METRIC

NOTICE OF CHANGE

MIL-STD-1472D
NOTICE 3
10 February 1994

MILITARY STANDARD
HUMAN ENGINEERING DESIGN CRITERIA FOR MILITARY
SYSTEMS, EQUIPMENT AND FACILITIES

TO ALL HOLDERS OF MIL-STD-1472D:

1. THE FOLLOWING PAGES OF MIL-STD-1472D HAVE BEEN REVISED AND SUPERSEDED THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
5	10 February 1994	5	14 March 1989
6	10 February 1994	6	14 March 1989
7	10 February 1994	7	20 March 1991
8	14 March 1989	8	REPRINTED WITHOUT CHANGE
11	10 February 1994	11	14 March 1989
12	10 February 1994	12	14 March 1989
61	10 February 1994	61	14 March 1989
62	10 February 1994	62	14 March 1989
123	10 February 1994	123	14 March 1989
124	10 February 1994	124	14 March 1989
127	10 February 1994	127	14 March 1989
128	14 March 1989	128	REPRINTED WITHOUT CHANGE
136a	30 June 1992	136a	DELETE
233	10 February 1994	233	14 March 1989
234	10 February 1994	234	14 March 1989
285	10 February 1994	285	30 June 1992
286	10 February 1994	286 288	14 March 1989

2. MAKE THE FOLLOWING PEN AND INK CHANGES:

a. Page 13, para 3.45, second line, change "paragraph 4" to "paragraph 6."

b. Page 16, para 3.72, third line: Change "on-set" to "onset."

AMSC N/A AREA HFAC

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c. Page 18, para 4.4.g., first line: Change "insuring" to "ensuring."

d. Page 24, para 5.1.4, change "Control display movement ratio" to "Control/display movement ratio."

e. Page 27, para 5.2.1.1, third line: Delete "his."

f. Page 28, para 5.2.1.3.1, third line: Change "that which is" to "information."

g. Page 29, para 5.2.1.4.4, fifth line: Change "insure" to "ensure."

h. Page 32, para 5.2.1.4.12, third line: Change "never be" to "be not."

i. Page 32, para 5.2.1.5.2, second line: Delete "coding."

j. Page 35, para 5.2.2.1.17, third line: Change "insure" to "ensure."

k. Page 35, para 5.2.2.1.18e., third line: Delete "etc."

l. Page 36, para 5.2.2.1.19, first line: Change "indicator" to "display."

m. Page 41, para 5.2.3.1.10.1, third line: Change to read, "level, caution, undesirable <u>condition</u> and inefficient <u>operation</u>."

n. Page 41, para 5.2.3.2, change "indicators" to "displays."

o. Page 46, para 5.2.3.3.3, 4th line: Delete "space before bat."

p. Page 65, para 5.3.12.1.a., second line: Change "S3.2-1960" to "ANSI S3.2".

para 5.3.12.1.c., third line: Delete "-1969".

q. Page 71, para 5.4.1.4.3, fifth and sixth lines: Change "not be" to "be not."

r. Page 72, para 5.4.1.8.1, fourth line: Change "degredation" to "degradation" and "functions" to "performance."

s. Page 73, para 5.4.1.8.4.f, third line: Add "is" after "control."

t. Page 73, para 5.4.1.8.5, second line: Add "or input" after "force."

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u. Page 75, para 5.4.2.1.2.1, second line: Change "go no-go" to "go/no-go."

v. Page 91, figure 11, change "9.5" to "10".

w. Page 94, para 5.4.3.1.4.1, fourth line: Edit to read "...control or legend switch control is not feasible or when the toggle...".

x. Page 99, para 5.4.3.1.7.3, third line: Delete third line.

y. Page 113, para 5.4.3.2.5.1, fourth line: Delete "etc."

z. Page 175, para 5.8.3.2, third line: Add "DA PAM 40-501" after "5100.238".

aa. Page 177, para 5.8.3.4.3, third line: Delete ", as defined by ANSI S1.1,"

bb. Page 193, para 5.9.11.3.3, second line: Change "XXIV" to "XXIII."

cc. Page 237, Change "5.13.7.5 Trainers" to "5.13.8 Trainers".

3. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

4. Holders of MIL-STD-1472D will verify that page changes and additions indicated above have been entered. These notice pages will be retained as a separate check list. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military standard is completely revised or cancelled.

Custodians:
Army - MI
Navy - AS
Air Force - 11

Preparing activity:
Army - MI

(Project HFAC-0058)

Review activities:
Army - AR, AT, AV, CR, ER, GL, ME, MD, MR, TE, TM, EA
Navy - EC, MC, MS, OS, PE, SH, TD
Air Force - 13, 14, 19, 26

User activities:
Army - AL
Navy - YD

Civilian agencies:
NASA - MSFC
DOT - RDS

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MIL-STD-783 Legends for Use in Aircrew Stations and on Airborne Equipment

MIL-STD-850 Aircrew Station Vision Requirements for Military Aircraft

MIL-STD-1179 Lamp, Reflectors and Associated Signalling Equipment for Military Vehicles

MIL-STD-1180 Safety Standards for Military Ground Vehicles

MIL-STD-1247 Markings, Functions and Hazard Designations of Hose, Pipe, and Tube lines for Aircraft, Missile and Space Systems

MIL-STD-1280 Keyboard Arrangements

MIL-STD-1294 Acoustical Noise Limits in Helicopters

MIL-STD-1333 Aircrew Station Geometry for Military Aircraft

MIL-STD-1348 Knobs, Control, Selection of

MIL-STD-1473 Standard General Requirements for Color and Marking of Army Materiel

MIL-STD-1474 Noise Limits for Military Materiel

MIL-STD-1787 Aircraft Display Symbology

HANDBOOKS

MILITARY

DOD-HDBK-743 Anthropometry of US Military Personnel

MIL-HDBK-759 Human Factors Engineering Design for Army Materiel

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

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PUBLICATIONS

ARMY

DA PAM 40-501 - Hearing Conservation

NAVY

OPNAVINST 5100.23B Hearing Conservation Program

AIR FORCE

AFR 161-35 - Hazardous Noise Exposure (Regulation)

FEDERAL REGULATION

29 CFR 1910 - Occupational Safety and Health Standards

(Copies of other government documents, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

Human Engineering Guide to Equipment Design, 1972 Edition

(Application for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, DC 20402)

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

Threshold Limit Values

(Application for copies should be addressed to the ACGIH Inc., 6500 Glenway Ave. Bldg. D-7, Cincinnati, OH 45211)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.4 Sound Level Meters (ASA 47)

ANSI S1.6 Preferred Frequencies and Band Numbers for Acoustical Measurements (ASA 53)

ANSI S3.2 Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ANSI S3.5 Articulation Index, Methods for the Calculation of.

(Application for copies of ANSI S1.4, S1.6, and S3.2 (ASA 47, 53 and 85) should be addressed to Professional Book Distributors, Inc., ASA Standards Distribution Center, 1650 Bluegrass Lake Parkway,

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P.O. Box 6996, Alpharetta, GA 30239-6996. Application for copies of other ANSI standards should be addressed to the American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.)

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM E 380 Metric Practice, Standard for

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

HUMAN FACTORS AND ERGONOMICS SOCIETY (HFES)

ANSI/HFS 100 American National Standard for Human Factors Engineering of Visual Display Terminal Workstations

(Application for copies should be addressed to the Human Factors and Ergonomics Society, Inc., P.O. Box 1369, Santa Monica, CA 90406)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO DIS 2631 Guide to the Evaluation of Human Exposure to Whole Body Vibration

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J925 Minimum Access Dimensions for Construction and Industrial Machinery

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

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

2.3 Order of preference. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, superseded applicable laws and regulation unless a specific exemption has been obtained.

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3.22 Dialogue. A structured series of interchanges between a user and a computer terminal. Dialogues can be computer initiated, e.g., question and answer, or user initiated, e.g., command languages.

3.23 Dichotic. The condition in which the sound stimulus presented at one ear differs from the sound stimulus presented at the other ear. The stimulus may differ in sound pressure, frequency, phase, time, duration, or bandwidth or other characteristics.

3.24 Display format. The organization of different types of data in a display, including information about the data such as labels, and other user guidance such as prompts, error messages.

3.25 Effective temperature. An empirically determined index which combines into a single value the effect of temperature, humidity, and air movement on the sensation of warmth or cold felt by the human body. The numerical value is that of the temperature of still, saturated air which would induce an identical sensation.

3.26 Enter. An explicit user action that effects computer processing of user entries. For example, after typing a series of numbers, a user might press an ENTER key that will add them to a data base, subject to data validation.

3.27 Equipment. General term designating any item or group of items.

3.28 Equipment failure. Cessation of the ability to meet the minimum performance requirements of the equipment specifications. Further, equipment failure shall imply that the minimum specified performance cannot be restored through permissible readjustment of operator controls.

3.29 Facilities. A physical plant, such as real estate and improvements thereto, including building and equipment, which provides the means for assisting or making easier the performance of a system function. The facilities to which this standard apply are those in which personnel perform system operational or maintenance duties.

3.30 Fail-safe design. Design where a failure will not adversely affect the safe operation of the system, equipment, or facility.

3 31 Field. See "Data Field."

3.32 File. A collection of data that is stored in a computer, treated as a single unit by the operating system of the computer.

3.33 Function key. A key, such as the SHIFT key, which initiates or modifies a machine function, (e.g., effects a control entry, instructs the computer to perform a step, or a series of steps) but Standard Code of Information Exchange (ASCII).

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3.34 Help. A capability that displays information upon user request for on-line guidance. HELP may inform a user generally about the system capabilities, or may provide more specific guidance in information handling transactions.

3.35 Highlighting. Emphasizing displayed data or format features in some way, e.g., through the use of underlining, bolding, or inverse video.

3.36 Human engineering design criteria. Stated limits on design to achieve the objectives of human engineering.

3.37 Information. Organized data that users need to perform their tasks successfully. Information serves as an answer to a user's questions about data and implies effective assimilation of data by a user. Data that have been processed and formulated by automated or manual means to satisfy a knowledge requirement for use by a decision maker.

3.38 Interrupt. Stopping an ongoing transaction in order to redirect the course of the processing. Examples of interrupt options are ABORT, BACKUP, CANCEL, and RESTART.

3.39 Luminance contrast. The contrast between the background and a figure equals the difference between the higher luminance (L1) and the lower luminance (L2) divided by the lower luminance (L2); i.e.,

$$C = \frac{L_1 - L_2}{L_2}$$

Conversions to the other contrast formulae are as follows:

L_1 (brighter)	L_2 (dimmer)	$\frac{L_1-L_2}{L_2}$	$\frac{L_1-L_2}{L_1}$	$\frac{L_1-L_2}{L_1+L_2}$	$\frac{L_1}{L_2}$
100	50	1.0	0.50 (50%)	0.33	2.0
100	25	3.0	0.75 (75%)	0.60	4.0
100	10	9.0	0.90 (90%)	0.82	10.0

3.40 Luminance ratio (LR). The ratio of the target, subject or symbol luminance to the surrounding field or background luminance. For projection systems, the luminance ratio is equal to the light output of a projector (measured with no film in the projector) reflected off the screen (image luminance) divided by all the light falling on the screen (measured from the greatest viewing angle) other than that actually forming the image (nonimage or background); i.e.,

$$LR = \frac{L_i}{L_n} \quad \text{where:} \quad L = \text{Image or subject luminance}, \quad L_n = \text{Nonimage or background luminance}$$

3.41 Macro. The capability to allow the user to assign a single name or function key to a defined series of commands for use with subsequent command entry. Sometimes called "smart key" or "script." Examples of use are storage of addresses or signature blocks that are frequently used. Usually initiated through use of a function key.

3.42 Maintainability, design for. Design considerations directed toward achieving those combined characteristics of equipment and facilities which will enable the accomplishment of necessary maintenance quickly, safely, accurately, and effectively with minimum requirements for personnel, skills, special tools, and cost.

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5.3.5.5 Message content. In selecting words to be used in audio warning signals, priority shall be given to intelligibility, aptness, and conciseness in that order.

5.3.5.6 Critical warnings and message priorities.

5.3.5.6.1 Critical warning signals. Critical warning signals shall be repeated with not more than a 3-second pause between messages until the condition is corrected or overridden by the crew.

5.3.5.6.2 Message priorities. A message priority system shall be established and more critical messages shall override the presentation of any message occurring below it on the priority list. If two or more incidents or malfunctions occur simultaneously, the message having the higher priority shall be given first. The remaining messages shall follow in order of priority. In the event of a complete subsystem failure, the system shall integrate previous messages via electronic gating and report the system rather than the component failure.

5.3.6 Controls for audio warning devices.

5.3.6.1 Automatic or manual shut-off. When an audio signal is designed to persist as long as it contributes useful information, a shut-off switch controllable by the operator, the sensing mechanism, or both, shall be provided, depending on the operational situation and personnel safety factors.

5.3.6.2 Automatic reset. Whether audio warning signal are designed to be terminated automatically, by manual control, or both, an automatic reset function shall be provided. The automatic reset function shall be controlled by the sensing mechanism which shall recycle the signal system to a specified condition as a function of time or the state of the signalling system so that the warning device can sound again if the condition repeats.

5.3.6.3 Redundant Visual Warning. All non-verbal aural annunciations shall be accompanied by a visual annunciation which defines the condition. In a cockpit, this may be an illuminated display. In the case of a warning horn on a backing vehicle, the vehicle's backward motion is adequate visual annunciation.

5.3.6.4 Volume control.

5.3.6.4.1 Automatic or manual. The volume (loudness) of an audio warning signal shall be designed to be controlled by the operator, the sensing mechanism, or both, depending on the operational situation and personnel safety factors. Control movements shall be restricted to prevent reducing the volume to an inaudible level or increasing it to an unacceptably high level.

5.3.6.4.2 Ganging to mode switches. Volume controls may be ganged to mode switches to provide maximum output during mission phases in which intense noise may occur and to provide reduced volume at other times. Ganging shall not be accomplished if there

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is a possibility that intense noise may occur in an emergency situation during a mission phase in which the volume would be decreased below an audible level.

5.3.6.4.3 Caution signal controls. Audio caution signals shall be provided with manual reset and volume controls.

5.3.6.5 Duration. Audio warning signal duration shall be at least 0.5 second, and may continue until the appropriate response is made. Completion of a corrective action by the operator or by other means shall automatically terminate the signal.

5.3.6.6 Duration limitations. In an emergency situation, signals that persist or increase progressively in level shall not be used if manual shut-off may interfere with the corrective action required.

5.3.7 Speech transmission equipment.

5.3.7.1 Frequency. Microphones and associated system-input devices shall respond optimally to that part of the speech spectrum most essential to intelligibility (i.e., 200 to 6,100 Hz). Where system engineering necessitates speech-transmission bandwidths narrower than 200 to 6,100 Hz, the minimum acceptable frequency range shall be 250 to 4,000 Hz.

5.3.7.2 Dynamic range. The dynamic range of a microphone used with a selected amplifier shall be great enough to admit variations in signal input of at least 50 dB.

5.3.7.3 Noise canceling microphones. In very loud, low frequency noise environments (100 dB overall), noise canceling microphones shall be used and shall be capable of effecting an improvement of not less than 10 dB peak-speech to root-mean-square-noise ratio as compared with non-noise-canceling microphones of equivalent transmission characteristics.

5.3.7.4 Pre-emphasis. If necessary, speech system input devices should employ frequency pre-emphasis with a positive slope frequency characteristic no greater than 18 dB per octave from 140 to 1,500 Hz, and no greater than 9 dB per octave over the frequency range 1,500 to 4,800 Hz, when no clipping is used.

5.3.7.5 Peak-clipping of speech signals. Where speech signals are to be transmitted over channels showing less than 15 dB peak speech to root-mean-square-noise ratios, peak clipping of 12 to 20 dB may be employed at system input and may be preceded by frequency pre-emphasis as specified in 5.3.7.4.

5.3.7.6 Noise shields. When the talker is in an intense noise field, the microphone should be put in a noise shield. Noise shields should be designed to meet the following requirements:

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5 5.5 Design of label characters.

5 5.5.1 Black characters Where the ambient illuminance will be above 10 lux (0.9 ft-c), black characters shall be provided on a light background.

5.5.5.2 Dark adaptation. Where dark adaptation is required, the displayed letters or numerals shall be visible without interfering with night vision requirements. Where possible, markings shall be white on a dark background.

5 5.5.3 Style. Style of label characters shall conform to MIL-M-18012, where consistent with 5.5.5.4, 5.5.5.5, 5.5.5.7, and 5.5.5.8, herein.

5.5.5.4 Capital vs lower case.

5.5.5.4.1 Labels. Labels shall be printed in all capitals; periods shall not be used after abbreviations.

5.5.5.4.2 Legends. Legends shall be printed in all capitals; periods or commas shall not be used.

5.5.5.4.3 Placards. Instructional material placards may employ capitals and lower case when the amount of material consists of several lines; however, for short, instructional material, all-capitals are preferred. All-capital material, consisting of larger caps for the initial letter in a paragraph, line of instruction or procedural step, may be used.

5.5.5.4.4 Signs. Signs shall consist of all-capitals, except when the sign is instructional and involves several lines of extended sentences, in which case capitals and lower case letters may be used.

5.5.5.5 Letter width. The width of letters should be 3/5 of the height, except for "M" and "W", which shall be 4/5 of the height, and "I", which shall be one stroke wide.

5.5.5.6 Numeral width. The width of numerals shall preferably be 3/5 of the height, except for the "4", which shall be one stroke width wider, and the "1" which shall be one stroke wide.

5 5.5.7 Wide characters. Where conditions indicate the use of wider characters, as on a curved surface, or where numerals must be aligned vertically in columns, the basic height-to-width ratio may be increased to as much as 1:1.

5.5.5.8 Stroke width, normal. For black characters on a white (or light) background, the stroke width shall be 1/6 to 1/7 of the height.

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5.5.5.9 Stroke width, dark adaptation. Where dark adaptation is required or legibility at night is a critical factor, and white characters are specified on a black background, the stroke width of the characters shall be from 1/7 to 1/8 of the height (i.e., narrower than specified for normal daytime vision). The stroke width shall be the same for all letters and numerals of equal height.

5.5.5.10 Stroke width, transilluminated characters. For transilluminated characters, the stroke width shall be 1/10 to 1/11 of the height.

5.5.5.11 Character spacing. The minimum space between characters shall be one stroke width.

5.5 5.12 Word spacing. The minimum space between words shall be the width of one character.

5.5.5.13 Line spacing. The minimum space between lines shall be one-half character height.

5.5 5.14 Label size vs luminance. The height of letters and numerals shall conform to Table XII.

5.5.5.15 Character height and viewing distance. For general dial and panel design, with the luminance normally above 3.5 cd/m^2 (1 fL), character height should be not less than 0.006 X the viewing distance.

5.5.6 Equipment labeling.

5.5.6.1 Units, assemblies, subassemblies and parts.

5.5.6.1.1 General requirements. Each unit, assembly, subassembly and part shall be labeled with a clearly visible, legible, and meaningful name, number, code, mark or symbol, as applicable.

5.5 6.1 2 Location. The gross identifying label on a unit, assembly or major subassembly shall be located:

a. Externally in such a position that it is not obscured by adjacent items.

b. On the flattest, most uncluttered surface available.

c. On a main chassis of the equipment.

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c. The units of measurement (e.g., volts, psi, meters) shall be labeled on the panel.

d. Labels shall be used to identify functionally grouped controls and displays. The labels shall be located above the functional groups they identify. When a line is used to enclose a functional group and define its boundaries, the label shall be centered at the top of the group either in a break in the line or just below the line. When colored pads are used, the label shall be centered at the top within the pad area.

e. Label location throughout a system and within panel groupings shall be uniform.

f. Adjacent labels should be separated by sufficient space so they are not read as one continuous label.

5.5.6.2.5 Hierarchical labeling. A hierarchical labeling scheme should be used on control and display panels to reduce confusion and search time. Major labels should be used to identify major systems or operator work stations and component labels should identify each panel or console element. Labels should not repeat information contained in higher-level labels.

5.5.6.2.6 Size graduation. To reduce confusion and operator search time, labels shall be graduated in size. The characters in group labels shall be larger than those used to identify individual controls and displays. The characters identifying controls and displays shall be larger than the characters identifying control positions. With the smallest characters determined by viewing conditions, the dimensions of each character shall be at least approximately 25 percent larger than those of the next smaller label.

5.5.6.2.7 Overhead items. Items that are located overhead and out of view should be identified with labels on walls with an arrow pointing in the direction of the item or by a label on the floor directly below the item.

5.5.6.3 Storage cabinets. The contents of storage cabinets should be labeled on the outside of the cabinet door. For large storage cabinets, labels should be placed at standing eye height, i.e., from 1.270 to 1.650 meters (50 to 65 inches) above the standing surface. A prominent redundant label that identifies the cabinet's contents should be visible when the door is open.

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5.13 Hazards and safety.

5.13.1 General. Design shall reflect the safety related human engineering criteria below as well as in other sections of this standard.

5.13.2 Safety labels and placards.

5.13.2.1 Warning placards. Conspicuous placards shall be mounted adjacent to any equipment which presents a hazard to personnel (e.g., from high voltage, heat, toxic vapors, explosion, radiation).

5.13.2.2 Center-of-gravity and weight. Where applicable, the center of gravity and the weight of equipment shall be distinctly marked.

5.13.2.3 Weight capacity. The weight capacity shall be indicated on stands, hoists, lifts, jacks, and similar weight-bearing equipment, so as to prevent overloading.

5.13.2.4 Identification of protective items. Areas of operation or maintenance where special protective clothing, tools, or equipment are necessary (e.g., insulated shoes, gloves, suits) shall be specifically identified.

5.13.2.5 "NO-STEP" markings. "NO-STEP" markings shall be provided when necessary to prevent injury to personnel or damage to equipment.

5.13.2.6 Electrical labels. All receptacles shall be marked with their voltage, phase, and frequency characteristics, as appropriate. For other electrical labeling and warning requirements, see MIL-STD-454.

5.13.2.7 Hand grasp areas. Hand grasp areas shall be conspicuously and unambiguously identified on the equipment.

5.13.3 Pipe, hose, and tube line identification. Pipe, hose, and tube lines for liquids, gas, and steam shall be clearly and unambiguously labeled or coded as to contents, pressure, heat, cold, or other specific hazardous properties in accordance with MIL-STD-1247.

5.13.4 General workspace hazards.

5.13.4.1 Alerting device. A hazard alerting device shall be provided to warn personnel of impending danger or existing hazards (e.g., fire, the presence of combustible or asphyxiating gas, and radiation).

5.13.4.2 Emergency doors and exits. Emergency doors and exits shall be constructed so that they:

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a. are simple to operate,

b. are readily accessible,

c. are unobstructed,

d. are simple to locate and operate in the dark,

e. are quick opening in three seconds or less,

f. require 44 to 133 N (10 to 30 lbs) of operating force to open,

g. do not themselves, or in operation, constitute a safety hazard, and

h. permit one person egress in 5 seconds or less.

5.13.4.3 Stairs. Stairs, including incline, step risers, and treads, shall conform to standard safe design practice. Skid-proof flooring, stair, and step treads shall be provided. Where conditions warrant special precaution, surfaces shall conform to the nonslip coating requirements of MIL-W-5044 and MIL-W-5050.

5.13.4.4 Obstructions. Workspace around areas where maintenance is performed shall be free of obstructions which could cause injury to personnel, either through accidental contact with the obstruction or because the obstruction requires an awkward or dangerous body position.

5.13.4.5 Illumination. Adequate illumination shall be provided in all areas. Warning placards, stairways, and all hazardous areas shall be illuminated, in accordance with the recommended levels of Table XXI.

5.13.4.6 Thermal contact hazards. Equipment which, in normal operation, exposes personnel to surface temperatures greater or less than those shown below, shall be appropriately guarded. Surface temperatures induced by climatic environment are exempt from this requirement. Cryogenic systems shall also be appropriately guarded.

Temperature limits

Exposure	Metal	Glass	Plastic or wood
Momentary contact	60° C (140° F)	68° C (154° F)	85° C (185° F)
Prolonged contact or handling	49° C (120° F)	59° C (138° F)	69° C (156° F)
Momentary contact	0° C (32° F)	0° C (32° F)	0° C (32° F)
Prolonged contact or handling	0° C (32° F)	0° C (32° F)	0° C (32° F)

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ESD-TR-63-403	Psychoacoustic Speech Test: A Modified Rhyme Test (AD 411 983)
ESD TR 86-278	Guidelines for Designing User Interface Software (AD-A 177 198)
RADC-TDR-62-315	Criteria for Group Display Chains for The 1962-1965 Time Period (AD 283 390)
WADC TR 52-204	Handbook of Acoustic Noise Control (AD 018 260 and AD 012 015)
WADC TR 55-159	Space Requirements of the Seated Operator (AD 087 892)
WADC TR 58-474	The Effect of Team Size and Intermember Communication on decision-Making Performance (AD 215 621)
WADD TR 60-814	Audio Warning Signals for Air Force Weapon Systems (AD 258 477)

60 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PUBLICATIONS

60.1 Standards

Copies of the following documents can be obtained by qualified requesters from MSIS Custodian/SP34, NASA-Johnson Space Center, Houston, TX 77058

NASA-STD-3000, Volume I	Man-Systems Integration Standards
NASA-STD-3000, Volume II	Man-Systems Integration Standards-Appendices

60.2 Book

Copies of the following document can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402

NASA SP-3006	Bioastronautics Data Book, Second Edition, J.F. Parker and V.R. West, eds.

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70 VOLUNTARY STANDARDS AND GUIDES

70.1 American National Standards Institute (ANSI). Copies of ANSI A12.1, A14.3, C2, and Z136.1 can be obtained at a nominal cost from the ANSI, 11 West 42nd Street, New York, New York 10036. Copies of ANSI S1.11 can be obtained at a nominal cost from the Professional Book Distributors, Inc., ASA Standards Distribution Center, 1650 Bluegrass Lake Parkway, P.O. Box 6996, Alpharetta, Georgia 30239-6996

ANSI A12.1	Floor and Wall Openings, Railings, and Toeboards, Safety Requirements for
ANSI A14.3	Ladders-Fixed-Safety Requirements
ANSI C2	National Electrical Safety Code (NBS H30)
ANSI S1.11	Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters (ASA 65)
ANSI Z136.1	Safe use of Lasers

70.2 American Society for Testing and Materials. Copies of the following documents can be obtained at a nominal cost from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103

ASTM F 1166-8	Standard Practice for Human Engineering Design Criteria for Marine Systems, Equipment and Facilities

70.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Copies of the following documents can be obtained at a nominal cost from the ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329

ASHRAE 55-81	Thermal Environmental Conditions for Human Occupancy
ASHRAE 62-81	Ventilation for Acceptable Indoor Air Quality Guide and Data Book (latest edition)

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70.4 Illuminating Engineering Society (IES) of North America. Copies of the following document can be obtained at a nominal cost from the IES, 345 East 47th Street, New York, NY 10017

IES Lighting HDBK SEC 9 Application-87, Industrial Lighting

70.5 National Fire Protection Association (NFPA). Copies of the following document may be obtained from the NFPA, 60 Batterymarch Street, Boston, MA 02110

NFPA 101 Code for Safety to Life from Fire in Buildings and Structures

80 BOOKS

The documents listed below are normally available in general and technical libraries:

a. A Collation of Anthropometry, J. W. Garett and K. W. Kennedy. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1971. (2 Volumes) (AD 723 629; Library of Congress Catalog Card No. 74-607818)

b. Directions in Human/Computer Interaction. A. Badre and B. Schneiderman, Eds., Ablex Publishing, Norwood, NJ, 1982

c. Fundamentals of Interactive Computer Graphics, J. D. Foley and A. Van Dam, Addison-Wesley, Reading, MA, 1982

d. General Safety Requirements - U.S. Army Engineer Manual 385-1-1.

e. Guide to Human Engineering Design for Visual Displays, D. Meister and D. J. Sullivan, The Bunker-Ramo Corp., Contract No. N0001468-C-027E, Work Unit No. NR196-080 (AD 693 237), Office of Naval Research, 30 August 1969.

f. Human Engineering Guide to Equipment Design - H. P. Van Cott, and R. G. Kinkade, eds., Wiley, 605 Third Ave., New York, NY 10158, 1972 (Library of Congress Catalog Card No. 72600054).

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g. Industrial Ventilation, Manual of Recommended Practice - Latest Edition, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, P.O. Box 453, Lansing, Michigan.

h. Lighting Handbook, Illuminating Engineering Society (IES), latest edition.

i. Software Psychology: Human Factors in Computer and Information Systems. B. Schneiderman, Winthrop Publishers, Cambridge, MA, 1980.

j. Symbol Source Book, H. Dreyfuss, 1972, McGraw-Hill Book Company, Library of Congress Card No. 71-172261.

k. The Human Body in Equipment Design, A. Damon, H. W. Stoudt, and R. A. McFarland, Harvard University Press, Cambridge, Mass, 1966. (Library of Congress Catalog Card No. 65-22067).

l. Engineering Anthropometry Methods. J. A. Roebuck, K. H. E. Kroemer and W. G. Thomson, John Wiley and Sons, New York, NY 1975 (Library of Congress) Catalog No. 74-34272.)

Copies of specification, standards, and other publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.

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