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Designation: F1337 – 91 (Reapproved 2006)

An American National Standard

Standard Practice for Human Engineering Program Requirements for Ships and Marine Systems, Equipment, and Facilities[1]

This standard is issued under the fixed designation F1337; 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.

1. Scope

1.1 This practice establishes and defines the requirements for applying human engineering to the development and acquisition of ships and marine systems, equipment, and facilities. These requirements are applicable to all phases of development, acquisition, and testing and shall be integrated with the total system engineering and development, and test effort. It is not expected nor intended that all of the human engineering activities should be applied to every marine program or program phase. Therefore, these activities shall be tailored to meet the specific needs of each program and the milestone phase of the program within the overall life cycle. This tailoring shall be performed by the procuring activity or by the contractor or subcontractor with the assistance and approval of the procuring activity in order to impose only the essential human engineering requirements on each program. Guidance for selection of only the essential requirements is contained in Appendix X1.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

2.2 *Other Standard:*

SNAME Sample Model Specification for Human Engineering Purposes—Technical and Research Bulletin 4–22[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *arrangement drawings*—engineering design drawings that provide plan, sectional, and elevation views of: (*1*) the configuration and arrangement of major items of equipment for manned compartments, spaces, or individual work stations, and (*2*) within the work station, such as in a modular rack or on a fiddleboard.

3.1.2 *critical activity*—any human activity that if not accomplished in accordance with system requirements (that is, time limits, specific sequence, necessary accuracy) will have adverse effects on system or equipment cost, reliability, efficiency, effectiveness, or safety.

3.1.3 *cultural expectation*—the cause and effect relationships (for example, red means stop or danger) that humans learn from their culture.

3.1.4 *duty*—a set of operationally related tasks within a given job (for example, communicating, operator maintenance).

3.1.5 *function*—an activity performed by a system (for example, provide electric power) to meet mission objectives.

3.1.6 *human engineering*—a specialized engineering discipline within the area of human factors that applies scientific knowledge of human physiological and psychological capabilities and limitations to the design of hardware to achieve effective man-machine integration.

3.1.7 *human factors*—the application of scientific knowledge about human characteristics, covering both biomedical and psychosocial considerations, to complete systems, individual equipments, software, and facilities. This application is through such specialized fields as human engineering, manning, personnel selection, training, training devices and simulation, life support, safety, job performance aids, and human performance testing and evaluation.

3.1.8 *human interface*—any direct contact (that is, physical, visual, or auditory) with a piece of hardware or software by a human operator or maintainer.

3.1.9 *job*—the combination of all human performance required for operation and maintenance of one personnel position in a system.

3.1.10 *life support*—that area of human factors that applies scientific knowledge regarding the effects of environmental factors on human behavior and performance to items that

[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.

Current edition approved Dec. 1, 2006. Published January 2007. Originally approved in 1991. Last previous edition approved in 2001 as F1337 – 91 (2001). DOI: 10.1520/F1337-91R06.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Society of Naval Architects and Marine Engineers, 601 Pavonia Ave., Jersey City, NJ 07306, Attn: Technical Coordinator.

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require special attention or provisions for health promotion, biomedical aspects of safety, protection, sustenance, escape, survival, and recovery of personnel.

3.1.11 *mission*—a specific performance requirement imposed on one or more systems (for example, unload cargo) within the operational requirements.

3.1.12 *operational requirements*—requirements under which the platform, system, equipment, or software will be expected to operate and be maintained (for example, day/night, all weather operation, sea state, speed, endurance) while completing a specific mission or missions.

3.1.13 *panel layout drawings*—detailed drawings that include such features as: a scale layout of the controls and displays on each panel or an item of equipment such as a shipboard command console; a description of all symbols used; identification of the color coding used for displays and controls; the labeling used on each control or display; and the identification of control type (for example, alternate action or momentary), also screen layouts for software generated displays.

3.1.14 *platform*—the major hardware (for example, ship, off-shore rig, barge, submarine) on, or in which, the individual equipment, system, or software will be installed or added.

3.1.15 *spatial relationships*—placement of multiple but separate components of a system together, so it is visually obvious that the components are related and used together, or placement of identical components used on multiple systems to provide the user with a spatial clue as to where the components are located.

3.1.16 *subtask*—activities (perceptions, decisions, and responses) that fulfill a portion of the immediate purpose within a task (for example, remove washers and nuts on the water pump).

3.1.17 *system*—a composite of subsystems, including equipment, communications, software, and personnel that either independently, or in conjunction with other systems, performs functions.

3.1.18 *system analysis*—a basic tool for systematically defining the roles of and interactions between the equipment, personnel, communications, and software of one or more systems. It is an iterative process, requiring updating. Used in the early phases of design, it can be useful in allocating assignment of tasks to personnel, equipment, software, or some combination thereof. Done in later design stages, it can serve as the basis for the arrangement of equipment and work stations.

3.1.19 *task*—a composite of related activities (perceptions, decisions, and responses) performed for an immediate purpose, written in operator/maintainer language (for example, change a water pump).

3.1.20 *task analysis*—a method used to develop a time-oriented description of the interactions between the human operator/maintainer and the equipment or software in accomplishing a unit of work with a system or individual piece of equipment. It shows the sequential and simultaneous manual and intellectual activities of personnel operating, maintaining, or controlling equipment, in addition to sequential operation of the equipment.

3.1.21 *task element*—the smallest logically and reasonably definable unit of behavior required in completing a task or subtask (for example, apply counterclockwise torque to the nuts, on the water pump, with a wrench).

3.1.22 *vendor drawings*—design drawings prepared by the manufacturer of an individual piece of equipment which is purchased for installation aboard a ship or other marine platform.

4. Summary of Practice

4.1 *Human Engineering Program Plan*—The human engineering program plan, in accordance with the requirements of this practice and the equipment or ship specification, shall include the tasks to be performed, human engineering milestones, level of effort, methods to be used, design concepts to be used, and the test and evaluation program, in terms of an integrated effort within the total project.

4.2 *Quality Assurance*—Verification of compliance with the requirements of this practice and other human engineering requirements specified by the contract will be the responsibility of the procuring activity. Human engineering performed during the development program by a contractor or subcontractor shall be demonstrated to the satisfaction of the procuring activity at the scheduled design and configuration reviews and inspections, as well as during development test and evaluation inspections, demonstrations, and tests.

4.3 *Nonduplication*—The efforts performed to fulfill the human engineering requirements specified herein shall be coordinated with, but not duplicate, efforts performed in accordance with other requirements. Necessary extensions or transformations of the results of other efforts for use in the human engineering program will not be considered duplication. Instances of duplication or conflict shall be brought to the attention of the procuring activity.

4.4 *Cognizance and Coordination*—The human engineering program shall be coordinated with maintainability, system safety, reliability, survivability/vulnerability, and integrated logistic support, as well as other human factors functions, such as life support and safety, personnel selection, preparation of job aids, and training. Results of human engineering analysis or lessons learned information shall be incorporated into the logistic support analysis as applicable. The human engineering portion of any analysis, design and development, or test and evaluation program shall be conducted by, or under the direct cognizance of, personnel properly trained and experienced in human engineering and assigned the human engineering responsibility by the contractor or subcontractor.

5. Significance and Use

5.1 *Intended Use*—Compliance with this practice will provide the procuring activity with assurance that the operator/maintainer will be efficient and effective in the operation and maintenance of systems, equipment and facilities. Specifically, it is intended to ensure that:

5.1.1 System performance requirements are achieved by appropriate use of the human component,

5.1.2 Proper design of equipment, software and environment permits the personnel-equipment/software combination to meet system performance goals,

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5.1.3 Design features will not constitute a hazard to personnel,

5.1.4 Trade-offs between automated versus manual operation have been chosen for peak system efficiency within appropriate cost limits,

5.1.5 Application of selected human engineering design standards are technically adequate and appropriate,

5.1.6 Systems and equipments are designed to facilitate required maintenance,

5.1.7 Procedures for operating and maintaining equipment are efficient, reliable and safe,

5.1.8 Potential error-inducing equipment design features are eliminated, or at least, minimized,

5.1.9 Layouts and arrangements of equipment afford efficient communication and use, and

5.1.10 Contractors provide the necessary, technically qualified manpower to accomplish the objectives listed.

5.2 *Scope and Nature of Work*—The human engineering effort shall include, but not necessarily be limited to, active participation in three major interrelated areas of platform, system, and equipment development.

5.2.1 *Analysis*—Starting with a mission analysis developed within baseline operational requirements, the functions that must be performed by the system in achieving its mission objectives shall be identified and described. These functions shall be analyzed to determine the best allocation to personnel, equipment, software, or combinations thereof. Allocated functions shall be further dissected to define the specific tasks that must be performed to accomplish the functions. Each task shall be analyzed to determine the human performance parameters, the system/equipment/software capabilities, and the operational/environmental conditions under which the tasks are conducted. Task performance parameters shall be quantified, where possible, and in a form permitting effectiveness studies of the crew-equipment/software interfaces in relation to the total system operation. Human engineering high risk areas shall be identified as part of the analysis.

5.2.2 *Design and Development*—Design and development of the equipment, software, systems, and total platforms requiring personnel as operators or maintainers, or both, shall include a human engineering effort that will ensure that adequate and appropriate human engineering design standards are incorporated into the overall engineering design. Such standards may be specifically stated in the system equipment, software, or facilities acquisition specifications, or they may be generated from the analysis work completed prior to design and development.

5.2.3 *Test and Evaluation*—Test and evaluation shall be conducted with the newly designed equipment, software, facilities, and environment to verify that they meet human engineering and life support criteria and are compatible with the overall system requirements. This shall include periodic on-site checks of the platform, systems, equipment, software, or facilities during construction to ensure that changes are not made during construction that would degrade earlier human engineering efforts.

6. Human Engineering Activities

6.1 *Scope*—The human engineering program shall include the following activities:

6.1.1 *Operational Requirements (OR)*—Operational requirements (ORs) are established first to define the parameters within which the individual equipment, system, or total platform shall be expected to perform. ORs shall be expressed in such terms as the weather conditions under which it must operate (for example, rain, snow, sea state limits); number of days it must operate without being refueled or resupplied; and maximum number of personnel that will be available to operate and maintain the hardware. Human engineering shall be considered in the development of ORs, especially when the ORs include requirements on the number, type, or training of operators or maintainers, or both.

6.1.2 *Mission Requirements Analysis*—Mission requirements define the performance parameters of the equipment, system, or total platform in greater detail than that provided by the ORs, and in terms of specific activities the hardware/software is supposed to accomplish. Human engineering shall be involved in establishing the mission requirements since the human's capabilities or limitations may well be a controlling factor regarding whether or not the mission requirements can be met.

6.1.3 *System Requirements Analysis*—System requirements analyses define the specific systems that will be needed to successfully complete each of the missions delineated above. Human engineering shall be involved in establishing system requirements, since some systems can require greater numbers of personnel and higher skill levels for operators or maintainers than others. Human engineering data from existing systems similar to those being proposed for the new design may be used as a baseline in defining the new system requirements.

6.1.4 *Function Definition*—The functions that must be performed by each system to achieve the desired mission objectives shall be defined. This definition shall be done without consideration as to whether the function will be performed by a human, by a machine, or by a combination of the two. Functions shall be stated as a required action (for example, monitor, receive, communicate, view, send, calibrate). Functional block diagrams shall be used, as appropriate, as a presentation tool. Functional definitions shall be as detailed as is necessary to permit the successful allocation of the functions. The transfer and processing of information (for example, verbal communications, electronic transmissions, printed material) shall be identified as a function but without reference to specific machine or human involvement. Human engineers shall be involved in identifying functions, since this activity serves as the base for the next step, which includes major participation by human engineering.

6.1.5 *Function Allocation*—Each function identified from the previous step shall be assigned to be machine implemented, performed by software, reserved for the human operator/maintainer, or performed by some combination thereof. Human engineering specialists shall participate in the function allocation process to ensure that each function assigned to the human is within the human's capability. Known human engineering

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