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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 F 1337; 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:*

F 1166 Practice for Human Engineering Design for Marine Systems, Equipment and Facilities[2]

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 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.

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

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[2] *Annual Book of ASTM Standards*, Vol 01.07.

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

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,

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 experiences with man-machine functional allocations on existing equipments, systems, or platforms similar to those under evaluation; personal human engineering experience in the function allocation field; and available information on human

physical and psychological performance capabilities shall be used when applicable in determining function allocations.

6.1.6 *Equipment Selection*—Hardware and software shall be selected to perform those functions assigned to them from the function allocation activity. Human engineering principles and design standards shall be included, along with other design considerations, in identifying and selecting that hardware/software. Human engineers shall ensure that the equipment provides the human with the opportunity to complete those functions assigned to the operator/maintainer, and that it complies with all of the applicable design criteria contained in Practice F 1166, as well as other human engineering design criteria contained in the contract, or in other human engineering design standards referenced in the contract. Known human engineering problems with equipment now in service (for example, information from equipment casualty reports or personnel injury data associated with equipment failure) that is similar to that being considered, personal experience with applying human engineering design criteria to equipment design, and review of potential supplier engineering data are examples of the human engineering resources that shall be used in assessing the acceptance of the selected equipment from a human engineering viewpoint.

6.1.7 *Human Engineering System Analysis Report (HESAR)*:

6.1.7.1 *HESAR (TYPE 1)*—Type 1 HESARs, which are prepared early in the design process (for example, during feasibility design), shall allow for the evaluation of the appropriateness and feasibility, from a human engineering perspective, of the mission, system, and functional requirements, and to serve as one basis for decisions made during the functional allocation effort. The HESAR shall contain the results of the mission, system, and functional requirements analyses and describe the human engineering rationale for, or contribution to, each. In addition, the potential impact, or the proposed use, of these analyses for future human engineering activities (for example, allocation of functions, equipment selection, detail design of equipment, arrangement of spaces or compartments) shall be discussed. The objective of the early HESAR shall be to demonstrate that human engineering considerations have been adequately addressed in the establishment of the mission, system, and functional requirements, and that there exists a sound basis on which to allocate the functions, select the equipment, and perform the detail design of the individual piece of equipment, system, or total platform.

6.1.7.2 *HESAR (TYPE 2)*—A Type 2 system analysis, completed late in the design process (for example, during development of construction drawings or production drawings) shall be done to provide a basis on which to base a particular equipment design, or system or compartment arrangement. In completing a Type 2 system analysis the following factors shall be considered, and shall be discussed in the HESAR: (*1*) description of the equipment, console, compartment, system, or work station on which the analysis was conducted, (*2*) externally imposed design requirements or criteria over which the human engineer had no control (for example, number of operators/maintainers, specific types and numbers of consoles, previously determined man-machine function allocations, predetermined locations of hardware), (*3*) communications requirements (for example, telephone, voice, sound powered phones, electronic), (*4*) work environment, (*5*) mission, system, backup, and functional requirements, and (*6*) human physical and psychological capabilities within the context of the existing design parameters. In conducting the analysis, consideration shall be given to such issues as projected work loads for each manned position; the kind, amount, and criticality of the information that goes into, and out of, each operator/maintainer station; the need for direct voice or visual communication between manned positions; location and suitability of backup equipment in case the primary hardware fails; and the interactions that are required between personnel or equipment, or both. Using the completed analysis, the human engineer shall participate in establishing the final design or arrangement of a piece of equipment, a system, or the total platform.

6.1.8 *Task Analysis*:

6.1.8.1 *Concurrence and Availability*—All task analyses shall be modified as required to remain current with the design effort and shall be available to the procuring activity as requested.

6.1.8.2 *Gross Task Analysis (GTA)*—A GTA consists of defining the major tasks required of the human operator/maintainer to complete each function identified and allocated to the human during the functional allocation activity (see 6.1.5). The GTA shall present these tasks in the sequence in which they must be completed and against an established time line reference. Information flows into, or out from, the human shall be included as a task. The GTA shall include both manual and cognitive tasks, and shall be written in operator/maintainer language (for example, change fuel pump, steer ship on constant heading, calculate fuel consumption rate). Where GTAs are required they shall be performed for both normal and emergency operating conditions. The GTAs shall be used to determine, to the extent practicable, whether the system performance requirements (see 6.1.3) can be met with the function allocations, backup facilities, and equipment selections that have been previously made. These analyses shall also be used as basic information for developing preliminary manning levels; equipment procedures; personnel skill, training, and communication requirements; and as logistic support analysis inputs. Personal experience of the human engineering analyst in the preparation of GTAs, information from equipment vendor operation and maintenance manuals, inputs from the design engineers (either at the procuring activity or the contractor) of the system(s) or equipment under evaluation, and established tasks on equipment similar to that under investigation are all resources that shall be used as appropriate in the creation of GTAs. GTAs shall be presented in diagrammatic form (for example, operational sequence diagrams) unless otherwise approved by the procuring activity.

6.1.8.3 *Critical Task Analysis (CTA)*—Those gross tasks identified in the GTA that require critical human performance (for example, no deviation from a fixed sequence; task completion within a fixed, and limited, time frame; accurate setting or reading of an important control or display), reflect possible unsafe practices, or that are subject to promising improvements

in operating efficiency shall be identified and further analyzed upon approval of the procuring activity. CTAs require detail to the subtask (for example, remove hose clamp from hose on the discharge side of water pump), or even task element level (for example, turn screw on the hose clamp on discharge side of water pump counterclockwise with Phillips head screwdriver). Other inputs which shall be made to a CTA include: (*1*) information required by the operator/maintainer for task initiation, (*2*) all information available to the operator/maintainer, (*3*) cognitive functions required of the operator/maintainer to process or act on the information, (*4*) actions required by the human based on the cognitive processes, (*5*) workspace envelope required by the actions, (*6*) workspace available, (*7*) frequency and accuracy required of the actions, (*8*) feedback required to the operator/maintainer regarding the adequacy of his/her actions, (*9*) tools or equipment, or both, required by the human, (*10*) job aids or references required, (*11*) number of personnel required or provided, as well as their specialty and experience, (*12*) communications required, and the types of communications, (*13*) safety hazards involved, (*14*) operational requirements of the human (for example, hours on duty, number of repetitive motions), (*15*) backup facilities available, and (*16*) operator interaction where more than one person is involved. The format shall include a time line base for presenting the information listed herein. Task analysis may be produced by automated programs after review and approval of the programs by the procuring activity.

6.1.9 *Human Engineering Design*—Human engineering principles and design standards shall be applied to the design of all compartments, spaces, systems, individual equipment, work stations, and facilities in which there is a human interface. Drawings, specifications, analyses, or other documentation shall reflect incorporation of these human engineering principles and standards. Where specific design criteria are required, they shall conform to Practice F 1166 or other human engineering criteria required by the contract. Design of the compartments, spaces, equipments, systems, work stations, and facilities shall provide for both normal and emergency conditions, and shall consider at least the following where applicable:

6.1.9.1 Environmental conditions, such as temperature, humidity, air flow, noise and illumination levels, and atmospheric contaminants,

6.1.9.2 Weather and climate, such as rain, snow, and ice,

6.1.9.3 Platform motion (for example, ship roll and pitch),

6.1.9.4 Space (that is, access) requirements for personnel to perform operations and maintenance, keeping in mind the special clothing or protective gear they may be wearing and the tools they may be carrying,

6.1.9.5 Safe and efficient walkways, ladders, work platforms, and inclines,

6.1.9.6 Adequate physical, visual, and auditory links between personnel, and between personnel and their equipment so that reach and visual envelopes are within standard limitations,

6.1.9.7 Provisions to minimize physical or emotional fatigue,

6.1.9.8 The effects on physiological and psychological performance due to special clothing, or chemical, biological, and radiological (CBR) protective suits,

6.1.9.9 Provisions to maximize cultural expectations and spatial relationships in the design,

6.1.9.10 Equipment removal and stores handling provisions,

6.1.9.11 Crew safety requirements, and

6.1.9.12 The range in physical size (for example, 5th to 95th percentile dimensions) and mental capabilities of the anticipated users of the equipment.

6.1.9.13 The adequacy of including human engineering principles and design standards into the overall design effort shall be evaluated during design reviews. Where such reviews involve a contractor or subcontractor, the individuals assigned the human engineering responsibilities by these organizations shall participate in the reviews. At quarterly design reviews these individuals shall provide the same type of presentation as is made by the other engineering disciplines.

6.1.10 *Application of Lessons Learned Information*—Information on known or suspected human engineering problems from past or existing equipments, systems, or total platforms similar to that under design shall be obtained and used in the design of the new equipment, system, or platform. This information shall be acquired from such sources as: personal inspection of current hardware, system, or platform (for example, conduct a ship check or ship survey), interviews with past or current operators or maintainers, or both, a review of sea trial deficiency cards, discussions with past or current designers of similar equipments, systems, or platforms, and investigation of personnel injury or equipment casualty reports, or both. Any summation reports prepared from the acquisition of this data shall provide the information by equipment, system, or ship compartment and shall include the ship work breakdown structure (SWBS) number or other corresponding specification section for each identified human engineering problem.

6.1.11 *Engineering Design Drawings*—Human engineering principles and design standards shall be reflected in the engineering design drawings produced for marine systems and equipment. These principles and standards shall be incorporated in all engineering drawings that involve a human interface and are developed during the various design phases. Specific types of drawings to which the human engineering principles and design standards shall be applied include: overall platform (for example, ship, off-shore rig, barge) arrangement drawings, individual compartment or space arrangement drawings, zone arrangement drawings, console or work station panel layout drawings, individual equipment design drawings, piping arrangement drawings, and other drawings depicting the design or arrangement, or both, of equipment requiring operation or maintenance, or both, by humans. The drawings shall comply with the applicable criteria contained in Practice F 1166 or other human engineering design standards, or a combination thereof, as specified in the contract.

6.1.11.1 Where the drawings are produced by a contractor, a specific list of the engineering drawings or a description of the types of drawings that will receive human engineering input

shall be included in the contractor's human engineering program plan (HEPP). Personnel assigned human engineering responsibility by the contractor shall approve all drawings included in the HEPP list before the drawings are released for production.

6.1.12 *Human Engineering in Vendor Hardware/Software*—Human engineering principles and design criteria from Practice F 1166 (or other approved design standards) shall be incorporated into hardware and software purchased by the contractor for inclusion on a marine platform or major system. The human engineering program plan shall include a list of the hardware/software items on which human engineering principles and design criteria will be imposed. The contractor shall also ensure that the vendor hardware/software complies with the design standards of Practice F 1166 after installation in or on the platform or system.

6.1.13 *Studies, Experiments, and Laboratory Tests*—The contractor shall conduct experiments, tests (including dynamic simulation per 6.1.14), and studies required to resolve human engineering and life support problems specific to the system. Human engineering and life support problem areas shall be brought to the attention of the procuring activity, and shall include the estimated effect on the system if the problem is not studied and resolved. These experiments, tests, and studies shall be accomplished in a timely manner, that is, such that the results may be incorporated into the design. The performance of any major study effort shall require approval by the procuring activity.

6.1.14 *Dynamic Simulation Studies*—Dynamic simulation studies shall be used as a human engineering design tool when necessary for the detail design of equipment requiring critical human activity (for example, precise ship maneuvering or handling tasks). If such studies are completed, the simulation hardware/software should be evaluated as a training tool as well, and shall be addressed in the dynamic simulation plan. No dynamic simulation studies shall be performed without prior approval of the simulation plan by the procuring activity.

6.1.15 *Mockups and Models*—Models and mockups built to resolve access, workspace design, equipment arrangements, or other human engineering problems shall be constructed at the earliest practical point and well before fabrication of the compartment, system, or equipment. The proposed human engineering program plan shall specify which models and mockups the contractor proposes to use for human engineering purposes. Mockups shall be full scale and models shall be built to SNAME Sample Model Specification for Human Engineering Purposes—Technical and Research Bulletin 4-22. For models and mockups specified primarily for human engineering use, the workmanship shall be no more elaborate than is necessary to determine the adequacy of size, shape, arrangement, access, or panel content of the equipment for human use. Models and mockups shall be constructed as simply and inexpensively as is compatible with the objective and use. They shall be updated regularly to reflect the latest designs. Upon approval by the procuring activity, scale models may be substituted for mockups. The models and mockups shall be available for inspection as determined by the procuring activity. Mockups and models may be disposed of only with the approval of the procuring activity.

6.1.16 *Human Engineering in Performance and Design Specifications*—Where the contractor prepares a specification for the design, development, construction, or acquisition of a marine platform, system, piece of equipment, facility or software, it shall conform to applicable human engineering criteria of Practice F 1166 and other human engineering criteria specified by the procuring agency.

6.1.17 *Equipment Procedure Plates and Manuals*—The contractor shall apply human engineering principles and criteria to the development of procedures and manuals for operating, maintaining, or otherwise using the system and equipment. For individual procedure plates (for example, lubrication charts, hazard warnings, operating instructions, schematics), mounted at the equipment, they shall comply with the design requirements in Practice F 1166. For computer systems, human engineering shall be applied throughout software program planning and development. This effort shall be accomplished to ensure that the procedures are concise, unambiguous, and easy to read and follow with a consistent presentation format, especially for the hazard identification statements. The results of this effort shall be reflected in the preparation of user-oriented operational, training, and technical plates, manuals, and other publications.

6.1.18 *Human Engineering Design Approach Document (HEDAD)*—Two types of HEDADs shall be prepared: the HEDAD-operator (HEDAD-O) and the HEDAD-maintainer (HEDAD-M).

6.1.18.1 *HEDAD-O*—The HEDAD-O shall describe the as-built system or equipment (for example, console, specific work station, compartment arrangement, lube oil system) from an operator's perspective. The system or equipment shall be described in detail (for example, each display or control on a console; each pump, controller, and meter in the lube oil system) explaining the design, layout, and location of each component from a human engineering perspective. The HEDAD-O shall describe where each component is located, why it was designed the way that it appears in the finished product, and why the as-built arrangement was selected (that is, the human engineering rationale). The HEDAD-O shall provide the procuring activity with sufficient detail to evaluate the as-built system or equipment to ensure that it is operable and complies with the human engineering requirements contained in the system or equipment design and acquisition contract.

6.1.18.2 *HEDAD-M*—The HEDAD-M shall be prepared in the same manner and detail as the HEDAD-O but shall describe the system or equipment from a maintenance perspective. In addition to a description of each component, such items as access openings, test or calibration points, lubrication fittings, and other maintenance specific design features shall be identified and discussed. The HEDAD-M shall be in sufficient detail to allow the procuring activity to determine that the system or equipment is maintainable and complies with the human engineering requirements contained in the design and acquisition contract.