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An American National Standard

Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities[1,2]

This standard is issued under the fixed designation F1166; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice provides ergonomic design criteria from a human-machine perspective for the design and construction of maritime vessels and structures and for ~~equipments,~~equipment, systems, and subsystems contained therein, including vendor-purchased hardware and software.

1.1.1 The focus of these design criteria is on the design and evaluation of human-machine interfaces, including the interfaces between humans on the one side and controls and displays, physical environments, structures, consoles, panels and workstations, layout and arrangement of ship spaces, maintenance workplaces, labels and signage, alarms, computer screens, material handling, valves, and other specific ~~equipments~~equipment on the other.

1.2 The criteria contained within this practice shall be applied to the design and construction of all hardware and software within a ship or maritime structure that the human crew members come in contact in any manner for operation, habitability, and maintenance purposes.

1.3 Unless otherwise stated in specific provisions of a ship or maritime structure design contract or specification, this practice is to be used to design maritime vessels, structures, equipment, systems, and subsystems to fit the full potential user population range of 5th % females to 95th % males.

1.4 This practice is divided into the following sections and subsections:

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[1] This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.07 on General Requirements.

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[2] A user-friendly format of this standard is available for download from ~~ASTM's~~ASTM's website. While the content is the same, ASTM Practice F1166 in standard published format should be considered the official version (for any legal or liability purposes).

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1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *Overall References:*

ABS Guidance Notes for the Application of Ergonomics to Marine Systems, ~~April 2003~~August 2013 (Updated August 2018)

~~MIL-STD-1472F~~ MIL-STD-1472 Department of Defense Design Criteria Standard: Human Engineering

2.2 *Alarms:*

~~DOT/FAA/CT—96/1~~ DOT/FAA/HF-STD-001B Ahlstrom, V. (2016). Human Factors Design ~~Guide~~Standard (HFDS) Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center

Engineering Equipment and Materials ~~User's~~User's Association (EEMUA) Publication # ~~191,~~191 Alarm Systems, a Guide to Design, Management and Procurement

International Maritime Organization (IMO) Resolution A.830(19) Code on Alarms and Indicators

2.3 *Integration of Controls, Displays, and Alarms:*

ABS (October 2003) Guidance Notes on Ergonomic Design of Navigation Bridges

2.4 *Anthropometry:*

ADULTDATA: The Handbook of Adult Anthropometrics and Strength Measurements—Data for Design ~~Safety,~~Safety Institute for Occupational Ergonomics, University of Nottingham, UK, 1998

International Labor Office (ILO) International Data on Anthropometry, 1990

McDowell, M. A., Fryar, C. D., Hirsch, R., and Ogden, C. ~~L.,~~L. Anthropometric Reference Data for Children and Adults: U.S. Population, ~~1999–2002,~~2003-2006, Advance Data from Vital and Health Statistics No. 361, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, July 2005

Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics, Technical Report NATICK/TR-15./007 U.S. Army NATICK Soldier RD&E Center, 2014

Woodson, ~~W.,~~W. Human Factors Design Handbook, 1981

2.5 *Access Aids:*

ABS Guide for Means of Access to Tanks and Holds for Inspection, ~~Draft, March 2006~~April 2016 (Updated March 2018)

International Maritime Organization (IMO) Guidelines for Safe Access to Tanker Bows, IMO Resolution MSC.62 ~~(67),~~ (67) 1996 International Maritime Organization (IMO) International Convention on Loadlines, 1966

2.6 *Human-Computer Interface:*

Defense Information Systems Agency (DISA) Common Operating Environment (COE) User Interface Specifications ~~(UIS),~~(UIS) 2003

~~FAA Human Factors Design Standard (HFDS) for Acquisition of Commercial-Off-the-Shelf (COTS) Subsystems, Non-Developmental Items (NDI), and Developmental Systems,~~DOT/FAA/HF-STD-001B ~~2003~~Ahlstrom, V. (2016) Human Factors Design Standard (HFDS). Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center

~~ANSI/HFS~~ANSI/HFES Standard No. ~~100–2001 (DRAFT)~~100–2007 American National Standard for Human Factors Engineering of ~~Visual Display Terminal~~ Computer Workstations, Human Factors and Ergonomics Society, Inc., Santa Monica, CA, ~~2001~~2007

~~MPR Associates, Common Presentation Layer Specification (DRAFT), 2005~~

2.7 *Habitability:*

ABS ~~(December 2001)~~(February 2016) Guide for Crew Habitability on Ships

Directive 2002/44/EC of the European Parliament and of the Council (25 June 2002) on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration)

DNVGL-OS-A301, April 2016 DNV-GL Offshore Standard for Human Comfort

International Maritime Organization (IMO) Resolution ~~A.468 (XII),~~MSC.337(91) Code on Noise Levels on Board Ships

~~International Standards Organization (ISO) 2631-1~~IEC 1260:1995 ~~Evaluation of Human Exposure to Whole-Body Vibration, Parts 1 and 5~~Electroacoustics — Octave-band and fractional-octave-band filters

~~Peterson, R., Price, B., LaBrecque, J., Bass, D., and Ziemba, A.,~~ISO 2041:1990 ~~Development of Impact Injury Design Rule for High Speed Craft, Naval Surface Warfare Center, Panama City, FL, August 26, 2004~~Vibration and shock — Vocabulary

ISO 2531:2009 Ductile iron pipes, fittings, accessories and their joints for water applications

ISO 2631-1:1997 Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration

ISO 5805:1997 Mechanical vibration and shock — Human exposure — Vocabulary

ISO 8041:1990 Human response to vibration — Measuring instrumentation

2.8 *Labeling:*

ANSI Z535.2 Environmental and Facility Safety Sign Standard

ANSI Z535.3 Criteria for Safety Symbols

Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

Peterson, R., Price, B., LaBrecque, J., Bass, D., and Ziemba, A., Development of Impact Injury Design Rule for High Speed Craft, Naval Surface Warfare Center, Panama City, FL, August 26, 2004

2.9 *Material Handling:*

Lifting: TLV Physical Agents, 7th edition, American Conference of Governmental Industrial Hygienists, 2005

~~FAA Human Factors Design Standard (HFDS)~~DOT/FAA/HF-STD-001B ~~for Acquisition of Commercial-off-the-Shelf (COTS) Subsystems, Non-Developmental Items (NDI), and Developmental Systems~~Ahlstrom, V. (2016). Human Factors Design Standard (HFDS). Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center

~~Kroemer, K., Kroemer, H., and Kroemer-Elbert, K.,~~Katrin Kroemer Elbert, Henrike Kroemer, Anne D. Kroemer Hoffman Ergonomics: How to Design for Ease and Efficiency, ~~Prentice Hall, Englewood Cliffs, NJ, 1999~~3rd edition, 2018

2.10 *Maintenance:*

MIL-HDBK-454 General Guidelines for Electronic Equipment

MIL-STD-130 Department of Defense Standard Practice for Identification Marking of U.S. Military Property

2.11 *Communications:*

~~DOT/FAA/CT—96/1~~ DOT/FAA/HF-STD-001B Ahlstrom, V. (2016). Human Factors Design ~~Guide~~Standard (HFDS). Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center

2.12 *Hazards and Safety:*

ANSI/ASSP Z590.3-2011 Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes

MIL-STD-882E Department of Defense Standard Practice, System Safety

2.13 *Small Boat and High Speed Craft Appendix:*

American Boat and Yacht Council (2014) Reboarding Means, Ladders, Handholds, Rails and Lifelines (ABYC H-41)

American Boat and Yacht Council (2019) Field of Vision from the Helm Position (ABYC H-1)

Dobbins, T., Rowley, I., and Campbell, L. (2008) High Speed Craft Human Factors Design Guide (Report Number ABCD-TR-08-01 v1.0). UK MOD Defence Equipment and Support Agency (DE&S); Directorate of Sea Systems supported by the ABCD Working Group

International Maritime Organization (2000) Adoption of the International Code of Safety for High-Speed Craft: 2000 HSC Code (MSC.97(73))
International Maritime Organization (2000) Maritime Safety Committee Circular 982: Guidelines on Ergonomic Criteria for Bridge Equipment and Layout (MSC.1-Circ. 982)
The International Organization for Standardization (2007) Ship's bridge layout and associated equipment — Requirements and guidelines: Annex A (normative): Bridge layout for high speed craft (ISO 8468, 3rd edition)
The International Organization for Standardization (2016) Small craft – Principle data (ISO 8666, 2nd edition)
The International Organization for Standardization (2019) Small craft – Field of vision from the steering position (ISO 11591, 3rd edition)
United States Coast Guard (2001) Navigation and Vessel Inspection Circular Number 5-01
Guidance for Enhancing the Operational Safety of Domestic High Speed Vessels (COMDTPUB P16700.4)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accessible, adj*—an item is considered accessible when it can be operated, manipulated, inspected, serviced, removed, or replaced by the suitably clothed and equipped user with applicable body dimensions conforming to the anthropometric range and database specified by the procuring activity or, if not specified by the procuring activity, with applicable 5th to 95th percentile body dimensions as defined in Section 9.

3.1.1.1 *Discussion*—
Applicable body dimensions are those dimensions that are design critical to the operation, manipulation, inspection, service, removal, or replacement task.

3.1.2 *advisory signal, n*—signal that indicates a safe or normal configuration, condition of performance, or operation of equipment or attracts attention and imparts information for routine action purposes.

3.1.3 *alarm, n*—visual or audible signal or both of a condition, or a predetermined out-of-tolerance condition, for machinery, equipment, components, or systems that require attention and response by a crewmember.

3.1.4 *alarm filtering, n*—technique by which unnecessary alarms are eliminated.

3.1.5 *alarm priority, n*—predicted assessment of the potential consequence of a condition or situation and the resulting urgency of mitigating responses required of personnel, that is, the more severe the potential consequence, the higher the alarm priority.

3.1.6 *alarm suppression, n—(1)* technique in which when a single-alarm event leads to subsequent alarm events (for example, cascading alarms), the initiating alarm is presented but the subsequent events are not (that is, are suppressed); and *(2)* technique by which alarm messages are not displayed but are available to the user upon request.

3.1.7 *analog display, n*—type of display that shows the complete range of a measured parameter on a continuous scale and by means of a pointer, or equivalent, indicating an instantaneous value of the parameter on the scale.

3.1.8 *angle of inclination, n*—angle that the stair rises measured from the deck or surface on which the stair is sitting to the underside of the stair stringers.

3.1.9 *annunciator, n—(1)* type of transilluminated display that provides written text, pictorial data, or both to a user to show status or condition of a system or equipment; and *(2)* (also called a legend light) type of transilluminated display consisting of a light source located behind a cover that contains a printed label (that is, legend).

3.1.9.1 *Discussion*—
The color of the light (usually red, green, white, or blue), whether it is ON or OFF, and the printed label all provide information to the operator about the status of a piece of equipment or system.

3.1.10 *anthropometrics, n—(1)* study of the physical size, strength, and range of motion of the human body and the application of that data to the design of systems, equipment, workspaces, and tools to maximize human performance and safety in a work setting; and *(2)* measurement of human variability of body dimensions and strength as a function of gender, race, and regional origin.

3.1.11 *anti-two-block alarm, n*—alarm used to warn a crane operator of the impending collision of the traveling block and crane tip sheave.

3.1.12 *articulation index (AI), n*—technique used to measure how intelligible (that is, understandable) spoken words are that are received over communication equipment and is expressed as a percentage of speech units that are understood by a listener when heard out of context.

3.1.13 *assembly, n*—number of parts or subassemblies or any combination thereof joined together to perform a specific function and capable of disassembly.

3.1.13.1 *Discussion—*

The distinction between an assembly and a subassembly is determined by the individual application. An assembly in one instance may be a subassembly in another in which it forms a portion of an assembly.

3.1.14 *assisted lifting devices, n*—items such as cranes, hoists, mobile A-frame and hydraulic jacking units, monorails, trolleys, or padeyes used by individuals to lift or move materials and equipment or both that is too heavy for direct manual lifting or carrying.

3.1.15 *audible alarm, n*—alarm comprised of tones, verbal messages, or verbal messages combined with tones and not all audible alarms are associated with visual alarms.

3.1.16 *auditory display, n*—device that provides readings, status, or condition of machinery, equipment, or system-operating parameters through the use of sound signals or spoken messages.

3.1.17 *band pass, n*—electronic filter designed to respond only to selected audio frequencies while blocking all other frequencies.

3.1.17.1 *Discussion—*

Commonly used in telephones.

3.1.18 *binaural, n*—sound coming to a headset from dual channels or signal paths with a different channel or signal path presented to each headset.

3.1.19 *case, n*—part of an item of equipment that encloses and protects the equipment from its surroundings and protects the surroundings—including personnel—from the equipment.

3.1.20 *caution signal, n*—signal that indicates the existence of a condition requiring attention but not immediate action.

3.1.21 *coaming, n*—vertical steel plate extending up 50 to 76 mm (2 to 3 in.) from the deck and placed around equipment or other areas in which liquids (for example, oil, water, grey or black water, and oily water) could be spilled to contain the liquids within a confined area.

3.1.22 *color pad, n*—area on a console or panel face that is shaded a different color than the panel itself to highlight a set of controls, displays, ~~and/or alarms~~ or alarms, or combination thereof, that are related in some manner.

3.1.23 *command, n*—instructions that cause a device to perform some action.

3.1.24 *command language, n*—limited programming language used strictly for executing a series of commands (for example, Linux or any DOS shells).

3.1.25 *console, n*—group of controls and displays associated with one or more individual pieces of equipment or systems mounted together on a structure dedicated to the control and monitoring of the individual equipment or systems.

3.1.25.1 *Discussion—*

Consoles may be freestanding units and include angled and vertical surfaces.

3.1.26 *continuous control, n*—continuous control is an actuator that operates at any point or value along a continuous scale (for example, engine throttle).

3.1.27 *contrast ratio, n*—ratio of the differences in luminance between the item on a video display and the background.

3.1.28 *control, n*—*(1)* any switch, pushbutton, knob, lever, keyboard, mouse, or other device manually manipulated by the operator/maintainer to alter or maintain the status of a particular piece of equipment or system; and *(2)* a device an operator or maintainer uses to input a signal, change the operating status of equipment or systems, or to manipulate displayed data. Examples include switches, knobs, cranks, thumbwheels, levers, keyboards, and foot pedals.

3.1.29 *cursor, n*—marker on the display screen that indicates the position where the computer expects the next input or will display the next output.

3.1.29.1 *Discussion*—
The cursor may be positioned by the computer or by the user.

3.1.30 *danger signal, n*—signal that indicates the existence of a hazardous condition requiring immediate action to prevent loss of life, major equipment damage or environmental contamination, or serious loss of mission capability.

3.1.31 *dead-man switch, n*—control that automatically stops machinery or systems from operating once the control is released by the operator.

3.1.32 *dependent symbol, n*—symbols that alone do not impart any specific information to the user but require the existence of supporting data to provide useful information.

3.1.33 *detent control, n*—*(1)* type of discrete control, characterized by the control locking into each position setting until the operator exerts extra force to move the control out of the setting.

3.1.33.1 *Discussion*—
These types of controls are preferable for machinery equipment or system operation requiring control in discrete steps or different modes.

(2) type of discrete control in which each control position setting is identified by a audible click and the control "locks" into that position setting until the operator exerts extra force to move the control out of that setting and into the next one.

3.1.34 *digital display, n*—type of display that uses numeric characters to provide an instantaneous value of a parameter.

3.1.35 *directly accessible, adj*—to be directly accessible, an object, space, component, or piece of equipment shall be in an area reachable without having to use tools or disassemble an access opening; be clear of, or protected from, obstructions, moving equipment, hot surfaces, or other obstructions that would prevent safe contact by the user; allow the user to get as close as necessary (for example, ~~arm's~~arm's reach) to perform the required tasks; be reachable ~~via~~ by means of a permanent access; and allow all of the above by a person wearing the required protective clothing and carrying tools, spare parts, and test equipment as required.

3.1.36 *directly visible, adj*—a directly visible object (for example, control, display, hazard warning, and so forth) shall not be located behind a door or other closure cover and shall be readable from the normal user position within the provided ambient lighting and from a position that does not require the reader to stand on pipes, cable trays, structural members, or other surfaces not intended to be a regular working surface or assume awkward body postures.

3.1.37 *discrete control, n*—actuator that allows for the selection between two or more mutually exclusive operating functions or points along a scale (for example, switching a machine ON or OFF or selecting one of three pumps to run).

3.1.38 *displacement joystick, n*—joystick that moves out of the detent in the direction it is pushed.

3.1.38.1 *Discussion*—
Displacement joysticks are usually spring-loaded so that they return to a neutral center (detent) position.

3.1.39 *display, n*—any gauge, light counter, printer, annunciator, sight glass, horn, siren, digital counter, cathode ray tube (CRT) screen, or any other device that provides visual or auditory information to the human operator/maintainer about the status of a piece of equipment or system.

3.1.40 *dynamic display, n*—display screen that is, or has portions within that are, updated on a regular basis, primarily alphanumeric values.

3.1.41 *emergency shutdown stations (ESDs), n*—manual controls that are located throughout a ship or maritime structure that shut down ~~equipments,~~equipment, systems, or complete structures and initiate an alarm at the same time.

3.1.42 *fixed ladder, n*—ladder permanently attached to a structure, building, or equipment.

3.1.43 *foot ~~candle,~~ candle (fc, lm/ft^2 or ft-c), n*—a non-SI measure of light intensity or illuminance, the amount of light striking a ~~surface.~~surface, in lumens per square foot. One foot candle is equal to approximately 10.76 lux (the corresponding SI unit).

3.1.44 *foot ~~lambert,~~ lambert (fl or ft-L), n*—a non-SI measure of luminance, the amount of light reflected from ~~the surface.~~a surface. A foot-lambert equals 1/π candela per square foot, or 3.426 candela per square metre (the corresponding SI unit).

3.1.45 *flicker, n*—perception of rapid fluctuations in luminance levels characterized by an impression of jerky movements.

3.1.46 *function keys, n*—labeled keys that serve as keyboard shortcuts (for example, F1, F2, F3, or with the function name such as Delete or Insert) by combining in one key the actions of a sequence of individual keys.

3.1.47 *general emergency alarms, n*—alarm given in the case of an emergency involving all persons on a vessel or other maritime facility and these alarms sound throughout a vessel or maritime installation and are intended to be heard by all personnel.

3.1.47.1 *Discussion*—
General emergency alarms relate to conditions of a serious nature such as announcing a fire or flooding, demanding evacuation of an area, or demanding abandonment of a vessel or installation.

3.1.48 *glare, n*—luminance or amount of light-per-unit area emitted or reflected from a surface, within a specific area of ~~personnel's~~personnel's field of view, that is greater than the luminance to which the eye is adjusted compared to the remainder of the field of view.

3.1.49 *graphic label, n*—type of label used to present information through line schematics, diagrams, charts, tables, and pictures.

3.1.50 *handle or handgrab, n*—U-shaped bar attached directly to bulkheads or other structures used by a person to hold onto where handholds are required such as when passing through hatches or lightening holes or climbing vertically through deck openings.

3.1.51 *handrail, n*—vertical barrier consisting of two or more horizontal rails connected to vertical stanchions that are erected along exposed edges of floor openings, wall openings, ramps, steps, platforms, and walkways to prevent a person from falling from one elevation to another.

3.1.52 *hazard identification sign, n*—type of sign used to identify and provide information about situations that may be hazardous to personnel, equipment, or the environment; there are two types of hazards: "DANGER" and "CAUTION."

3.1.53 *hazard label, n*—type of label used to identify and provide information about situations that may be hazardous to personnel, equipment, or the environment and only two types of hazards should be allowed, that is, "DANGER" and "CAUTION," based on the following criteria.

3.1.53.1 *DANGER*—used where the hazard could result in serious injury or death to a person, serious damage to vital equipment, or a major environmental problem.

3.1.53.2 *CAUTION*—used where the hazard could result in a minor injury to a person, minor damage to the equipment, or a minor environmental problem.

3.1.54 *hierarchical menus, n*—large series of options or menus that are organized as a multilevel, branching structure in which an option in a higher-level menu is the name of another menu at the next lower level and the options in the lowest-level menus are not the names of other menus.

3.1.55 *human engineering (ergonomics), n*—scientific discipline concerned with the understanding of interactions among humans and other elements of a system and the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance.

3.1.56 *human machine interface (HMI), n*—means by which humans and machines/computers communicate/work with each other to control and operate systems.

3.1.57 *human systems integration (HSI), n*—systems engineering discipline that is focused on human performance, human skills and training, manpower, personnel survivability, health and safety, and quality of life at sea.

3.1.58 *hyperlinks, n*—text that provides the capability to, when selected using a pointing device or ENTER key, direct the user to another location within the window or another window.

3.1.58.1 *Discussion—*

Hyperlinks are generally indicated by textual formats such as alternate text color or underlining or both.

3.1.59 *icon, n*—picture or drawing that represents an actual piece of equipment or system on the ship or maritime structure.

3.1.60 *identification label, n*—type of label used to: *(1)* identify, and be placed on, all individual ~~equipments~~equipment or components, for example, valves, gauges, junction boxes, filters, pumps, sensor, consoles, transmitters, pressure vessels, control panels, local motor controllers, fans, heaters, cabinets, lockers, and all other items used by the crew for operation, maintenance, or habitability use; *(2)* identify spaces (for example, rooms, compartments, open deck areas, buildings, tanks, voids, or any area in which the crew may enter); and *(3)* identify individual controls, displays, alarms, or groups thereof as shown in Section 8 that appear on consoles, control panels, or are individually mounted.

3.1.61 *independent symbol, n*—pictorial representation that alone provides information to personnel without requiring elaboration by supporting text.

3.1.62 *individual rung ladder, n*—fixed ladder, each rung of which is individually attached to a structure, building, or equipment rather than to ladder stringers.

3.1.63 *information label or placard, n*—type of label or placard used to present nonprocedural information of a general nature related to health, first aid, sanitation, rules, housekeeping, and general conduct.

3.1.64 *instruction label, n*—instruction label provides step-by-step instructions for accomplishing a specific task (operation or maintenance related) along with hazard and safety information related to performing the task.

3.1.65 *isometric joystick, n*—joystick that has no perceptible movement but output is a function of applied force.

3.1.66 *jitter, n*—interference in electron-gun displays (for example, CRT displays) as a result of magnetic fields from other devices such as motors and generator sets.

3.1.67 *keyboard lockout, n*—state determined by an application in which the application does not accept input from the keyboard.

3.1.68 *kickout panel, n*—part of a joiner bulkhead or wall that is marked and designed especially to be “kicked out” and used as an emergency escape exit.

3.1.69 *label, n*—term, when used alone, shall mean any type of plate, sign, placard, inscription, legend, marking, or combination of these, that is used for purposes of identification or to impart visual information or instructions to the reader.