Navy Personnel Research and Development Center

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HUMAN FACTORS CHECKLIST FOR EVALUATION OF SYSTEM DESIGN AND SUPPORT EFFECTIVENESS

DEPARTMENT OF THE NAVY
NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
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1. This project was conducted in response to a Naval Surface Weapons Center, White Oak work request (N609218WRW0032) to conduct human factors research in support of the Shipboard Nuclear Weapons Security (SNWS) development effort. The current task objective was to develop a concise human factors checklist to assist design engineers and others in addressing operability, maintainability, and logistics support provisions during the system development process.

2. Although the human factors checklist was developed to meet specific project needs in accordance with reference (a), the methodology could be applied to any type of system development. Users would be expected to include system design and evaluation personnel at contractor facilities in addition to personnel assigned to system development tasks at government agencies.

3. Subject checklist is submitted herewith as enclosure (1). Distribution to other Navy facilities and SNWS contractors will be made upon request. If clarification is needed concerning enclosure (1) provisions, questions may be addressed to the Human Factors and Organizational Systems Laboratory point of contact, Mr. W. J. Stinson (Code 41), Autovon 933-6617 or (619) 225-6617.

R. E. BLANCHARD
By direction

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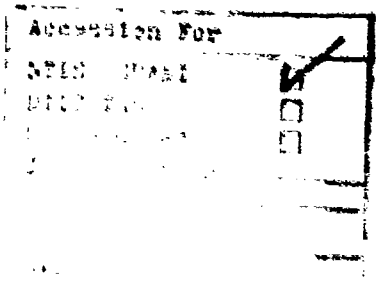
W. J. Stinson

Reviewed by
E. A. Koehler
System Design Division Head

Released by
R. E. Blanchard
Laboratory Director



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Design engineers are required to implement human factors provisions specified in various guidance documents. However, practical procedures have not been available in the past to assist performance of this important function. This report provides a concise, user-friendly checklist to support review of human factors and logistics support provisions throughout the development cycle. In addition to operability provisions for displays and controls, the checklist includes coverage of operator/computer interface requirements. Maintainability issues include consideration of test equipment and maintenance aids in addition to equipment packaging provisions. Personnel procedures and workloads are addressed. The adequacy of workspace layouts, environment, and safety provisions is covered. Technical documentation of operation, maintenance, and computer programming procedures is addressed. Finally, the adequacy of logistics planning for future support of hardware and software maintenance requirements is considered.

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SUMMARY

Problem

Design engineers are required to implement human factors provisions specified in various guidance documents. However, practical procedures have not been available in the past to assist performance of this important function. Improvements in system operability and maintainability could be achieved by providing a concise, user-friendly checklist to support review of human factors and logistics support provisions throughout the development cycle.

Purpose

The human factors checklist is intended to facilitate review of system design and logistics support provisions by various users. The checklist may be used as a reference guide to ensure comprehensive consideration of important development concerns. Alternatively, if desired, the adequacy of checklist items may be indicated by marking evaluation ratings on copies of the checklist sheets using a value scale ranging from 1 to 5 ("Unacceptable" to "Very Good"). When a design feature or logistics support provision is evaluated as "Poor" or "Unacceptable," an explanation must be provided on a problem identification sheet with suggested corrective action.

Results and Discussion

In addition to operability provisions for displays and controls, the checklist includes coverage of operator/computer interface requirements. Maintainability issues include consideration of test equipment and maintenance aids in addition to equipment packaging provisions. Personnel procedures and workloads are addressed. The adequacy of workspace layout, environment, and safety provisions is covered. Technical documentation of operation, maintenance, and computer programming procedures is addressed. Finally, the adequacy of logistics planning for future support of hardware and software maintenance requirements is considered. The comprehensive assessment of system provisions in areas outlined above would be expected to result in greatly improved integration of hardware and human capabilities for effective performance of mission functions.

Recommendations

1. Provide for implementation of the human factors checklist in assessing the adequacy of system design and logistics support provisions throughout the development cycle.

2. Consider updating and expanding the human factors checklist in the future as suggestions for improvement are received from users.

CONTENTS

INTRODUCTION

The human factors checklist provided herein has been developed as a means of ensuring appropriate consideration of system design and logistics support factors impacting operation and maintenance effectiveness. In evaluating system provisions, criteria established by the following principal guidelines must be applied:

1. NAVAIRINST 3900.10--Lead Systems Command Policies for Human Factors (Naval Air Systems Command (NAVAIRSYSCOM), 1986).

2. MIL-STD-1472C--Human Engineering Design Criteria for Military Systems, Equipment and Facilities (Department of Defense (DoD), 1981).

3. MIL-H-46855B--Human Engineering Requirements for Military Systems, Equipment and Facilities (DoD, 1979).

These principal guidance documents and other relevant military specifications applicable to design checklist items are further identified in the list of references provided herein (page 19).

Under circumstances where evaluation time is limited (particularly where groups of equipment are involved), the human factors checklist may be used most effectively as a reference guide without assignment of rating values to the various assessment factors. Under this procedure, problems discovered through inspection of equipment features or through observation of operational performance would be noted on problem identification sheets, as shown in the appendix, together with recommended corrective action where appropriate. This procedure is the most practical means of applying the checklist.

Alternatively, if desired, the adequacy of checklist factors may be indicated by marking evaluation ratings on copies of the checklist sheets in accordance with the following value scale:

5 - Very Good
4 - Good
3 - Satisfactory
2 - Poor
1 - Unacceptable

When a design feature or logistics support provision is evaluated as "Poor" or "Unacceptable," an explanation should be provided on the problem identification sheet. When a checklist item is not considered applicable to the system or equipment under evaluation, the abbreviation "N/A" may be inserted in the space provided. If information is not available to permit evaluation of a particular checklist item, the abbreviation "UNK" may be used.

This checklist is intended to facilitate review of system provisions by various users, including design engineers, mission area subject matter experts, and others. If further clarification of assessment items or procedures is needed, a human factors specialist should be consulted.

EQUIPMENT OPERABILITY

Control-Display Integration

1. A minimum amount of control/display decoding (interpretation) or mental involvement is required on the part of the operator. ___

2. Controls are located adjacent to their associated displays. ___

3. The precision required of control manipulation is consistent with the degree of resolution required by the associated display. ___

4. Functional groups of controls and displays are located to provide for left-to-right or top-to-bottom order of use, or both. ___

5. Providing that the integrity of grouping by function and sequence has not been compromised, the most frequently used and most important groups of controls are located in areas of easiest access. ___

6. Functional groups of controls are set apart and outlined with contrasting lines. ___

7. The location of recurring functional groups and individual items is similar from panel to panel. ___

8. If an operator must use a large number of controls and displays, their location and arrangement are designed to aid in determining which controls are used with which displays and which components each control affects. ___

9. The display information clearly and unambiguously directs and guides the appropriate control response. ___

10. Controls are selected so that the direction of movement of the control is consistent with movement of an associated display. ___

Visual Displays

1. Information is presented to the operator in a readily usable form (requirements for transposing, computing, interpolating, or mental translation into other units avoided). ___

2. Displays are designed so that failure of a display or loss of power is immediately apparent to the operator. ___

3. Display faces are perpendicular to the operator's normal line of sight or not less than 15 degrees from the horizontal line of sight (parallax is minimized). ___

4. Vibration (jittering) of visual displays does not degrade user performance below the level required for mission accomplishment. ___

5. All displays necessary to support an operator activity or sequence of activities are grouped together. ___

6. Very important or critical displays are placed in a privileged position in the optimum visual zone or otherwise highlighted. ___

7. Displays are coded by color, size, location, shape, or flash coding, as applicable. ___

8. Warning lights are an integral part of, or are located adjacent to, the lever, switch, or other controls by which the operator is to take action. ___

9. Transilluminated indicators are used, where appropriate, to display qualitative information requiring immediate reaction or to call attention to an important system status. ___

10. The brightness of transilluminated indicators is compatible with the expected ambient illumination level, and is at least 10 percent greater than the surrounding area brightness; however, the indicator brightness does not exceed 300 percent of surrounding area brightness. ___

11. Indicator lights incorporate filament redundancy or dual bulbs, so that when one filament or bulb fails, the intensity of the light is decreased sufficiently to indicate the need for lamp replacement. ___

12. When more than three indicator lights are installed on a control panel, a master light test control is provided. ___

13. Provisions are made for removal of lamps from the front of the display panel without the use of tools. ___

14. Red indicator lights are used to alert an operator that the system/equipment is inoperative or that a successful mission is not possible until appropriate corrective action is taken. ___

15. Flashing red indicator lights are used to denote emergency conditions. The flash rate is three to five flashes per second, with approximately equal amounts of on and off time. The indicator is designed so that, if energized and the flasher device fails, the light will illuminate and burn steadily. ___

16. Yellow indicator lights are used to advise an operator that a condition exists which is marginal insofar as system/equipment effectiveness is concerned. Yellow lights are also used to alert the operator to situations where caution, recheck, or unexpected delay is necessary. ___

17. Green indicator lights are used to advise an operator that the monitored system/equipment is performing within acceptable limitations or a condition is satisfactory and that it is all right to proceed. ___

18. White indicator lights are used to denote system/equipment conditions that do not have right or wrong implications. ___

19. Blue indicator lights are used optionally, as appropriate, to provide neutral advisory information. ___

20. Legend lights are preferred to simple indicator lights, where feasible. ___

21. Legend lights are coded appropriately in red, yellow, green, etc., colors to indicate related operational conditions. ___

22. Scale indicators are used where only quantitative information is to be displayed and there is no requirement (such as speed and accuracy of response) that demands the use of printers or counters. ___

23. Unless system requirements clearly dictate nonlinearity to satisfy operator information needs, linear scales are preferred to nonlinear scales. ___

24. Scale graduations progress by 1, 2, or 5 units or decimal multiples thereof. ___

25. Brightness contrast of at least 75 percent is provided between the scale face and the markings and pointer. ___

26. If certain operating conditions always fall within a given range on the scale, these areas are readily identifiable by means of pattern or color coding applied to the face of the instrument. ___

27. When positive and negative values are displayed around a zero position, the zero point is located at either the 12 o'clock or 9 o'clock position. ___

28. If practicable, the viewing distance for CRT displays is 16 inches (40.6 centimeters). If scope observation periods are short, or dim signals are to be detected, viewing distance is reduced to 10-12 inches (25.4 to 30.4 centimeters). ___

29. Ambient illumination contributes no more than 25 percent to screen brightness through diffuse reflectance and phosphor excitation. ___

30. Except for emergency indicators, there are no light sources in the immediate surroundings that are brighter than CRT display signals. ___

31. Ambient illumination in the CRT area is appropriate for performance of other visual functions (setting controls, reading instruments, etc.). ___

32. Counters are used for presentation of quantitative data when a continuous directional trend of parameter changes is not required. ___

33. Printers are used when a permanent visual record of quantitative data is necessary or desirable. ___

34. Printed information is presented in a readily usable form, with minimal requirements for coding, transposing, or interpolating. ___

35. Printers provide for quick and easy insertion or removal of printing materials. ___

36. Printers provide a positive indication of the remaining supply of printing materials (paper, ink, and ribbon). ___

Auditory Signals

1. Audio signals are provided as necessary to warn personnel of impending danger, to alert an operator to a critical change in system or equipment status, and to remind the operator of a critical action that must be taken. ___

2. If used in conjunction with visual displays, auditory warning devices are supplementary or supportive in nature. ___

3. All audio warning devices are equipped with circuitry test devices or other means of operability testing. ___.

4. Alarms that are perceptibly different correspond to conditions requiring critically different operator responses (maintenance, emergency conditions, health hazards, etc.). ___

5. If equipment is not regularly monitored, an auditory alarm is provided to indicate critical malfunctions. ___

6. The sound pressure level of audio warning signals is at least 20 dB(A) above the maximum anticipated ambient noise level but does not exceed 100 dB(A). ___

7. If an audio signal is designed to persist as long as it contributes useful information, a shut-off switch which is controllable by the operator or the sensing mechanism is provided, depending on the operational situation and personnel safety factors. ___

8. An automatic reset function is provided for audio warning signals that are terminated automatically or manually. ___

9. Depending on the operational situation and personnel safety factors, the volume of audio warning signals is designed to be controlled by the operator, the sensing mechanism, or both. ___

10. Audio warning signal duration is at least 0.5 seconds. ___

11. When several channels are to be monitored simultaneously by loudspeakers, the speakers are mounted so that they are not less than 10 degrees apart radially with respect to a central operator position. ___

12. When additional channel differentiation is required, low-pass signal filtering (frequency cutoff, F_c = 1,800 hertz) is applied to loudspeakers on one side of the central operator position. If there are three channels involved, one channel is left unfiltered, a high-pass filter with 1,000 hertz cutoff is provided in the second channel, and a low-pass filter with 2,500 hertz cutoff is provided in the third channel. A visual signal is provided to show which channel is in use. ___

13. Operator microphones, headphones, and telephone headsets permit hands-free operation under normal working conditions. ___

14. Accessible volume or gain controls are provided for each communication receiving channel (loudspeaker or headphones), with sufficient electrical power to drive peak sound level to 110 dB(A) overall when using two earphones. ____

15. Where communication channels are to be continuously monitored, each channel is provided with a signal-activated switching device (squelch control) to suppress channel noise during no-signal periods. ___

16. When normal working conditions permit the operator to remain seated while using "talk-listen" or "send-receive" control switches for normal operation or if console operation requires the use of both hands, foot-operated controls are provided. Hand-operated controls for the same function are provided for emergency use and for use when the operator may need to move from one position to another. ___

17. Communication audio circuits are designed so that the speaker hears his or her own voice in the headset as a side tone in phase with speech content. This side tone is not filtered or modified before it is received in the headset. ___

Controls

1. Controls are selected and distributed so that none of the operator's limbs will be overburdened. Reach distance to frequently used controls is no more than 25 inches (63.5 centimeters) in a seated position. ___

2. Multirotation controls are used when precision is required over a wide range of adjustment. ___

3. Detent controls are used whenever the operational mode requires discrete step adjustments. ____

4. Where sequential operations follow a fixed pattern, controls are arranged to facilitate operation in a related manner. ___

5. The most important and frequently used controls have the most favorable position with respect to ease of reaching and grasping (particularly rotary controls and those requiring fine settings). ___

6. The arrangement of functionally similar, or identical, primary controls is consistent from panel to panel throughout the equipment/system configuration. ___

7. No more than three different sizes of controls are used in coding controls for discrimination by physical size. Controls used for performing the same function on different equipment are the same size. ___

8. Controls are designed and located so that they are not susceptible to being moved accidentally. Particular attention is given to critical controls whose inadvertent operation might cause damage to equipment, injury to personnel, or degradation of system functions. ___

9. Rotary selector switches are used for discrete functions when three or more detented positions are required. ___

10. Rotary selector switches are not used for a two-position function unless ready visual identification of control position is of primary importance and speed of control operation is not critical. ___

11. Rotary selector switches are designed with a moving pointer and a fixed scale.

___

12. Moving-point knobs are bar-shaped, with parallel sides tapering to a point at the index end (exceptions may be justified when pointer knobs are shape-coded or when space is restricted and torque is light). ___

13. A reference line is provided on rotary switch controls, and this line has at least 75 percent contrast with the control color. ___

14. Knobs are used when little force is required and when precise adjustments of a continuous variable are required. ___

15. Pushbuttons are used when a control or an array of controls is needed for momentary contact or for activating a locking circuit, particularly in high-frequency-of-use situations. ___

16. The surface on pushbuttons is concave (indented) to fit the finger. A positive indication of control activation is provided (snap feel, audible click, integral light, etc.).

___

17. Toggle switches are used for functions that require two discrete positions or where space limitations are severe. ___

18. Toggle switches should generally be vertically oriented and actuated. The down position should indicate a de-energized (off) condition. ___

19. Keyboards are provided for entry of alphabetic, numeric, or special function data into system operations. ___

20. Cursor controls are provided, where required, for selection of data entry points on geometric displays. Precision positioning of the cursor is supported by an appropriate movement control (track ball, mouse, or equivalent). ___

21. Designation of geometric display data entry points is optionally supported by touch panel or light pen provisions where precision positioning is not required. ___

Operator/Computer Interface

1. Operator error is minimized by built-in software that checks data entry parameters, input sequence, and completeness where appropriate. ___

2. A capability is provided for on-line editing and correction before final data entry. ___

3. Error display messages indicate the type of corrective action needed or the specific nature of problems. ___

4. When operating in a special mode, the system indicates the selection in use, together with identification of related files being processed. ___

5. Information is displayed in plain, concise text whenever possible. However, when space does not permit use of plain text, standard abbreviations and acronyms are selected in accordance with MIL-STD-12D and MIL-STD-783D (DoD, 1981; 1984). ___

6. Language used for entry of operational commands reflects the user's knowledge and experience rather than the programmer's preference. ___

7. Feedback is provided to the operator acknowledging data entry, requesting further operator action, or referencing other data processing events where appropriate (may be indicated directly by related display changes). ___

8. Explicit operator action is required to discontinue or exit data processing activities in progress. ___

9. When programming supports multiple levels of procedures, the capability to bypass lower priority sequences is included as an option for experienced operators. ___

10. Programming is designed to minimize loss of data and avoid rekeying input in the event of equipment failure. ___

11. Dedicated keyboard function keys are provided where operator input actions are time-critical, error-critical, or repetitive in nature. ___

12. Operator input is not delayed more than 20 milliseconds by the system. If system response time is longer than one second, acknowledgement of operator action is provided. ___

13. Where a rapidly changing pattern of information is graphically displayed, an option is provided to freeze the presentation temporarily for operator inspection. ___

14. Display format coding (pattern, location, brightness, color, symbology, etc.) is used to differentiate between variable events or performance status. ___

15. Flash coding is used only to alert the operator to mission-critical events. The flash rate is between three and five flashes per second with equal on/off time. Controls are provided for operator acknowledgement and suppression. ___

16. Data that must be scanned and compared are presented in a tabular or graphic display format. ___

17. A capability is provided for making hard copy printouts of alphanumeric and graphic display information. ___

18. When a string of five or more characters is displayed, the information is presented in blocks of three to four characters with each block separated by a blank space. ___

19. Where lists extend beyond one display page, the first line of each succeeding page repeats the last line of the prior page. Headings of columnar data are repeated on each page. A capability for scrolling between pages is provided. ___

20. Keyboard design conforms to MIL-STD-1280 unless the keyboard serves some other special use (DoD, 1969). ___

Labeling

1. Controls, displays, and any other items of equipment that must be located, identified, read, or manipulated are appropriately and clearly labeled to permit rapid and accurate human performance. ___

2. Labels are located in a consistent manner throughout the equipment/system and normally placed above the controls and displays they describe. ___

3. Labels describe equipment control/display functions in a manner readily understandable to users with minimum specialized training or experience. ___

4. Since frequent design changes may be anticipated in prototype equipment, labels for such equipment are designed so that they can be easily affixed, altered, or removed.

___

5. Label abbreviations are selected in accordance with MIL-STD-12D and MIL-STD-783D (DoD, 1981; 1984). ___

6. Trade names and other irrelevant information do not appear on labels or placards. ___

7. The height of letters and numerals is determined by the required reading distance and illumination. ___

8. Only capital characters are used in label printing. Periods or commas are normally omitted. ___

9. Where the ambient illumination will be above 10 lux (0.9 ft-c), black characters are used on a light background. ___

10. Each unit, assembly, subassembly, and part is labeled with legible and meaningful identification. ___

EQUIPMENT MAINTAINABILITY

General

1. Units are designed so that they cannot be mounted improperly. ___

2. Cables are routed or protected in such a way that they may not be pinched by doors, lids, etc., walked on, used for hand holds, or bent or twisted sharply or repeatedly. ___

3. Electrical cables are not routed below fluid lines or near high temperature sources. ___

4. Connector plugs are so designed that it is impossible to insert a plug incorrectly into a receptacle. ___

5. Plugs or receptacles are provided with aligning pins or equivalent devices to aid in alignment. Aligning pins extend beyond the plug's electrical pins to ensure that alignment is obtained before the electrical pins engage. ___

6. Where equipment lubrication is required, the type of lubricant to be used and the frequency of lubrication are specified by a label mounted at or near the lube port. ___

Accessibility

1. Equipment is designed to enhance the ease with which it can be assembled and disassembled. ___

2. Hinged covers are provided wherever possible to minimize the number of fasteners required. ___

3. Captive, quick-opening fasteners are provided on cases and covers, except where equipment performance would be jeopardized thereby. ___

4. If hinged access or quick-opening fasteners will not meet stress, pressurization, shielding, or safety requirements, the minimum number of the largest screws consistent with these requirements is used. ___

5. Sliding, rotating, or hinged units to which rear access is required are free to open or rotate their full distance without being supported by hand. ___

6. Unless a unit is completely self-checking, provision is made for checking the operation of the unit in the normal operating condition without the use of special rigs or harnesses. ___

7. Where fuses are used, they are readily accessible for removal and replacement. Spare fuse holders are provided. ___

Test Points

1. When a unit is not completely self-checking, readily accessible test points (primary and secondary) are provided, utilizing standard crimp-on connections or test jacks. ___

2. Primary test points are so located and coded as to be readily distinguishable from secondary test points. ___

3. When sequential testing is required, test points are grouped in a line or matrix reflecting the sequence of tests to be made. ___

4. Where space is available, desired signal and tolerance limits of test points are specified at the test points themselves, provided that equipment performance is not compromised thereby. ___

5. A secondary test point is provided at the input and output of each part of a throwaway component, except where this would conflict with other requirements. ___

6. Sufficient test points are provided so that it is not necessary to remove subassemblies from assemblies to accomplish troubleshooting. Each test point is marked for ready identification. ___

Test Equipment and Maintenance Aids

1. Required portable or built-in test equipment is provided for accomplishing performance checkout, malfunction analysis, adjustment, and calibration functions. ___

2. Where feasible, a continuous indication of test equipment performance adequacy is provided to preclude the use of faulty equipment in accomplishing troubleshooting and adjustment functions. ___

3. Adequate storage space is provided within portable test equipment, its handling case, or lid to contain leads, probes, spares, manuals, special tools, etc., as required for operation. ___

4. Instructions for operating portable test equipment are provided on the face of the test equipment, in a lid, or in a special compartment. Where applicable, the instructions include a reminder to check calibration of the equipment before use. ___

5. Test probes have tips designed to ensure proper contact with test points. ___

6. Equipment is designed with built-in test and fault isolation aids, when cost effective. ___

7. Where computer-aided operations are involved, provisions are made to rapidly differentiate between programming software malfunctions and hardware performance malfunctions. ___

Packaging

1. Equipment is adequately ruggedized to avoid vibration and shock damage in the operational environment or during transit off-site. ___

2. Replaceable units weighing more than 10 pounds (4.5 kg) are equipped with carrying handles. ___

3. Adequate cooling is uniformly distributed to all interior components within enclosures to prevent buildup of hot spots or overall thermal stress that could result in

circuitry damage or failure. Built-in temperature measuring devices (thermistors or equivalent) are incorporated into equipment assemblies, when cost-effective. ___

PERSONNEL TASK REQUIREMENTS

Operation

1. Task procedures are clearly delineated in Operational Instruction Charts (OICs) or other documentation readily available to all system/equipment users. ___

2. The workload at each operator position can be satisfactorily handled by normally assigned personnel. Additional personnel are not required. ___

3. Task functions can be readily accomplished within mission time and accuracy limitations. Unusual stress or fatigue conditions are not generated in the accomplishment of objectives. ___

4. Task functions are properly allocated for performance by man or machine. Overall control and decision-making functions requiring the exercise of human judgment are assigned to man. Routine tasks performed in frequently recurring, identical fashion are assigned to machine automation. ___

5. Manual tasks have been simplified, where feasible, to minimize specialized knowledge/skill requirements. ___

Maintenance

1. Corrective maintenance task procedures are clearly delineated in system/equipment technical manuals. Adjustment and calibration requirements are identified for major equipment. Related troubleshooting and repair procedures are indicated in each case. ___

2. Correction of typical equipment malfunctions can be reliably accomplished within planned mean-time-to-repair (MTTR) time periods. ___

3. Maintenance workloads can be satisfactorily handled by normally assigned technicians. Additional personnel are not required. ___

4. Maintenance tasks have been simplified, where feasible, through the provision of special maintenance aids or incorporation of improved maintainability design features (such as "plug-in" replacement of faulty modules) to minimize specialized knowledge/skill requirements on the part of maintenance personnel. ___

5. Planned maintenance system (PMS) documentation, consisting of maintenance requirement cards (MRCs), maintenance index pages (MIPs), etc., has been prepared for each type of installed equipment. ___

6. Information contained in the MIPs, MRCs, and other PMS documentation is considered to be valid. Essential maintenance tasks are listed. ___

WORKSPACE LAYOUT

Work Flow Characteristics

1. Equipment is arranged within workspaces so that walking distance is minimized between positions requiring frequent, direct physical interaction. ___

2. Dispersed positions requiring coordinated operations in the transfer of verbal information, video data, or narrative documentation are linked by appropriate communication devices to avoid delay in accomplishing work functions. ___

3. Where applicable, pneumatic tubes or other rapid-transfer devices are provided to facilitate the physical movement of record documentation between associated, dispersed positions. ___

4. Where feasible, functionally interdependent workspaces are located in close proximity to each other. Repair and spare parts supply spaces are located adjacent to related operational spaces. ___

Space Provisions

1. Whenever feasible, free deck space of at least four feet is provided in front of equipment consoles. ___

2. Adequate space is provided around "slide-out" cabinet units for performance of troubleshooting and adjustment tasks without blockage of personnel passageways while equipment units are in the "extended" operational position. ___

Ancillary Work Aids

1. The writing surface height of desks and writing tables is 30 inches (76.2 centimeters) above the deck, unless otherwise specified. ___

2. The height of workbenches and other work surfaces is 35 inches (88.9 centimeters) above the deck, unless otherwise specified. ___

3. Chairs to be used with "sit" consoles are designed to permit vertical seat adjustment from 16 to 21 inches (40.6 to 53.3 centimeters) in increments of no more than 1 inch (2.5 centimeters). A backrest that reclines between 100 degrees and 115 degrees is provided. Unless otherwise specified, armrests are provided. ___

4. Display consoles are designed with standard dimensions for display surface angle, shelf height, knee clearance, etc. ___

WORKSPACE ENVIRONMENT

Heating, Ventilation, and Air Conditioning

1. A minimum effective temperature level of 65 °F (18 °C) is maintained within permanent and semi-permanent facilities. Air conditioning is provided, if required, to prevent a rise in temperature level beyond 85 °F (29.5 °C). ___

2. Adequate ventilation is assured by introducing a minimum of 30 cubic feet of air per minute per person into each personnel enclosure; approximately two-thirds is outside air. ___

3. Humidity values approximate 45 percent relative humidity at 70 °F (21 °C). ___

Lighting

1. General and supplementary lighting is used as appropriate to ensure that adequate illumination is available at each duty station position. ___

2. A capability is provided for manual variation of illumination levels, where applicable. ___

Noise

1. Noise generation and penetration are controlled to the extent that acoustic energy will not cause personnel injury, interfere with voice or any other communications, cause fatigue, or in any other way degrade overall system effectiveness. ___

2. Equipment does not generate noise in excess of maximum allowable [illegible] prescribed by MIL-STD-740B and OPNAVINST 5100.23B (DoD, 1965; Office of the Chief of Naval Operations, 1986). ___

3. Where applicable, sound baffles consisting of acoustical materials of appropriate size, shape, and design are provided in proximity to noise-generating sources. ___

4. Ambient noise level does not exceed 65 dB(A) in spaces where frequent direct voice communications must be conducted at distances up to 5 feet (1.52 meters). ___

SAFETY CHARACTERISTICS

General

1. Conspicuous warning placards are mounted adjacent to any equipment that presents a hazard to personnel. ___

2. Jacking and hoisting points are conspicuously and unambiguously labeled on equipment. ___

3. Printed "no-step" markings are provided where necessary on low-strength equipment surfaces to prevent injury to personnel or damage to equipment. ___

4. All electrical receptacles are marked with their voltage, phase, and frequency characteristics, as appropriate. ___

5. Where devices with high speed rotation are accessible while energized, protective guard covers or screens are installed to prevent accidental physical contact. _____

High Voltage

1. Guards, grounding, interlocks, and warning placards are provided to minimize the possibility of exposing personnel to dangerous voltages. ___

2. Tools and test leads to be used near high voltages are adequately insulated. ___

TECHNICAL DOCUMENTATION

Operation

1. Accurate operational procedures information is provided for each equipment type in Operational Instruction Charts (OICs) or other applicable documentation. Sufficient copies are available to ensure convenient access to all system/equipment users. ___

2. The binding of OICs or other operational procedures documentation permits convenient removal and replacement of pages for future updating of material. ___

3. Satisfactory illustrations are provided to show the location of equipment controls and displays. ___

4. The purpose of controls and displays, method of adjustment, and sequential usage procedures are explained satisfactorily. ___

5. Where feasible, a concise description of equipment turn-on, operational checkout, and turn-off procedures is included as a chart (or separate section) within documentation concerning overall equipment operational procedures. ___

Maintenance

1. Accurate maintenance information is provided in applicable technical manuals for each equipment assembly (including coverage of performance checkout, troubleshooting, adjustment, calibration, and repair procedures). ___

2. The location of equipment test points is clearly illustrated. Normal test point readings (and allowable tolerances, if any) are identified. ___

3. Where applicable, special test equipment set-ups for maintenance purposes are clearly illustrated and explained. ___

4. Schematic diagrams are presented clearly and accurately. ___

5. A replacement parts list is provided. Parts are properly identified by stock number and listed in a manner facilitating easy reference. ___

6. Satisfactory illustrations are provided to show the location of equipment controls and displays. The purpose of controls/displays and method of adjustment are explained satisfactorily. ___

7. A concise description of equipment turn-on, operational checkout, and turn-off procedures is provided. ___

8. The binding of technical manuals permits convenient removal and replacement of pages for future updating of material. ___

9. Where computer capabilities are used in system operations, supplementary technical documentation is provided to describe programming functions and logical routines at the level of detail needed in supporting user maintenance responsibilities. ___

LOGISTICS SUPPORT PLANNING

Hardware

1. A practical maintenance philosophy has been established for each equipment assembly, providing for the performance of specified repairs at organizational-, intermediate-, or depot-level facilities, as appropriate. ___

2. Estimated mean-time-between-failure (MTBF) and mean-time-to-repair (MTTR) values have been identified for each equipment assembly. ___

3. Action has been initiated to provide for procurement and storage of required spare parts to support projected requirements for each equipment assembly. ___

4. Detailed plans have been formulated to provide for periodic calibration of test equipment at intermediate- or depot-level facilities, as appropriate. ___

Software

1. Additional copies of system/equipment documentation and computer programs are available at a centralized location to supplement or replenish the supply. ___

2. Detailed plans have been formulated to provide for follow-on computer programming support. Operational equipment will be made available for performance checkout and "debugging" of updated computer programs. ___

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Department of Defense. (29 May 1981). Abbreviations for use on drawings, specifications, standards, and in technical documents (MIL-STD-12D). Washington, DC: Author.

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APPENDIX

HUMAN FACTORS PROBLEM IDENTIFICATION SHEET

HUMAN FACTORS PROBLEM IDENTIFICATION SHEET

Equipment/System Name or Function: _____

Equipment/System Nomenclature: _____

Evaluator:

Name: _____ Rate/Rank: _____

Organization: _____

Evaluation Date: _____

Unit Affected	Brief Description of Problem	Recommended Corrective Action