		X		
8.4.1		X		
8.4.2		X		
8.4.3		X		
8.4.4		X		
8.5	X			
8.5.1	X			
8.5.2	X			
8.5.2.1	X			
8.5.2.2	X			
8.5.3	X			
8.5.3.1	X			
8.5.3.2	X			
8.5.3.3	X			
8.5.3.4	X			
8.6	X			
8.6.1	X			
8.6.2	X			
8.6.2.1	X			
8.6.2.2	X			
8.6.2.3	X			
8.6.2.4	X			
8.6.3	X			
8.6.3.1	X			
8.6.3.2	X			
8.6.4		X		
8.6.4.1		X		
8.6.4.2		X		
8.6.4.3		X		
8.7	X			
8.7.1	X			
8.7.2	X			
8.7.2.1	X			
8.7.2.2		X		
8.7.2.3		X		
8.7.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
8.7.3.1	X			
8.7.3.2	X			
8.7.3.3	X			
8.7.3.4	X			
8.8	X			
8.8.1		X		
8.8.2		X		
8.8.3	X			
8.8.3.1		X		
8.8.3.2		X		
8.8.3.3	X			
8.8.3.4	X			
8.9		X		
8.9.1		X		
8.9.2		X		
8.9.2.1		X		
8.9.2.2		X		
8.9.3		X		
8.9.3.1		X		
8.9.3.2		X		
8.9.4		X		
8.10	X			
8.10.1	X			
8.10.2	X			
8.10.3	X			
8.10.3.1	X			
8.10.3.2	X			
8.10.3.3	X			
8.10.3.4	X			
8.10.3.5	X			
8.10.3.6	X			
8.10.3.7	X			
8.10.4	X			
8.11	X			
8.11.1	X			
8.11.2	X			
8.11.2.1	X			
8.11.2.2	X			
8.11.3	X			
8.12	X			
8.12.1	X			
8.12.2	X			
8.12.2.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
8.12.2.2	X			
8.12.2.3	X			
8.12.2.4	X			
8.12.3	X			
8.12.3.1	X			
8.12.3.2	X			
8.12.3.4	X			
8.12.3.5	X			
8.12.3.6	X			
8.13	X			
8.13.1	X			
8.13.2	X			
8.13.2.1	X			
8.13.2.2	X			
8.13.2.3	X			
8.13.2.4	X			
8.13.2.5	X			
8.13.2.6	X			
8.13.2.7	X			
8.13.3	X			
8.13.3.1	X			
8.13.3.1.1	X			
8.13.3.1.2	X			
8.13.3.1.3	X			
8.13.3.1.4	X			
8.13.3.2	X			
8.13.3.2.1	X			
8.13.3.2.2	X			
8.13.3.2.3	X			
8.13.3.3	X			
8.13.3.4	X			
8.13.3.5	X			
8.13.3.6	X			
9.0	X			
9.1	X			
9.2	X			
9.2.1	X			
9.2.2	X			
9.2.2.1	X			
9.2.2.1.1	X			
9.2.2.1.2	X			
9.2.2.1.3	X			
9.2.2.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.2.2.2.1	X			
9.2.2.2.2	X			
9.2.2.2.3	X			
9.2.2.2.4	X			
9.2.2.2.5	X			
9.2.2.2.6	X			
9.2.3	X			
9.2.3.1	X			
9.2.3.2	X			
9.2.3.2.1.	X			
9.2.3.2.2	X			
9.2.3.2.3	X			
9.2.3.2.4.	X			
9.2.3.2.5	X			
9.2.3.2.6	X			
9.2.3.2.7	X			
9.2.3.2.8	X			
9.2.3.2.9	X			
9.2.3.2.10	X			
9.2.4	X			
9.2.4.1	X			
9.2.4.1.1	X			
9.2.4.2	X			
9.2.4.2.1	X			
9.2.4.2.2	X			
9.2.4.2.3	X			
9.2.5	X			
9.2.5.1	X			
9.2.5.1.1	X			
9.2.5.1.2	X			
9.2.5.2	X			
9.2.5.2.1	X			
9.2.5.2.2		X		X
9.2.6	X			
9.3	X			
9.3.1	X			
9.3.2	X			
9.3.2.1	X			
9.3.2.2	X			
9.3.3	X			
9.3.3.1	X			
9.3.3.2	X			
9.3.3.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.3.3.3.1	X			
9.3.3.3.2	X			
9.3.3.3.3	X			
9.3.3.3.4	X			
9.3.3.3.5	X			
9.3.3.3.6	X			
9.3.3.3.7	X			
9.3.3.3.8	X			
9.3.3.3.9	X			
9.3.3.3.10	X			
9.3.3.3.11	X			
9.3.3.3.12	X			
9.3.3.3.13	X			
9.3.3.3.14	X			
9.3.3.3.15	X			
9.3.3.3.16	X			
9.3.3.3.17	X			
9.3.3.4	X			
9.3.3.4.1	X			
9.3.3.4.1.1	X			
9.3.3.4.1.2	X			
9.3.3.4.2	X			
9.3.3.4.3	X			
9.3.3.4.4	X			
9.3.3.4.5	X			
9.3.3.4.6	X			
9.3.3.4.7	X			
9.3.3.4.8	X			
9.3.3.5	X			
9.3.3.6	X			
9.3.3.7	X			
9.3.4	X			
9.4	X			
9.4.1	X			
9.4.2	X			
9.4.2.1	X			
9.4.2.2	X			
9.4.2.3	X			
9.4.2.3.1	X			
9.4.2.3.1.1	X			
9.4.2.3.1.2	X			
9.4.2.3.1.3	X			
9.4.2.3.1.4	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.4.2.3.1.5	X			
9.4.2.3.2	X			
9.4.2.3.3	X			
9.4.2.3.3.1	X			
9.4.2.3.3.2	X			
9.4.2.3.3.3	X			
9.4.2.3.3.4	X			
9.4.2.3.3.5	X			
9.4.2.3.3.6	X			
9.4.2.3.3.7	X			
9.4.2.3.3.8	X			
9.4.2.3.3.9	X			
9.4.2.3.3.10	X			
9.4.2.3.4	X			
9.4.3	X			
9.4.3.1	X			
9.4.3.2	X			
9.4.3.3	X			
9.4.3.3.1	X			
9.4.3.3.2	X			
9.4.3.3.3	X			
9.4.3.3.4	X			
9.4.4	X			
9.4.4.1	X			
9.4.4.2	X			
9.4.4.3	X			
9.4.4.3.1	X			
9.4.4.3.1.1	X			
9.4.4.3.1.2	X			
9.4.4.3.1.3	X			
9.4.4.3.2	X			
9.4.4.3.3	X			
9.4.4.3.4	X			
9.4.4.3.4.1	X			
9.4.4.3.4.2	X			
9.4.4.3.4.3	X			
9.4.5	X			
9.4.5.1	X			
9.4.5.1.1	X			
9.4.5.1.2	X			
9.5	X			
9.5.1	X			
9.5.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.5.3	X			
9.5.3.1	X			
9.5.3.1.1	X			
9.5.3.1.2	X			
9.5.3.1.3	X			
9.5.3.1.4	X			
9.5.3.1.5	X			
9.5.3.1.6	X			
9.5.3.1.7	X			
9.5.3.1.8	X			
9.5.3.1.9	X			
9.5.3.1.10				
9.5.3.1.11	X			
9.5.3.1.12	X			
9.5.3.1.13	X			
9.5.3.1.14	X			
9.5.3.1.14.1	X			
9.5.3.1.14.2	X			
9.5.3.1.14.3	X			
9.5.3.1.14.4	X			
9.5.3.1.14.5	X			
9.5.3.1.14.6	X			
9.5.3.1.14.7	X			
9.5.3.1.14.8	X			
9.5.3.1.14.9	X			
9.5.3.1.14.10	X			
9.5.3.2	X			
9.6	X			
9.6.1	X			
9.6.2	X			
9.6.2.1	X			
9.6.2.2	X			
9.6.2.3	X			
9.6.2.3.1	X			
9.6.2.3.2	X			
9.6.2.4	X			
9.6.2.4.1	X			
9.6.2.4.2	X			
9.6.2.4.3	X			
9.6.2.4.3.1	X			
9.6.2.4.3.2	X			
9.6.2.4.4	X			
9.6.2.4.4.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.6.2.4.4.2	X			
9.6.2.5	X			
9.6.2.5.1	X			
9.6.2.5.2	X			
9.6.2.6	X			
9.6.2.6.1	X			
9.6.2.6.2	X			
9.6.2.7	X			
9.6.2.7.1	X			
9.6.2.7.2	X			
9.6.2.8	X			
9.6.2.8.1	X			
9.6.2.8.2	X			
9.6.2.9	X			
9.6.2.9.1	X			
9.6.2.9.2	X			
9.6.3	X			
9.6.3.1	X			
9.6.3.1.1	X			
9.6.3.1.2.	X			
9.6.3.1.3	X			
9.6.3.1.3.1	X			
9.6.3.1.3.2	X			
9.6.3.1.4	X			
9.6.3.1.5	X			
9.6.3.1.6	X			
9.6.3.1.6.1	X			
9.6.3.1.6.2	X			
9.6.3.1.6.3	X			
9.6.3.1.6.3.1	X			
9.6.3.1.6.3.2	X			
9.6.3.1.6.4	X			
9.6.3.1.6.4.1	X			
9.6.3.1.6.4.2	X			
9.6.3.1.7	X			
9.6.3.1.7.1	X			
9.6.3.1.7.2	X			
9.6.3.1.7.3	X			
9.6.3.1.7.3.1	X			
9.6.3.1.7.3.2	X			
9.6.3.1.7.4	X			
9.6.3.1.7.5	X			
9.6.3.1.7.5.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
9.6.3.1.7.5.2	X			
9.6.3.1.8	X			
9.6.3.1.8.1	X			
9.6.3.1.8.2	X			
9.6.3.2.8.3	X			
9.6.3.1.9	X			
9.6.3.1.9.1	X			
9.6.3.1.9.2	X			
9.6.3.1.10	X			
9.6.3.1.10.1	X			
9.6.3.1.10.2	X			
9.6.3.2	X			
9.6.3.2.1	X			
9.6.3.2.1.1	X			
9.6.3.2.1.2	X			
9.6.3.2.2	X			
9.6.3.2.3	X			
9.6.3.2.4	X			
9.6.3.2.5	X			
9.6.3.2.5.1	X			
9.6.3.2.5.2	X			
9.6.3.3	X			
9.6.3.3.1	X			
9.6.3.3.1.1	X			
9.6.3.3.1.2	X			
9.6.3.3.1.3	X			
9.6.3.3.2	X			
9.6.3.3.2.1	X			
9.6.3.3.2.2	X			
10.0	X			
10.1	X			
10.2	X			
10.2.1	X			
10.2.2	X			
10.2.3	X			
10.2.3.1	X			
10.2.3.2	X			
10.2.3.3	X			
10.2.3.4	X			
10.2.3.5	X			
10.3	X			
10.3.1	X			
10.3.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
10.3.3	X			
10.3.3.1	X			
10.3.3.2	X			
10.3.4		X		
10.4	X			
10.4.1	X			
10.4.2		X		
10.4.3	X			
10.5	X			
10.5.1	X			
10.5.2	X			
10.5.3	X			
10.5.3.1	X			
10.5.3.2	X			
10.5.3.3	X			
10.5.3.4	X			
10.6	X			
10.6.1	X			
10.6.2	X			
10.6.3	X			
10.6.4		X		
10.7	X			
10.7.1	X			
10.7.2	X			
10.7.3	X			
10.8		X		
10.8.1		X		
10.8.2		X		
10.8.3		X		
10.8.3.1		X		
10.8. 3.1.1		X		
10.8.3.1.2		X		
10.8.3.1.2.1		X		
10.8.3.1.2.2		X		
10.8.3.2		X		
10.8.3.2.1		X		
10.8.3.2.1.1		X		
10.8.3.2.1.2		X		
10.8.3.2.1.3		X		
10.8.3.3		X		
10.8.3.4		X		
10.8.3.5		X		
10.8.4		X		

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
10.9	X			
10.9.1	X			
10.9.2	X			
10.9.2.1	X			
10.9.2.2	X			
10.9.2.3	X			
10.9.3	X			
10.9.3.1	X			
10.9.3.2	X			
10.9.3.2.1	X			
10.9.3.2.2	X			
10.9.3.2.3	X			
10.9.3.2.4	X			
10.9.3.2.5	X			
10.9.3.2.6	X			
10.9.3.2.7	X			
10.9.3.2.8	X			
10.9.3.2.9	X			
10.9.3.2.10	X			
10.9.3.2.11	X			
10.9.3.2.12	X			
10.9.3.2.13	X			
10.9.3.2.14	X			
10.9.3.2.15	X			
10.9.3.2.15.1	X			
10.9.3.2.15.2	X			
10.9.3.2.16	X			
10.10	X			
10.10.1	X			
10.10.2	X			
10.10.3	X			
10.11	X			
10.11.1	X			
10.11.2	X			
10.11.3	X			
10.12	X			
10.12.1	X			
10.12.2	X			
10.12.3	X			
11.0	X			
11.1	X			
11.2	X			
11.2.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
11.2.2	X			
11.2.2.1	X			
11.2.2.2	X			
11.2.3	X			
11.2.3.1	X			
11.2.3.1.1	X			
11.2.3.1.2	X			
11.2.3.1.3	X			
11.2.3.2	X			
11.2.3.3	X			
11.2.3.4	X			
11.2.3.5	X			
11.2.3.6	X			
11.2.3.7	X			
11.2.4	X			
11.2.4.1	X			
11.2.4.2	X			
11.3	X			
11.3.1	X			
11.3.2	X			
11.3.3	X			
11.3.3.1	X			
11.3.3.2	X			
11.3.3.3	X			
11.3.3.4	X			
11.4	X			
11.4.1	X			
11.4.2	X			
11.4.3	X			
11.4.4	X			
11.5	X			
11.5.1	X			
11.5.2	X			
11.5.3.1	X			
11.5.3.2	X			
11.5.4	X			
11.6	X			
11.6.1	X			
11.6.2	X			
11.6.3	X			
11.6.3.1	X			
11.6.3.2	X			
11.6.3.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
11.6.3.4	X			
11.7	X			
11.7.1	X			
11.7.2	X			
11.7.2.1	X			
11.7.2.2	X			
11.7.2.3	X			
11.7.2.3.1	X			
11.7.2.3.2	X			
11.7.2.3.2.1	X			
11.7.2.3.2.2	X			
11.7.2.3.2.3	X			
11.7.2.3.2.4	X			
11.7.2.3.3	X			
11.7.2.3.3.1	X			
11.7.2.3.3.2		X		
11.7.2.3.3.3	X			
11.7.2.3.3.4	X			
11.7.2.3.4		X		X
11.7.2.4		X		
11.7.3	X			
11.7.3.1	X			
11.7.3.2	X			
11.7.3.3	X			
11.7.3.4		X		
11.8	X			
11.8.1	X			
11.8.2	X			
11.8.2.1	X			
11.8.2.2	X			
11.8.2.2.1	X			
11.8.2.2.2	X			
11.8.2.2.3	X			
11.8.2.2.4	X			
11.8.2.2.5	X			
11.8.2.2.6	X			
11.8.3	X			
11.8.3.1	X			
11.8.3.2	X			
11.8.3.3		X		
11.9	X			
11.9.1	X			
11.9.2	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
11.9.3	X			
11.9.3.1	X			
11.9.3.2	X			
11.9.3.3	X			
11.9.3.4	X			
11.9.4	X			
11.10	X			
11.10.1	X			
11.10.2	X			
11.10.3	X			
11.10.3.1	X			
11.10.3.2	X			
11.10.3.3	X			
11.10.3.4	X			
11.10.3.5	X			
11.10.3.6	X			
11.10.4	X			
11.11	X			
11.11.1	X			
11.11.2	X			
11.11.2.1	X			
11.11.2.2	X			
11.11.2.3	X			
11.11.2.4	X			
11.11.3	X			
11.11.3.1	X			
11.11.3.1.1	X			
11.11.3.1.2	X			
11.11.3.1.3	X			
11.11.3.1.4	X			
11.11.3.1.5	X			
11.11.3.1.6	X			
11.11.3.1.7	X			
11.11.3.1.8	X			
11.11.3.1.9	X			
11.11.3.2	X			
11.11.3.2.1	X			
11.11.3.2.1.1	X			
11.11.3.2.2	X			
11.11.3.2.3	X			
11.11.3.2.4	X			
11.11.3.3	X			
11.11.3.4	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
11.11.3.5	X			
11.11.3.6	X			
11.11.4	X			
11.12	X			
11.12.1	X			
11.12.2	X			
11.12.3	X			
11.13	X			
11.13.1	X			
11.13.1.1	X			
11.13.1.2	X			
11.13.1.2.1	X			
11.13.1.2.2	X			
11.13.1.2.3	X			
11.13.1.3	X			
11.13.1.3.1	X			
11.13.1.3.2	X			
11.13.1.4	X			
11.13.2	X			
11.13.2.1	X			
11.13.2.2	X			
11.13.2.3	X			
121.13.2.4	X			
11.14	X			
11.14.1	X			
11.14.2	X			
11.14.3	X			
11.14.4	X			
12.0	X			
12.1	X			
12.2	X			
12.3	X			
12.3.1	X			
12.3.1.1	X			
12.3.1.2	X			
12.3.1.3	X			
12.3.1.4	X			
12.3.2	X			
12.3.2.1	X			
12.3.2.2	X			
12.3.3	X			
13.0	X			
13.1	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
13.2	X			
13.2.1	X			
13.2.2	X			
13.2.3	X			
13.2.3.1	X			
13.2.3.2	X			
13.2.3.3	X			
13.2.3.4	X			
13.2.4	X			
13.3	X			
13.3.1	X			
13.3.2	X			
13.3.3	X			
13.3.3.1	X			
13.3.3.2	X			
13.4	X			
13.4.1	X			
13.4.2	X			
13.4.3	X			
13.4.3.1	X			
13.4.3.2	X			
13.4.3.3	X			
13.4.4	X			
14.0	X			
14.1	X			
14.1.1	X			
14.1.2	X			
14.1.2.1	X			
14.1.2.1.1	X			
14.1.2.1.2	X			
14.1.2.1.3	X			
14.1.2.1.4	X			
14.1.3	X			
14.1.4	X			
14.2	X			
14.2.1	X			
14.2.2	X			
14.2.2.1	X			
14.2.2.2	X			
14.2.2.3	X			
14.2.2.4	X			
14.2.2.5	X			
14.2.2.6	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
14.2 2.7	X			
14.2.2.8	X			
14.2.2.9	X			
14.2.3	X			
14.2.3.1	X			
14.2.3.2	X			
14.2.3.3	X			
14.2.3.4	X			
14.2.3.5	X			
14.2.3.6	X			
14.2.3.7	X			
14.2.3.8	X			
14.2.3.9	X			
14.2.4		X		X
14.2.4.1		X		X
14.2.4.2		X		X
14.2.4.3	X			
14.2.4.4	X			
14.2.4.5	X			
14.3.1	X			
14.3.2	X			
14.3.2.1	X			
14.3.2.1.1	X			
14.3.2.1.2	X			
14.3.2.1.3	X			
14.3.2.2	X			
14.3.2.3	X			
14.3.2.4	X			
14.3.2.5	X			
14.3.2.6	X			
14.3.2.7	X			
14.3.3	X			
14.3.4	X			
14.3.4.1	X			
14.3.4.2	X			
14.3.4.3	X			
14.3.4.4	X			
14.3.4.5	X			
14.4.1	X			
14.4.2	X			
14.4.2.1	X			
14.4.2.2	X			
14.4.2.3	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
14.4.2.4	X			
14.4.2.5	X			
14.4.3	X			
14.4.3.1	X			
14.4.3.2	X			
14.4.3.3	X			
14.4.3.4	X			
14.4.3.5	X			
14.4.4	X			
14.4.4.1	X			
14.4.4.2		X		X
14.4.4.3		X		X
14.5.1	X			
14.5.2	X			
14.5.2.1	X			
14.5.2.2	X			
14.5.2.3	X			
14.5.2.4	X			
14.5.2.5	X			
14.5.2.6	X			
14.5.3.1	X			
14.5.3.2	X			
14.5.3.3	X			
14.5.3.4	X			
14.5.3.5	X			
14.5.3.6	X			
14.6.1	X			
14.6.2.1	X			
14.6.2.2	X			
14.6.2.3	X			
14.6.2.4	X			
14.6.2.4.1	X			
14.6.2.4.2	X			
14.6.3.1	X			
14.6.3.2	X			
14..6.3.3	X			
14.6.4.1	X			
14.6.4.2	X			
14.6.4.3	X			
14.7.1	X			
14.7.2	X			
14.7.3	X			
14.7.4	X			

Paragraph No	All	Orbital	Launch/ReEntry	Planetary
14.7.4.1	X			
14.7.4.2		X		
14.7.4.3		X		

APPENDIX H

VIDEOTAPE USER'S GUIDE

What is this videotape and why is it useful?

A videotape entitled, "Living and Working in Space," has been prepared by the ex-Skylab astronauts, Bill Pogue and Jerry Carr, for the Boeing Aerospace Company. This videotape incorporates scenes from Gemini, Apollo, Skylab, and Shuttle. It is intended to provide a wide scope general introduction to microgravity human factors/human engineering issues.

This videotape is specifically designed to create awareness of the basic microgravity considerations for workers involved in planning, engineering, and design work who are new to space programs. The content is biased towards the specific requirements of the Space Station and other long-duration space flights.

How is this videotape to be used?

The 34 minute videotape has been divided into 37 scenes. An on-screen clock serves as a counter for locating these scenes. There are 2 sub-appendices that are to be used for locating MSIS informaiton on this videotape:

Appendix H1-Video Scenes Description

This sub-appendix lists the 37 video scenes in time sequence. A short description for each scene is provided. A listing of the MSIS paragraphs that pertain to each scene is provided.

Appendix H2-Video Scenes Pertaining to MSIS Paragraphs

This sub-appendix lists MSIS paragraphs and then provides the scene numbers where information pertinent to each paragraph will be found.

How do you obtain a copy of the videotape?

A copy of the videotape can be obtained from the following source:

MSIS Custodian/SP3
NASA - Johnson Space Center
Houston, TX 77058

APPENDIX H1

VIDEO SCENES DESCRIPTION

APPENDIX H1
VIDEOTAPE USER'S GUIDE
SCENE DESCRIPTIONS

APPENDIX H1

Living and Working in Space
Video Scenes Descriptions

Scene Description	Time	MSIS Paragraphs*
1. Skylab in orbit	0:00-0:41	5.1, 5.2
2. Shuttle Orbiter in orbit	0:41-1:01	5.1, 5.2
3. Crew on Orbiter flight deck	1:01-1:23	3.3.4, 5.2, 8.4, 8.6, 8.12, 8.13, 9.2.4.2, 10.6
4. Graphic: space neutral posture	1:23-2:24	3.3.4, 5.2, 8.6, 9.2.4.2, 10.2.3.2, 10.4, 10.8.3.4, 10.9, 11.6, 11.7, 11.8, 12.3.1.2, 12.3.1.3
5. Crewman at Skylab wardroom window	2:24-2:33	3.3.4, 5.2, 8.11, 9.2.5.1.2, 11.7, 11.11
6. Spacelab crewmember holds arms	2:33-2:50	3.3.4, 4.6, 5.2, 8.6, 8.9.3.1, 8.9.3.2, 9.2.4.2, 11.6, 11.7
7. Skylab crewmember on exercise ergometer	2:50-3:13	3.3.4, 5.2, 7.2.3.3, 8.9.3.2, 10.8.3.4, 11.7
8. Skylab crewmen don suits	3:13-3:46	3.3.2, 3.3.3, 4.8, 5.2, 8.6, 11.7.2, 11.7.3, 11.9, 14.4.3.4
9. Space motion sickness experiments: crew participation	3:46-4:52	4.5, 5.2, 7.2.3, 11.7
10. Fluid shift: graphics & discussion	4:52-5:45	5.2, 7.2.3, 7.2.7
11. Sequence showing body rotations and rapid translations	5:45-6:44	3.3, 4.0, 5.2, 6.3, 8.2, 8.6, 8.7, 8.8, 8.9, 11.6, 11.7, 11.8
12. Contingency maintenance: poor restraint & bad lighting	6:44-7:51	3.3, 4.2, 4.8, 5.2, 6.3, 8.2, 8.4, 8.6, 8.9, 8.13, 9.2.2, 11.6, 11.8, 11.9, 12.3
13. Earth scene & scene showing docking-discussion of vision	7:51-8:34	4.2, 5.1, 10.7
14. Crewmember translates through Skylab-discussion of sense of orientation	8:34-9:04	4.2, 4.5, 4.6, 5.2, 6.3, 8.2, 8.3, 8.4, 8.6, 8.7, 8.8, 8.9, 8.10, 8.12, 8.13, 9.2.2, 9.2.4, 11.6, 11.7, 11.8
15. Wardroom table & eating scenes from Skylab; group meal on shuttle	9:04-11:51	3.3, 4.8, 5.2, 8.2, 8.6, 8.9.3, 8.12, 8.13, 10.5.3, 10.6, 11.7
16. Skylab & Orbiter sleep stations	11:51-13:02	3.3, 4.6, 4.10, 5.2, 7.2.4, 8.4, 8.6, 11.7
17. Exercise: scenes from Skylab & Shuttle showing different types of exercise	13:02-14:04	3.3, 4.6, 4.8, 4.9, 4.10, 5.2, 7.2.3.3, 7.2.7, 8.4, 8.6, 8.9.3, 10.7, 10.8, 11.7
18. Body cleansing scenes from Skylab & Shuttle	14:04-14:44	7.2.5, 8.6, 10.2.3, 11.3, 11.7

* Refer to Appendix H2 for listing of MSIS paragraphs cross matrixed to video scenes

APPENDIX H1
VIDEOTAPE USER'S GUIDE
SCENE DESCRIPTIONS

APPENDIX H1 (CONTINUED)

Living and Working in Space
Video Scenes Descriptions

Scene Description	Time	MSIS Paragraphs*
19. Space housekeeping: debris accumulation on filters/screens, vacuuming operations on Skylab & Shuttle, and housekeeping requirements, trash disposal and inventory management	14:44-16:02	5.2, 8.3, 8.6, 8.7, 8.8, 8.9, 8.10, 9.2.5.2, 10.11, 11.4, 11.6, 11.7, 12.3, 13.2, 13.3
20. Medical monitoring: Shuttle	16:02-16:20	7.2.7, 10.9
21. Body restraint illustrations: arresting/controlling body motion, handling equipment, use of tools and tool restraint during tasks	16:20-18:25	3.3, 5.2, 6.4, 8.7, 8.8, 8.9, 11.2, 11.6, 11.7, 11.8, 11.10, 12.3
22. Paper/hard copy/document management, document restraint	18:25-19:14	4.8, 5.2, 8.6, 8.9.2.2, 11.7.3, 13.4.3.2
23. Manual dexterity during task *performance: tool restraint during* tasks	19:14-19:44	3.3.2, 4.8, 8.6, 8.9.3, 9.2.2.2, 9.2.4.2, 11.2, 11.7, 12.3
24. Work bench innovations on Skylab: fan housing and filter screen	19:44-20:12	5.2, 8.4, 8.6, 9.2.2, 11.7, 12.3
25. Difficulty in handling small items	20:12-20:36	3.3.2, 3.3.3, 4.8, 5.2, 8.9, 9.2.2, 11.7, 11.13, 12.3
26. Work station/work area architecture and panel orientation considerations	20:36-21:23	4.2, 4.5, 5.2, 8.2, 8.3, 8.4, 8.6, 8.12, 9.2.2, 9.2.3, 12.3.1.3
27. Windows as work stations: crowding & interference issues	21:23-21:49	3.3, 5.2, 8.6, 8.11, 9.2.2, 11.7, 11.11, 11.14
28. *Manipulation of hardware in* microgravity and difficulty created by poorly restrained documents. Difficulty in freeing stuck mechanisms	21:49-23:01	3.3, 4.2, 4.8, 4.9, 4.10, 5.2, 6.3, 8.6, 9.2.2, 11.7, 12.3, 13.4.3
29. Cable & hose management: clutter, snag & interference potential	23:01-23:28	5.2, 6.3, 8.2, 8.7, 8.8, 11.14, 12.3
30. *Body translation-equipment* vulnerability/inadvertent control actuation or damage potential during crew translation	23:28-26:30	3.3, 4.8, 5.2, 6.3, 8.2, 8.6, 8.7, 8.8, 8.9, 9.2.2, 11.6, 11.7, 11.8

* Refer to Appendix H2 for listing of MSIS paragrapns cross matrixed to video scenes

APPENDIX H1
VIDEOTAPE USER'S GUIDE
SCENE DESCRIPTIONS

APPENDIX H1 (CONTINUED)

Living and Working in Space
Video Scenes Descriptions

Scene Description	Time	MSIS Paragraphs*
31. Equipment translation illustrations, body restraint during equipment handling	26:30-26:56	3.3, 4.8, 5.2, 8.6, 8.7, 8.8, 8.9, 11.7, 11.8
32. Introduction to EVA-suited restrictions to dexterity/mobility and body/equipment restraints and mobility aids	26:56-27:27	14.1, 14.2, 14.3, 14.4, 14.5
33. Body and equipment restraints: EVA considerations and provisions Gemini to Shuttle	27:27-29:28	14.4
34. Equipment manipulation and translation - EVA	29:28-30:53	14.4, 14.5, 14.7
35. Manned maneuvering unit OPS: satellite retrieval operations	30:53-31:42	14.5, 14.7
36. EVA lighting consideration, vehicle external lighting considerations/ requirements	31:42-32:48	14.4
37. Summary Posture, restraints, access, single reference frame	32:48-33:40	

* Refer to Appendix H2 for listing of MSIS paragraphs cross matrixed to video scenes

APPENDIX H2

VIDEO SCENES PERTAINING TO MSIS PARAGRAPHS

APPENDIX H2
VIDEOTAPE USER'S GUIDE
MSIS PARAGRAPHS
VS. SCENES

APPENDIX H2

Living and Working in Space
Video Scenes Pertaining to MSIS Paragraphs*

3.3	**Anthropometrics and Biomechanics**
3.3.1	11, 12, 15, 16, 17, 21, 27, 28, 30, 31
3.3.2	8, 11, 12, 15, 16, 17, 21, 23, 25, 27, 28, 30, 31
3.3.3	8, 11, 12, 15, 16, 17, 21, 27, 28, 30, 31
3.3.4	3, 4, 5, 6, 7, 11, 12, 15, 16, 17, 21, 27, 28, 30, 31
4.0	**Human Performance Capabilities**
4.2	12, 13, 14, 26, 28
4.3	13
4.5	9, 13, 14, 26
4.6	13, 14, 16, 17
4.8	8, 13, 15, 17, 22, 23, 25, 28, 30, 31
4.9	13, 17, 28
4.10	13, 16, 17, 28
5.0	**Natural and Induced Environments**
5.1	1, 2, 18
5.2	Virtually all scenes
6.0	**Crew Safety**
6.3	11, 12, 14, 28, 29, 30
6.4	21
7.0	**Health Maintenance**
7.2.3	7, 9, 10, 17
7.2.4	16
7.2.5	18
7.2.7	10, 17, 20

* Refer to Appendix H1 for listing of video scenes and their description

APPENDIX H2
VIDEOTAPE USER'S GUIDE
MSIS PARAGRAPHS
VS. SCENES

APPENDIX H2 (CONTINUED)

Living and Working in Space
Video Scenes Pertaining to MSIS Paragraphs*

8.0	**Architecture**
8.2	11, 12, 14, 26, 29, 30
8.3	14, 19, 26
8.4	3, 12, 14, 16, 17, 24, 26
8.6	3, 4, 6, 8, 11, 12, 14, 17, 18, 19, 22, 23, 24, 26, 27, 28, 30, 31
8.7	11, 14, 19, 21, 29, 30, 31
8.8	11, 14, 19, 21, 29, 30, 31
8.9	7, 7, 11, 12, 14, 17, 19, 21, 22, 23, 25, 30
8.10	14, 19
8.11	5, 27
8.12	3, 14, 26
8.13	3, 12, 14
9.0	**Work Stations**
9.2.2	12, 14, 22, 24, 25, 26, 27, 28, 30
9.2.3	26
9.2.4	4, 6, 14, 23
9.2.5.1	5
9.2.5.2	19
10.0	**Personal Hygiene**
10.2.3.1	18
10.2.3.2	4, 18
10.4	4
10.5	15
10.6	3, 15
10.7	17
10.8	4, 7, 17
10.9	4, 20
10.11	19

* Refer to Appendix H1 for listing of video scenes and their description

APPENDIX H2
VIDEOTAPE USER'S GUIDE
MSIS PARAGRAPHS
VS. SCENES

APPENDIX H2 (CONTINUED)

Living and Working in Space
Video Scenes Pertaining to MSIS Paragraphs*

11.0	**Hardware & Equipment**
11.2	21, 23
11.3	18
11.4	19
11.5	None
11.6	4, 5, 6, 11, 12, 14, 19, 21, 30
11.7	4, 5, 6, 7, 8, 9, 11, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 27, 28, 30, 31
11.8	4, 5, 11, 12, 14, 21, 30, 31
11.9	8, 12
11.10	21
11.11	6, 27
11.13	25
11.14	27, 29
12.0	**Design for Maintainability**
12.3	4, 12, 19, 21, 23, 24, 25, 26, 28, 29
13.0	**Facilities Management**
13.2	19
13.3	19
13.4	22, 28
14.0	**EVA**
14.1	32
14.2	32
14.3	32, 33
14.4	8, 32, 34, 36
14.5	32, 34, 35
14.6	None
14.7	34, 35

* Refer to Appendix H1 for listing of video scenes and their description

APPENDIX I

STANDARDS DATA MANAGEMENT SYSTEM (SDMS)

USER'S GUIDE

(This appendix has been deleted from this volume)

APPENDIX J

MSIS KEYWORD LIST

1-g conditioning

7.2.3.2	Reduced Gravity Countermeasures Design Considerations

Abbreviations

9.5.3.1.14.3	Upper/Lower Case Design Requirements
9.6.2.8.2	Design Requirements for Format
9.6.4.3	Design Requirements for Data Entry Design

Acceleration

3.3.3.2.1	Gravity Condition Design Considerations
3.3.3.3.2	Strike Reach Envelope Data Design Requirements
4.2.2	Vision - Design Considerations
4.6.2	Kinesthetic Design Considerations
5.3	Acceleration
10.4.3	Individual Crew Quarters Design Requirements
11.7.2.3.3.2	Body Restraint Loads Design Requirements

Acceleration effects

5.3.2.2.2	Subjective Effects of Linear Accelerations

Acceleration environment

5.3.2	Acceleration Design Considerations

Acceleration limits

5.5.3.2.2	Decreased Proficiency Boundary

Acceleration regime

1.4.3.3	Acceleration Regimes - Applicability
5.2.3	Microgravity Design Requirements

Acceleration responses

5.3.2.2 Human Responses to Linear Acceleration

Access air filters

13.2.3.4 Air Filter Design Requirements

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8.13.2.2	Lighting Intensity Design Considerations

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11.10.3.1 Fluid Connectors Design Requirements

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6.3.3.10 Mechanically Stored Energy Requirements

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6.3.2 Mechanical Hazards Design Considerations

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7.3.2.1 Objectives of Medical Care - Design Considerations

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10.9.3.1 Medical Communications/Computing Design Requirements

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10.9.3.1 Medical Communications/Computing Design Requirements

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7.3.2.3 Earth- versus Space-Based Medical Care-Design Considerations
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8.13.3.5 Medical Lighting Requirements

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7.3.2.3 Earth- versus Space-Based Medical Care-Design Considerations

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7.3.2.3 Earth- versus Space-Based Medical Care-Design Considerations
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7.3.3.4 Treatment (Therapeutics) Design Requirements

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10.6 Meeting Facility

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5.2 Microgravity

Microgravity controls

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10.8 Microgravity countermeasures Facility
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10.8.3.1 Microgravity Countermeasures Equipment/Supplies Design Requirements

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9.6.2.1 Design Considerations for Data Display

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10.5.3.3 Food Packaging and Stowage Design Requirements

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9.6.4.3 Design Requirements for Data Entry Design

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8.9.3.1 IVA Mobility Aid Integration Design Requirements

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8.9.2.1 Location of IVA Mobility Aids Design Considerations

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8.9.2.1 Location of IVA Mobility Aids Design Considerations

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10.8.3.2 Countermeasure Monitoring Design Requirements

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11.5.2 Mounting Hardware Design Considerations
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9.4.2.3.3.4 Scales and Pointers Design Requirements

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9.2.5.1.2 Window Workstation Design Requirements

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9.6.3.1.2 Design Requirements for User-Computer Dialogues

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9.6.4.4 Design Requirements for Interactive Control

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10.8.3.1 Microgravity Countermeasures Equipment/Supplies Design Requirements
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11.7.2.3.1 General Personnel Restraints Design Requirements

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9.5.3.1.6 Equipment Identification Design Requirements

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5.4.3.2.1.2 Narrow-Band, Long-Term Hearing Conservation Noise Exposure Requirement

Narrow band noise

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9.2.5.2.1 Maintenance Workstation Design Considerations

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5.4.4	Example Acoustics Design Solutions
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4.3.2.2	Noise Design Considerations
5.4.2.3	Human Responses to Noise - Design Considerations

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5.4.3	Acoustics Design Requirements

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5.4.2.4.1	Hearing Conservation Criteria Considerations

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5.4.2.3.2 Performance Effects of Noise

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5.4.2.1 Acoustic Environments - Design Considerations
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5.4.3.2.1.2 Narrow-Band Long-Term Hearing Conservation Noise Exposure Requirements

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5.4.3.2.4 Measurement of Noise Levels

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5.4.3.2.5 Noise Reduction For Equipment Upgrades
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5.4.4.2 Control of Noise Path Transmission

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9.3.3.5 Speech Transmission Equipment Design Requirements

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5.4.4.1 Noise Control at the Source

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5.4.3.2 Noise Exposure Requirements

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5.7.3.1.2 Sources of Non-Ionizing Radiation

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5.7.3.1.1 Types of Non-Ionizing Radiation
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5.7.3.2.2 Non-Ionizing Radiation Protection Design Requirements

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8.3.3.2 Non-Adjacent Crew Stations - Design Requirements

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11.2.3.7 Special Tool Features Design Requirements

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13.2.3.4 Air Filter Design Requirements

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7.2.3.4 Nonexercise Countermeasures
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11.6.3.3 Nonfixed Handles Design Requirements

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11.11.3.2.1 Material

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13.2.3.3 Vacuum Cleaning Design Requirements

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10.9.3.2.6 Diagnostic Imaging

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11.2.3.7 Special Tool Features Design Requirements

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11.9.3.3 Tool-Actuated Fastener Design Requirements

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11.4.3 Closures and Covers Design Requirements

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13.2.3.3 Vacuum Cleaning Design Requirements

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5.1.2.1.2 Gas Environment Design Considerations

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9.3.3.4.1.1 Layout

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9.5.3.1.14.5 Special Character Design Requirements

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9.6.3.2.2 Design Requirements for Scrolling

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7.2.2.2.1	Goal of Nutrition Program - Design Considerations
7.2.2.4	Example Nutritional Program

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11.2.4.1	Example Manual Tools

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13.4.2	Information Management Design Considerations

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9.6.3.4.6.2	Design Requirements for On-Line Instruction

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5.4.2.1.2	On-Orbit Phase Acoustic Environment

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5.5.2.1.2 On-Orbit Phase Vibration Environment

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11.7.3.3 Equipment Restraint Design Requirements
11.9.3.2 Hand-Actuated Fastener Design Requirements
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12.3.2.1 Fault Detection and Isolation Design Requirements

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9.6.3.1.7.5.1 Design Considerations for Interactions with Windows
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9.5.3.1.8 Operating Instruction Design Requirements
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9.5.3.1.8 Operating Instruction Design Requirements

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11.3.3.2 Design Requirements Common to Both Stowage & Equipment Drawers

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14.2.4.3 EVA Example Medical Monitoring Design Solutions

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9.4.2.3.2 Information Presentation Design Requirements

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9.6.3.4.3.2 Design Requirements for System Status Messages

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9.4.3.3.3 Operator Comfort and Convenience Design Requirements

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9.4.3.3.3 Operator Comfort and Convenience Design Requirements

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8.9.2.2 Considerations for Location of IVA Personnel Restraints

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11.10.3.4 Optical Connectors Design Requirements

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11.11.3.1.4 Optical Density

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11.11.3.3 Visual Protection Design Requirements

Optical laser radiation exposure limits

5.7.3.2.1 Non-Ionizing Radiation Exposure Limits

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5.7.3.1.1 Types of Non-Ionizing Radiation
5.7.3.1.3 Human Responses to Non-Ionizing Radiation
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5.7.3.2.2 Non-Ionizing Radiation Protection Design Requirements

Optical surface microfractures

11.11.3.2.1 Material

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7.2.5.3 Personal Hygiene - Design Requirements
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5.1.3.3 Atmosphere Toxicological Monitoring Design Requirements

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8.4.2 Orientation Design Considerations
8.4.4 Example Orientation Design Solutions

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Potable water temperature

7.2.2.3.2.3 Potable Water Temperature Design Requirements

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Printed circuit switches

9.3.3.3.16 Printed Circuit (DIP) Switches Design Requirements

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9.3.3.3.11 Rocker Switch Design Requirements

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APPENDIX K
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Company: U.T. Design Library

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Company: NASA Johnson Space Center

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Company: NASA Lewis Research Center

Library, Judy Joba -
Mail Code:
Company: Canadian Space Agency

Library, Technical
Mail Code: T40
Company: Allied Signal Aerospace

Library, Technical
Mail Code: PS33
Company: NASA Johnson Space Center

Library, Technical
Mail Code:
Company: Boeing Defense & Space Group

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Company: NASA Ames Research Center

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Company: NASA Lewis Research Center

Lineberry, Edgar C.
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Company: NASA Johnson Space Center

Linsley, Jerald
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Company: Florida Institute of Technology

Lippert, Buddy
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Company: Lockheed

Liput, J. J.
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Company: NASA Johnson Space Center

Livingston, John M.
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Company: NASA Marshall Space Flight Center

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Lloyd, C.
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Company: Lockheed

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Company: ERA Technology

Loftus, Joseph P.
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Logan, James S.
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Logan, Cory
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Loman, Marty
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Company: McDonnell Douglas Corporation

Lomax, Piper
Mail Code: T20-G-2
Company: NASA Ames Research Center

Loo, David
Mail Code: AD60
Company: Rockwell International

Lopresti, Sam
Mail Code:
Company: Blackwell North America Inc.

Lounge, John M.
Mail Code: CB
Company: NASA Johnson Space Center

Love, Alton K.
Mail Code: ND335
Company: NASA Johnson Space Center

Low, G. David
Mail Code: GA22
Company: NASA Johnson Space Center

Lowerison, John C.
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Company: NASA Aerospace Education Services Project

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Lozar, Charles C.
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Luckstead, John
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Luczkowski, Stanley M.
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Lufkin, Ann
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Luse, M. B.
Mail Code: EE
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Luttges, Marvin
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Lynch, Lettie
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MOD Library,
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Company: NASA Johnson Space Center

MSFC Doc. Rpos.,
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Company: NASA Marshall Space Flight Center

MSFC Library,
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Mac Donald, Edward
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MacDonald, Kathy
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Company: Tufts University

Mackey, Christy
Mail Code:
Company: Honeywell

Maclise, Dougal
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Mah, Frank
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Mahla, Gary
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Majors, Cindy
Mail Code: DA2
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Mallary, W. E.
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Mallory, Ken
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Company: Performance Mastery Company

Malone, Ray C
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Maloy, Joe
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Company: NASA Johnson Space Center

Malpass, Al
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Company: Space Industries Inc.

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Mancuso, T. G.
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Company: NASA Johnson Space Center

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Marette, D.
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Company: Aerospatiale, Incorporated

Marr, Phil
Mail Code: C18
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Marriott, Rich
Mail Code: 313
Company: NASA Goddard Space Flight Center

Marshall, Paul
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Marshall, Louis B.
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Company: NASA Aerospace Education Services Project

Marshall, Andrew
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Company: Marshall Associates

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Company: Lockheed Missiles & Space Co.

Martin, Joyce
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Martinez, P. A.
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Company: NASA Johnson Space Center

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McAllister, Donna
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McCauley, Nan
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McCauley, Lisa A.
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McCline, Carole
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McDonald, David
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Company: Johnson Engineering Corporation

McEwen, W.W.
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McFeron, L. O. (Lou)
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Company: Lockheed Aeronautical Systems Co.

McGuffey, Douglas
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McVicker, J. P.
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Moore, Gary
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Moore, Jerry
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Company: Federal Aviation Administration

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Company: NASA Marshall Space Flight Center

Ngo, Ken
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Company:

Notaro, Joe
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Company: Naval Air Development

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Company: Ford Motor Company

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O'Kane, Jim
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O'Neil, Harold F.
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Company: Advance Design Information

O'Neil, Graham
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Office, Field
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Mail Code: ADEA
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Office, Field
Mail Code: OMMCS
Company: U.S. Army Human Engineering Lab.

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Company: U.S. Army Human Engineering Laboratory

Ogburn, Ivan
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Okushi, Jun
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Oleson, Mel
Mail Code: 7E-ER
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Olsen, Kolleen
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Olsm, Richard
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Company: Boeing Aerospace

Olson, Pam
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Oman, Charles
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Parmet, Alan J.
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Parra, C. G.
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Parsons, Stuart
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Company: Lockheed Missiles & Space Co.

Parsons, Carmen
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Company: NASA Johnson Space Center

Parsons, Stuart O.
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Company: Parsons and Associates

Patlach, Bob
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Company: NASA Johnson Space Center

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Company: NASA Space Station Program Office

Patton, Jeff
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Company: SYD Mead, Inc.

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Company: Martin Marietta - Manned Space Systems

Percipalle, Piergiorgio
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Company:

Perera, S.T.
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Company: Commercial Space Technologies

Perino, M.A.
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Company: Alenia Spazio S.p.A.

Perkins, Richard
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Company: Lockheed

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Company: Ebasco Services, Inc.

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