Human Factors Checklist for the Design and Evaluation of Air Traffic Control Systems

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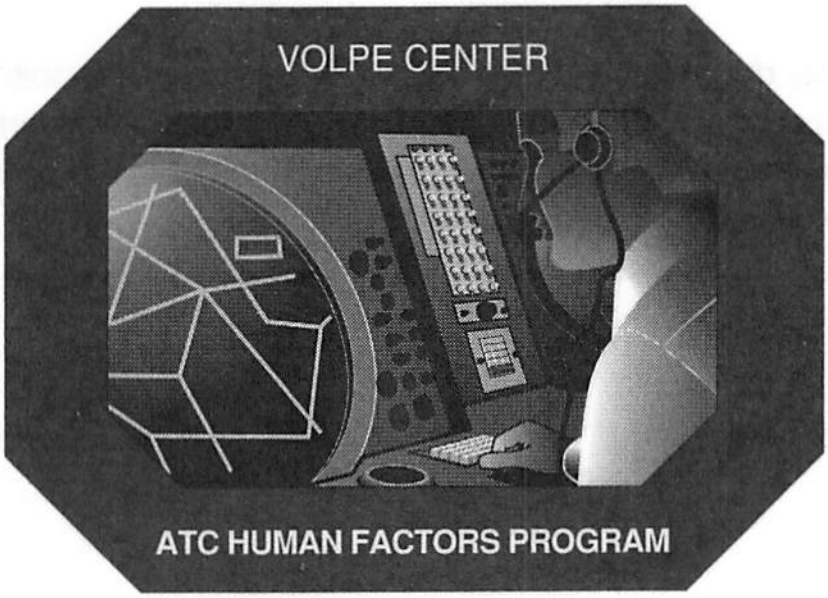

U.S. Department of Transportation
Research and Special Programs Administration
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Final Report
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13. ABSTRACT *(Maximum 200 words)*

This document presents human factors issues that should be considered in the design and evaluation of air traffic control (ATC) systems and subsystems. The checklist is a companion document to *Human Factors in the Design and Evaluation of Air Traffic Control Systems*. The goal of this checklist is to point air traffic controllers and other operations specialists to questions that they may wish to consider in their evaluation of new systems or subsystems, or a new component of an existing system. Some checklist items may be used as a rough filter for known design flaws; others are more appropriate for group discussion.

The numbers in parenthesis at the end of each checklist item refer to the section in *Human Factors in the Design and Evaluation of Air Traffic Control Systems* that discusses the issue. This mapping allows the checklist user to learn about the basis for the item, why it is important, and the implications of compromise. Checklist items marked with an "E" indicate items that must be assessed with equipment and/or by referring to the specifications documentation.

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PREFACE

This checklist, as well as the companion handbook, Human Factors in the Design and Evaluation of Air Traffic Control Systems was funded by the Federal Aviation Administration's Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100).

For additional copies of the handbook and/or checklist, please write to:

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 3.0 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32)(5/9)]°F = y°C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeters (mm) = 0.04 inch (in)
1 centimeters (cm) = 0.4 inch (in)
1 meter (m) = 2.2 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectares (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliters (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5)(y + 32)]°C = x°F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES 0 1 2 3 4 5 6 7 8 9 10

CENTIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

25.40

QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C1310286.

TABLE OF CONTENTS

Section		Page
I.	GENERAL	1
II.	VISUAL DISPLAYS	3
	A. General	3
	B. Visual Alerts	11
III.	AUDITORY ALERTS	15
	A. General	15
	B. Speech Messages	18
IV.	COGNITIVE WORKLOAD	21
	A. General	21
	B. Automation	27
V.	DATA ENTRY PROCEDURES	31
	A. General	31
	B. Commands and Command Execution	34
	C. Menus	36
	D. Error Messages and User Guidance	38

Section **Page**

VI. DATA ENTRY AND CONTROL DEVICES 41

A. General 41
B. Keyboards 42
C. Touchscreens 45
D. Trackballs 47
E. Control Grip Devices 49
F. Mice 49
G. Graphics Tablets 50
H. Pushbuttons (Actual and Virtual) 51
I. Foot Switches and Pedals 52

VII. ERGONOMICS AND WORKSTATION DESIGN . . 55

A. User-Centered Workstation Design 55
B. Design of Control Room Seating 59
C. Design of Communications Equipment 59
D. Environmental Design 63

VIII. HUMAN FACTORS PLANNING AND EVALUATION 65

A. Human Factors Plan 65
B. Test Methods 67
C. Analysis of Test Results 69

Note: Checklist items marked with an "E" indicate items that must be assessed with equipment and/or by referring to the specifications documentation.

INTRODUCTION

This checklist is a companion document to *Human Factors in the Design and Evaluation of Air Traffic Control Systems.* The items contained in this checklist have been derived from this handbook. The primary purpose of the checklist is to point air traffic operations specialists (and other operations specialists) to human factors issues that they may wish to include in their consideration of a new system or subsystem, or a new component of an existing system. Responses to the checklist items can help to focus group discussions and identify issues that should be addressed in every stage of the acquisition process, from the development of system requirements to formal operational testing. Operations specialists may wish to use some of the items as a basis for identifying human factors issues that should be formulated into appropriate requirements and specifications. In order to do this, a knowledge of the system will be necessary to relate the checklist items to a specific system attribute or function. Use of the checklist in this way can also support the development of a Human Factors Plan as required by FAA Order 1810.1F, Acquisition Policy. (For specific information on how to write a human factors plan, see Chapter 2 in *Human Factors in the Design and Evaluation of Air Traffic Control Systems.*)

The checklist is intended to add structure and objectivity to the selection and evaluation of ATC systems and subsystems. It is not meant to serve as a comprehensive assessment or to replace usability testing. The checklist can only examine individual components of a system and point to broader issues (such as how these components fit together, the uses of automation, etc.). In many cases, the ability of the checklist to identify potential problems will be entirely dependent on the person using the checklist. Where checklist items are general or broad, an intimate knowledge of the system and how the user will use the system, is required to make the connection between the intent of the item and specific system attributes or functions. Many of the checklist items are objective and precise and can be answered with observations alone (e.g., "the user can adjust symbol size"). However, other items are more general and the answer may require objective testing (e.g, "the meanings of auditory displays are readily apparent"). Also, some of the items are idealistic; they represent the ideal based on current human factors knowledge. They are not offered as system requirements or standards, nor do they preclude compromise; where compromises must be made, however, the implications should be clearly understood. This material is provided solely for guidance and is intended to be used by air traffic specialists as they see fit.

The numbers in parentheses at the end of each checklist item refer to the section in *Human Factors in the Design and Evaluation of Air Traffic Control Systems* that discusses the issue. This mapping allows the checklist user to learn about the basis for the item, why it is important, and the implications of compromise. Checklist items marked with an "E" indicate items that must be assessed with equipment and/or by referring to the specifications documentation.

Key to Checklist responses:

S	U	N/A

S = Satisfactory
U = Unsatisfactory
N/A = Not Applicable

I.

GENERAL

1. Separately developed subsystems are effectively integrated into the operational environment so that they are compatible with existing equipment and procedures (6.1.2).

S	U	N/A

2. With this design, the controller can find the necessary information quickly so that the computer does not delay the controller in any way (6.1.2).

S	U	N/A

3. This design provides all the information needed for planning purposes (5.2.1).

S	U	N/A

4. This design provides the controller with all the necessary information for a specific task when it is needed/in the appropriate sequence (5.3.2).

S	U	N/A

5. The information provided helps the controller to recognize situations that require control action (5.2.3).

S	U	N/A

Notes

6. Visual and auditory coding techniques help the controller maintain productive scanning and problem-detection strategies (5.3.2). S U N/A ☐☐☐

7. Perceptual displays help the controller in building and maintaining situational awareness, i.e., in perceiving, integrating, and projecting information about the ATC situation (5.6.1, 5.4.2). S U N/A ☐☐☐

8. Information presentation is split between auditory and visual displays such that neither mode is overused or cluttered (7.3.9). S U N/A ☐☐☐

9. If predictive displays are provided, they assist the controller in projecting the combined effects of many situational factors (5.2.3). S U N/A ☐☐☐

10. If predictive displays are provided, they do not place additional memory demands or other information-processing burdens on the controller (5.2.3). S U N/A ☐☐☐

Notes

II.

VISUAL DISPLAYS

A. General

1. Information that the controller needs does not disappear from the screen without being deleted or suppressed by the controller (7.1.20).

S	U	N/A

2. The computer responds quickly so that the controller is not kept waiting for information (5.1.2).

S	U	N/A

3. Essential ATC information is never blocked or obstructed by other information (7.2.17).

S	U	N/A

4. All information that a controller needs to accomplish a task that is essential and time-critical is located on a single page or in a single window (7.2.17).

S	U	N/A

5. Visual displays provide necessary information in a usable form when it is needed (5.3.2, 7.2).

S	U	N/A

Notes

6. Display clutter is not a problem (7.2.20). S U N/A

7. The meaning of each icon is immediately apparent to the controller or it is labelled (7.2.1). S U N/A

8. Symbols chosen for the display are intuitive so that the controller can interpret them quickly and accurately (7.2.9, 5.1.5). S U N/A

9. Controllers can change the amount of task-related detail that is presented (7.2.20). S U N/A

10. When the meaning of the color is critical, color is used redundantly with another type of visual cue, such as shape, text, or size. For example, all yellow objects have a triangular shape (7.2.12, 3.2.3). S U N/A

11. The controller is able to recognize and differentiate between color codes under all anticipated lighting conditions (9.6.1). S U N/A

Notes

12. The controller will not need to identify more than five colors (to interpret the meaning of the color when it stands alone) (7.2.13, 3.2.4).

S	U	N/A

13. Color displays are readable and adequately bright under all anticipated lighting conditions (9.6.1).

S	U	N/A

14. When the controller must distinguish between the color of characters and symbols, small blue characters and symbols are not used (7.2.11, 3.2.3).

S	U	N/A

15. Saturated (i.e., vivid) red and blue are never presented next to each other (7.2.14, 3.1.8; also see Figure 3-11).

S	U	N/A

16. Colors are far enough apart in perceptual terms that they are not confusable even when "washed out" by sunlight, if applicable (3.2.3).

S	U	N/A

17. Characters and symbols can be read easily under all anticipated lighting conditions (e.g., from dim light to direct sunlight, if applicable) (9.3.4, 9.6.1, 9.6.2, 7.2.8).

S	U	N/A

Notes

	S	U	N/A
18. Computer displays and controls are clearly visible and easy to use under all anticipated lighting conditions (e.g., from dim light to direct sunlight, if applicable) (9.3.4, 9.6.1, 9.6.3, 7.2.8).			
19. To acquire needed information, the controller only needs to look at a single, localized display i.e., switching back and forth between two or more displays is not necessary to perform an individual task. (6.1.2).			
20. The position and form of displayed objects appear the same to the controller while seated directly in front of the object as they do from other anticipated viewing angles (7.2.7).			
21. If windows are used, the controller can scroll the underlying data set (7.2.17).			
22. If windows are used, the controller can move windows (7.2.16).			
23. If windows are used, the controller can resize windows (7.2.17).			
24. If windows are used, the controller can iconify display pages (7.2.17).			

Notes

	S	U	N/A
25. If windows are used, the controller can open and close windows (7.2.17).			
26. The active window is highlighted to distinguish it from inactive windows (7.2.17).			
27. The relationship between different windows is clear to the user (7.2.17).			
28. All information that a controller needs to accomplish a given task is located in a single window or within a small number of related windows (7.2.17).			
29. Abnormal data are emphasized effectively so that it attracts the controller's attention (7.2.11).			
30. Updated data are emphasized effectively so that it attracts the controller's attention (7.2.11).			
31. Acronyms in the new display system have the same meanings as in the previous system (7.2.2).			

Notes

32. Terms in the new display system have the same meanings as in the previous system (7.2.2). S U N/A ☐☐☐

33. Symbols in the new display system have the same meanings as in the previous system (7.2.3). S U N/A ☐☐☐

34. Symbol size can be adjusted by the controller (7.2.10). S U N/A ☐☐☐

35. Visual displays and their labels are sufficiently visible under all anticipated lighting conditions (9.3.4). S U N/A ☐☐☐

36. If size coding is used, it is limited to two widely different sizes (7.2.11). S U N/A ☐☐☐

37. Graphic displays are used only to present information that is naturally pictorial and to present dynamic data (7.2.5). S U N/A ☐☐☐

38. Placement of standard data fields is consistent from one display to another (7.2.18). S U N/A ☐☐☐

Notes

		S	U	N/A
39.	Formats used within data fields are consistent from one display to another (7.2.18).			
40.	Labels, terms, and abbreviations are used consistently across the display set (7.2.15).			
41.	Only one abbreviation is used for each word or item and abbreviations are used consistently on all visual displays (7.2.15).			
42.	Punctuation is used conservatively and consistently (7.2.15).			
43.	Continuous text is presented in mixed upper-and-lower case (7.2.15).			
44.	Computer printouts (in upper and lower case) are available for lengthy text (7.2.15).			
45.	Visual displays maintain good image quality even at the dimmest possible setting (7.2.8).			

Notes

E 46. According to the display monitor manufacturer's report, the display refreshes at a rate of 65 cycles (or more) per second so that the display does not appear to flicker (7.2.6, 7.2.22, 3.1.6). S U N/A

E 47. According to the display monitor manufacturer's report, a displayed object moves no more than .0002 times the viewing distance (in inches) in one second so that no display jitter can be detected (7.2.22, 7.2.23). S U N/A

E 48. The heights and widths of characters appearing at the center and the four corners of the displays do not vary by more than 10 percent (7.2.22). S U N/A

E 49. When the center of the display is compared to an edge, brightness uniformity does not vary by more than 50 percent (7.2.22). S U N/A

E 50. The luminance of dynamic text and symbols are eight times that of the static background (7.2.22). S U N/A

E 51. All colors are 8 times brighter than the static background symbology (7.2.14). S U N/A

Notes

E 52. When the controller must distinguish between the color of characters, character height is at least 21 minutes of arc (7.2.10, 3.2.4). S U N/A

B. Visual Alerts

1. Information that the controller must read and understand quickly, such as alarms or critical error messages, never blinks or flashes rapidly (greater than 3 Hz) (5.1.3, 5.1.5, 7.2.11). S U N/A

2. High-priority alerts and other critical information are located within the central display area (i.e., the central 15 degrees of the area where the controller normally looks, given the normal viewing position) (7.2.11, 9.3.4). S U N/A

3. Highlighting and blinking are used sparingly (7.2.11). S U N/A

4. Alerts have a low incidence of false alarms (7.2.11). S U N/A

5. The same color coding strategy is applied to every display used by the same controller (7.2.12). S U N/A

Notes

	S	U	N/A
6. The color red is used only for warning/danger (7.2.12).			
7. Yellow is used to indicate caution (7.2.12).			
8. Green is used to indicate for normal/ready status (7.2.12).			
9. No more than two levels of blinking are used (7.2.11).			
10. If blinking is used, it is cancelable by the controller (7.2.11).			
11. For a time-critical warning system (such as a conflict detection or resolution advisory), the controller response time that is assumed by the algorithm has been measured (5.1.5).			
12. This design effectively directs the controller's attention by means of alerting, coding, and emphasis techniques (5.3.1, 7.2.11).			
E 13. Information that is blinking, has an "on" period that is at least as long as the "off" period (5.1.5).			

Notes

E 14. If blinking is used, the blink rate is between 2 and 3 Hz (5.1.5, 7.2.11).

S	U	N/A

Notes

Notes

III.

AUDITORY ALERTS

A. General

		S	U	N/A
1.	Auditory alerts are used only when necessary (7.3.2, 7.3.3).			
2.	The number of auditory alerts is sufficient, that is, auditory alerts are included wherever they are needed (7.3.2).			
3.	The meanings of auditory alerts are readily apparent (7.3.7).			
4.	All proposed auditory alerts have been tested and evaluated in a realistic environment by a representative set of controllers (7.4.3).			
5.	The auditory alert does not nag, or otherwise annoy, the controller (7.3.5, 7.3.6).			
6.	Auditory signals (and speech messages) are not masked by other auditory alerts or background noise (7.3.7, 7.3.8, 4.1.3).			

Notes

7. For any situation, it is impossible for more than a few auditory alerts to be presented simultaneously (7.3.7). S U N/A ☐☐☐

8. The number of auditory signals (e.g., warnings, alerts) that the controller may need to identify is fewer than five (7.3.8). S U N/A ☐☐☐

9. Auditory alerts are easily discernible from other signals or noise (7.3.7, 7.3.8, 4.1.3). S U N/A ☐☐☐

10. Auditory alerts do not provide more information than is necessary (7.3.7). S U N/A ☐☐☐

11. The same auditory signal always indicates the same information (7.3.7). S U N/A ☐☐☐

12. Auditory alerts are consistently implemented throughout the system (7.3.7). S U N/A ☐☐☐

13. The information contained in an auditory alert is also displayed visually (7.3.8). S U N/A ☐☐☐

14. Auditory alerts are only used when immediate action is required (7.3.8). S U N/A ☐☐☐

Notes

15. Auditory alerts terminate automatically when the problem is corrected (7.3.8). S U N/A

16. Auditory alerts are cancelable by the controller (7.3.7, 7.3.8). S U N/A

E 17. A modulated signal emits from one to eight beeps per second (7.3.8). S U N/A

E 18. A warbling sound varies from one to three times per second (7.3.8). S U N/A

E 19. The frequency of all auditory signals is between 500 and 3000 Hz so that they are well within the band of frequencies that humans are most sensitive to. (7.3.8). S U N/A

E 20. Auditory alerts sound for at least a 0.5 second duration (7.3.8). S U N/A

E 21. The pause between a repeating auditory signal is less than or equal to three seconds (7.3.8). S U N/A

Notes

E 22. Auditory alerts are at least 10 dB above ambient noise or have been demonstrated to be sufficiently intense for a specific working environment (7.3.7, 7.3.8).

S	U	N/A

B. Speech Messages

1. A detection signal display (for example the sound of static on the line) precedes a voice warning, unless a distinctive synthesized voice is used (7.3.3).

S	U	N/A

2. Speech messages are short enough to be easily remembered. (7.3.4).

S	U	N/A

3. Brief speech messages are available to the controller when there is the need to explain the specific nature of alarm and warning signals (7.3.4).

S	U	N/A

4. Speech displays are distinct from and not easily confused with other voices in the control room (7.3.4).

S	U	N/A

5. The controller does not need to remember more than one or two speech messages at a time in order to accomplish any of his or her ATC tasks (7.3.5, 7,3,7).

S	U	N/A

Notes

6. Speech messages are not masked by other auditory alerts or background noise (7.3.7, 4.1.3).

S	U	N/A

E 7. If important messages are produced by synthetic speech, they are at least 8 db above the surrounding noise (4.2.5).

S	U	N/A

Notes

Notes

IV.

COGNITIVE WORKLOAD

A. General

	S	U	N/A
1. With this design, the controller will be able to build and maintain sufficient situational awareness (6.2.1, 6.3.3, 8.3.4).			
2. The design assists the controller in detecting errors in data entry (5.2.4, 6.3.3).			
3. The design assists the controller in correcting errors in data entry (5.2.4, 6.3.3).			
4. This design presents all information in usable form; the controller is never required to transform data from one unit to another or to perform mental calculations in order to use the data (5.1.1, 7.5.3).			
5. This design helps the controller to integrate information from multiple sources, if the information is not already integrated before it is presented to the controller (5.1.2, 5.4.2, 5.6.1).			

Notes

6. The design allows the controller sufficient time to perceive and act upon new information (5.1.1, 5.1.5). S U N/A ☐☐☐

7. The design allows the controller sufficient time to project potential outcomes of optional control actions (5.1.1). S U N/A ☐☐☐

8. This design requires little or no unaided recall of information (5.4.7, 8.2.4). S U N/A ☐☐☐

9. This system provides appropriate memory joggers (e.g., prompts, cues) (5.2.1, 5.4.4, 8.2.4). S U N/A ☐☐☐

10. This design does not require the controller to recall infrequently used data-entry commands (8.2.5). S U N/A ☐☐☐

11. This design does not place greater demands on memory than the previous system did (8.2.4). S U N/A ☐☐☐

12. This design does not increase the amount of data entry for controller tasks (8.2.5). S U N/A ☐☐☐

Notes

13. In comparison to the established baseline (e.g., the previous system), controller workload stays about the same with this design (8.2.3). S U N/A ☐☐☐

14. Controllers will be able to make this design work without having to invent ways around design flaws (8.1.5). S U N/A ☐☐☐

15. This design supports timesharing of information processing activities, that is, visual, auditory, and decision-making processes can be performed together without overloading the controller. (5.2.1). S U N/A ☐☐☐

16. This design supports complete, accurate awareness of the ATC situation (5.2.1). S U N/A ☐☐☐

17. This design is not likely to overload the controller's working memory (5.2.1, 5.4.4). S U N/A ☐☐☐

18. The information that is selected and presented supports the controller in making judgement calls and decisions (5.2.1). S U N/A ☐☐☐

Notes

19. Information from subsystems is integrated and presented in a way that minimizes the need to switch from one display to another (5.2.1, 5.4.2).

S	U	N/A

20. This design alerts the controller to critical situations with enough lead time to formulate and execute appropriate responses (5.3.2).

S	U	N/A

21. This design allows the controller to keep some information processing resources in reserve for unexpected events (5.3.2, 5.4.4).

S	U	N/A

22. This design calls attention to situations that depart from what the controller would normally expect (5.4.5, 5.4.6, 5.6.2).

S	U	N/A

23. This design provides adequate support for achieving aircraft separation and for detection of potential conflicts (5.5.1).

S	U	N/A

24. The design allows sufficient time for the controller to perceive, integrate, project, and act upon ATC information (5.6.1, 5.6.3, 5.1.5).

S	U	N/A

Notes

25. Workload evaluations have considered both observable and perceived effects of task demand on the controller (8.1.1). S U N/A

26. System demands do not overload or underload the controller for prolonged periods of time (8.1.2, 8.3.3). S U N/A

27. Participants in workload assessments represent the range of experience, skills and abilities that are present in the controller workforce (8.1.3). S U N/A

28. Workload has been assessed with an appropriate battery of measures (8.1.3, 8.3.3). S U N/A

29. This design fosters an active, yet comfortably manageable, role for the controller (8.2.1). S U N/A

30. When tasks are performed together, workload remains manageable with this design (8.3.1). S U N/A

31. This design does not contribute to increased information-processing workload (8.3.2). S U N/A

Notes

32. With this design, the controller is able to maintain the highest standards of safety, without having to exert extreme effort (8.3.4). S U N/A ☐☐☐

33. The design supports the controller in making projections about the near-future traffic situation (8.3.4). S U N/A ☐☐☐

34. This design does not require timesharing of many moderately difficult tasks (8.3.4). S U N/A ☐☐☐

35. When timesharing is necessary, the tasks to be timeshared are spread across the controller's resources, that is, visual, auditory, and manual capacities, instead of loading up on just one or two capacities (8.3.4). S U N/A ☐☐☐

36. When timesharing demands are heavy, this design helps the controller remember to execute intended actions (8.3.4). S U N/A ☐☐☐

37. Procedural task sequences are interruptable at any point (8.3.4). S U N/A ☐☐☐

38. With this design, the controller does not experience abrupt changes in normal task loading (8.3.4). S U N/A ☐☐☐

Notes

39. With this design, timing of tasks can be flexible (8.3.4). S U N/A ☐☐☐

40. When certain tasks must be completed at specific times, their initiation is at the controller's discretion (8.3.4). S U N/A ☐☐☐

41. Use of this design over time will not have a negative effect on job satisfaction (8.3.5). S U N/A ☐☐☐

42. This design will have positive effects on the ways in which ATC team members interact and communicate with each other (8.3.6). S U N/A ☐☐☐

43. This design provides appropriate information to all members of ATC teams (8.3.6). S U N/A ☐☐☐

B. Automation

1. Automated features behave in ways that are consistent with controller expectations (6.3.3). S U N/A ☐☐☐

2. After system recovery from degradation or failure, a smooth return to automated operations will be possible (6.2.1). S U N/A ☐☐☐

Notes

3. Automated features provide explanation of their intentions, recommendations, and actions in ways that are readily understood by controllers (6.3.2).

S	U	N/A

4. With this design, reversion to manual control will be easy; that is, the controller will have no problem stepping in when the automation fails (6.2.1, 6.3.3).

S	U	N/A

5. Increased ATC automation results in better integration of data from multiple sources (6.1.2).

S	U	N/A

6. The limitations of the computer's information and advice are clear to the controller (6.2.1).

S	U	N/A

7. This design provides an active, involved role for the controller (5.3.2, 5.6.2, 6.2.1, 6.3.3).

S	U	N/A

8. This design does not require the controller to perform purely monitoring tasks for more than 20 to 30 minutes at a time (5.3.2, 6.2.1).

S	U	N/A

9. Automated aids are adequately integrated with each other (5.5.1).

S	U	N/A

Notes

	S	U	N/A
10. Decision aids don't need to be monitored continuously (5.6.1).			
11. Decision aids benefit the controller (5.6.1).			
12. This design supports the controller's development of strategies for dealing with short-term (tactical) and long-term (strategic) situations (5.6.2).			
13. Changes in the situation or unusual events are clearly indicated and are not easy to miss (5.6.2).			
14. This design will not induce complacency (6.2.1).			
15. Provisions have been made to help controllers maintain operational skills and efficiency (6.2.1).			

Notes

Notes

V.

DATA ENTRY PROCEDURES

A. General

1. The number of keystrokes (or other control actions) necessary to input data is kept to a minimum and the amount and complexity of data entry is about the same as was required in the previous system (6.2.2).

S	U	N/A

2. With this system, data-entry errors can be caught and corrected before they propagate through the system (6.3.3).

S	U	N/A

3. The design assists the controller in detecting and correcting errors in data entry (5.2.4, 6.3.3, 7.5.3).

S	U	N/A

4. This system makes it easy to recover from data-entry errors (6.3.3, 7.5.3).

S	U	N/A

5. Keystrokes or other data-entry actions are echoed immediately on the screen, that is, there is no delay in providing a legible representation of what has been entered (7.5.3).

S	U	N/A

Notes

6. The data entry method helps to minimize errors and provides for quick, simple data editing and correction (7.5.3).

S	U	N/A

7. This user interface system queries the controller at critical choice points, e.g., "Are you sure you want to delete this flight plan?" (6.3.3).

S	U	N/A

8. A particular data item, such as assigned altitude, must be entered only once; the computer can retain this value and enter it in other fields, as appropriate (7.5.3).

S	U	N/A

9. The controller receives appropriate feedback on data acceptance or rejection (7.5.3).

S	U	N/A

10. The computer does not erase all or part of any erroneous data entry (7.5.3).

S	U	N/A

11. The controller controls the pace of data entry, that is, the computer does not impose time limits or time outs (7.5.3).

S	U	N/A

12. The computer does not restrict the order in which data items are entered (7.5.3).

S	U	N/A

Notes

	S	U	N/A
13. The computer prompts the controller for data that have been deferred for entry (7.5.3).			
14. Data processing is initiated only after an explicit command from the controller (7.5.3).			
15. Boundaries indicate where to enter the data and show maximum field length (7.2.17).			
16. A cursor appears to indicate data-entry mode and location (7.5.3).			
17. The controller can edit all or part of a data field (7.5.3).			
18. The controller is not required to enter leading zeroes for numeric entries (7.5.3).			
19. When delimiters, such as punctuation, are required to partition long entries, the computer provides the required format and prompts for the order of data entry (7.5.3).			
20. Field labels use accepted ATC terminology and are used consistently (7.5.4).			

Notes

B. Commands and Command Execution

		S	U	N/A
1.	Command execution requires minimal controller action (7.5.2).			
2.	The consequences of destructive commands are explained (7.5.2).			
3.	Destructive commands require controller confirmation of intention before they are executed (7.5.2).			
4.	Command execution always occurs by explicit controller action, never as a by-product of another action (7.5.2).			
5.	The controller can suspend/interrupt or cancel/undo a transaction in progress (7.5.3).			
6.	Command ordering is consistent from screen to screen/window to window (7.5.2).			
7.	Command labels use accepted ATC terminology and are used consistently (7.5.4).			

Notes

8. The relevant command set is displayed to show the controller which commands are currently available (7.5.2). S U N/A

9. Commands are consistent in their placement across multiple screens, panels, or windows; in their wording; and in their method of activation (7.5.2). S U N/A

10. The computer indicates the current operational mode (7.5.2). S U N/A

11. Entry of long sequences of command parameters is not required (7.5.2). S U N/A

12. Upper- and lower-case letters are accepted as equivalent when the controller is entering a command or command parameter (7.5.2). S U N/A

13. Feedback is always given to indicate that the computer has initiated a command (7.5.2). S U N/A

14. Commands should be stated in the affirmative; that is, they should tell the controller what to do, rather than what not to do (7.2.15, 5.1.5). S U N/A

Notes

C. Menus[1]

	S	U	N/A
1. Menu options are phrased to reflect the action executed and worded in user vocabulary (7.2.18).			
2. Options that perform opposing actions are not placed adjacent to each other (7.2.18).			
3. The number of menu options is between three and ten (five to six options is optimal) (7.2.18).			
4. If an option, or set of options, is never available to the user, the option(s) is not in the menu (7.2.18).			
5. If an option is temporarily unavailable, it is displayed in the menu, but dimmed (7.2.18).			
6. Menu options are organized in logical or functional groupings with clear titles (7.2.18).			
7. If not in logical groups, order is by frequency of usage, with most frequently used options at the top (7.2.18).			

Notes

1 From User Interface Specifications for the Joint Maritime Command Information Systems, Version 1.3, by Kathleen Fernandes, November 1993.

	S	U	N/A
8. If not in logical groups or by frequency, options are in alphabetical or numerical order (7.2.18).			
9. Less frequently executed options and destructive commands are at the bottom of the menu (7.2.18).			
10. If similar options are in different menus, the options are ordered in a consistent manner (7.2.18).			
11. Each word in the menu is presented in upper and lower case with the first letter capitalized (7.2.18).			
12. Cascading submenus appear to the right of the parent menu (below, if space to the right is limited) (7.2.18).			
13. When a menu is displayed, the location cursor is in the first available option (7.2.18).			
14. When a pop-up menu appears, it appears near the element with which it is associated (7.2.18).			

Notes

15. A window containing a pop-up menu provides an indication that the menu is available (7.2.18). S U N/A ☐☐☐

16. If they are presented in a vertical list, menu options are left justified (7.2.18). S U N/A ☐☐☐

17. Menu organization supports specific controller tasks (7.2.18). S U N/A ☐☐☐

18. Graphical or textual aids are provided to assist controllers in navigating through menu structures (7.2.18). S U N/A ☐☐☐

19. The controller is required to traverse no more than four levels in a menu structure (7.2.18). S U N/A ☐☐☐

20. When a trade-off is required between menu breadth (i.e., number of options at a level) and menu depth (i.e., number of levels), the design increases breadth rather than depth (7.2.18). S U N/A ☐☐☐

D. Error Messages and User Guidance

1. Error messages are provided whenever needed (7.5.5). S U N/A ☐☐☐

Notes

2. Each error message briefly summarizes the specific problem and proposes a specific solution (7.5.5, 7.5.6). S U N/A ☐☐☐

3. Error messages are direct and precise (7.2.14, 7.5.6). S U N/A ☐☐☐

4. Error messages are presented immediately after an error's occurrence (7.5.7). S U N/A ☐☐☐

5. Error messages are not redundant (7.5.6). S U N/A ☐☐☐

6. Guidance messages are presented in mixed upper and lower case (7.5.7). S U N/A ☐☐☐

7. Messages about limits not met or exceeded specify the appropriate range for data entry (7.5.8). S U N/A ☐☐☐

8. Questionable data entries elicit cautionary messages (7.5.8). S U N/A ☐☐☐

9. Feedback regarding processing delays specifies the process, the length of the delay, and completion of the process (7.5.8). S U N/A ☐☐☐

Notes

Notes

VI. DATA ENTRY AND CONTROL DEVICES

A. General

1. Input devices work in ways that are compatible and consistent with the controller's tasks (7.4.1). — S U N/A ☐☐☐

2. The overall design of input devices does not require frequent switching between devices (7.4.2). — S U N/A ☐☐☐

3. The input device(s) is/are appropriate for performing the necessary functions (e.g., alphanumeric data entry; selection of displayed objects; cursor positioning) (7.4.3). — S U N/A ☐☐☐

4. Input devices have been compared not only for speed and accuracy, but also for factors such as induced fatigue, resolution capability, and space requirements (7.4.4). — S U N/A ☐☐☐

5. Controls and their labels are sufficiently visible under dim lighting conditions (9.3.4). — S U N/A ☐☐☐

Notes

B. Keyboards

1. Alphanumeric keys are arranged consistently on all keyboards that the controller will use (7.4.3). (The preferred arrangement is the QWERTY layout.)

S U N/A

2. Keyboards are readable under all operating conditions and backlit, if necessary (7.4.3).

S U N/A

3. If a numeric keypad is provided, it is visually separated from the main keyboard and arranged in a 3 X 3 + 1 matrix (7.4.3).

S U N/A

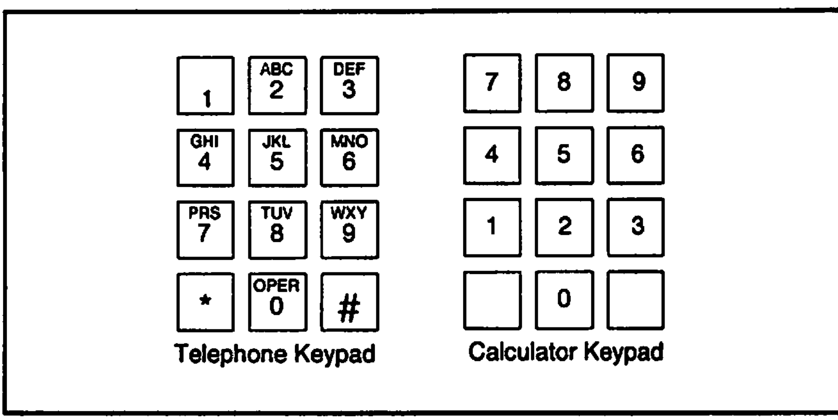


Figure 1. Telephone Keypad and Calculator Keypad Layouts

Notes

4. Function keys are provided for frequently used commands (7.4.3).

S	U	N/A

5. Function keys are clearly labeled to indicate their function (7.4.3).

S	U	N/A

6. The functions invoked by the function keys are consistent throughout the system (7.4.3).

S	U	N/A

7. Keys on keyboards and keypads have no more than two functions (9.2.2).

S	U	N/A

8. Nonactive keys are left blank (i.e., not labeled) (7.4.3).

S	U	N/A

9. The key used to initiate a command is clearly labeled "Enter" (7.4.3).

S	U	N/A

10. Keyed data are displayed quickly (echoed) on the screen (7.4.3).

S	U	N/A

11. Tactile and auditory feedback are provided in response to keystrokes (7.4.3).

S	U	N/A

Notes

12. The main keyboard is located directly in front of and below the associated visual display, at a comfortable distance from the seated controller's position (7.4.3).

S U N/A

13. Forearm and wrist supports are provided (7.4.3).

S U N/A

14. Alphanumeric keys meet standards for dimensions, displacement, separation and resistance (7.4.3).

S U N/A

	DIMENSIONS*	RESISTANCE Numeric	Alpha-numeric	Dual Function
Minimum	10 mm (0.385 in.)	1 N (3.5 oz.)	250 mN (0.9 oz.)	250 mN (0.9 oz.)
Maximum	19 mm (0.75 in.)	4 N (14.0 oz.)	1.5 N (5.3 oz.)	1.5 N (5.3 oz.)
Preferred	13 mm (0.5 in.)			

	DISPLACEMENT Numeric	Alpha-numeric	Dual Function	SEPARATION
Minimum	0.8 mm (0.03 in.)	1.3 mm (0.05 in.)	0.8 mm (0.03 in.)	6.4 mm (0.25 in.)
Maximum	4.8 mm (0.19 in.)	6.3 mm (0.25 in.)	4.8 mm (0.19 in.)	
Preferred				6.4 mm (0.25 in.)

*Refers to dimension D shown below.

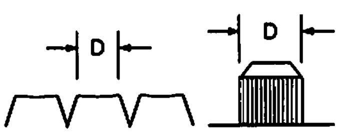


Figure 2. Keyboard Dimensions, Resistance, and Displacement

From *Human Engineering Design Criteria for Military Systems, Equipment and Facilities* by the Department of Defense, 1989, Table X, p. 95

Notes

15. Guards have been considered for any key that would present a problem if inadvertently activated (7.4.3).

S	U	N/A

16. If alternative keyboards are featured, they have been tested for usability and operational suitability (7.4.3).

S	U	N/A

E 17. The slope of the keyboard is adjustable between 15 and 25 degrees from the horizontal (7.4.3).

S	U	N/A

E 18. Keyboard height is adjustable between 23 and 32 inches (7.4.3).

S	U	N/A

C. Touchscreens

1. If a touchscreen is used, it is suitable for the task(s) to be performed by the controller (7.4.3).

S	U	N/A

2. Controllers can achieve sufficient touch accuracy with the touchscreen (7.4.3).

S	U	N/A

3. Touchscreen displays can be read easily under all anticipated lighting conditions (7.4.3).

S	U	N/A

Notes

4. The touch input strategy (e.g., land-on, first contact, or lift-off) is compatible with the controller's task objectives (7.4.3).

S	U	N/A

E 5. Touchscreen displays meet standards for required finger pressure (displacement), separation of touch areas, and resistance (7.4.3).

S	U	N/A

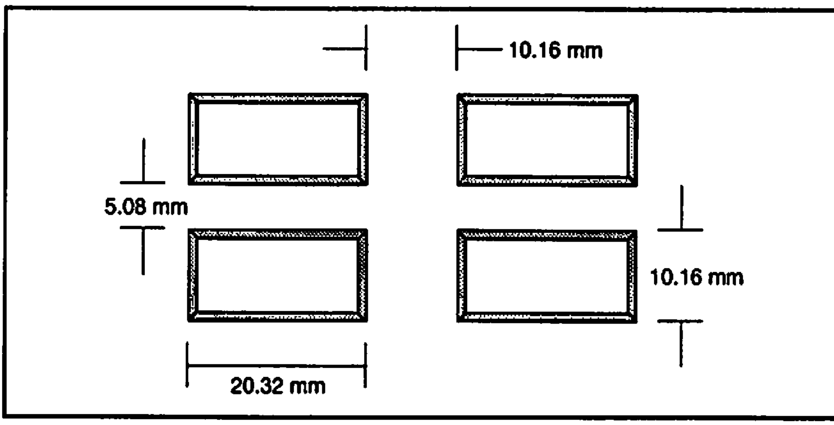


Figure 3. Recommended Dimensions for Size and Separation Between Touch Keys

From a study by R. Beaton and N. Weiman as cited in Human Factors in Engineering and Design (5th edition) by M.S. Sanders and E.J. McCormick, Figure 11-19, p. 361. Copyright by McGraw-Hill. Used by permission.

Notes

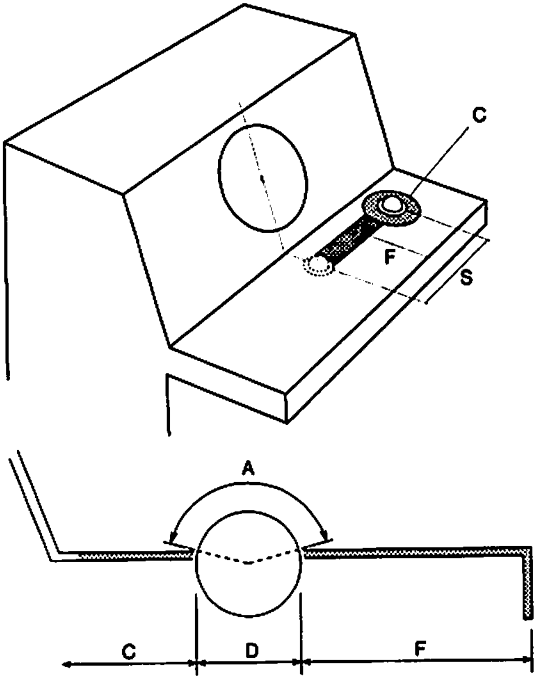
D. Trackballs

1. The trackball can move the cursor in any direction without causing cursor movement in the opposite direction (7.4.3). S U N/A ☐☐☐

2. The trackball allows the controller to move the cursor quickly across relatively large distances and also to precisely position the cursor within a small area (7.4.3). S U N/A ☐☐☐

E 3. The trackball meets standards for physical dimensions, resistance, and clearance (7.4.3). S U N/A ☐☐☐

Notes



	DIMENSIONS		RESISTANCE		CLEARANCE		
	D Diameter	A Surface Exposure	Precision Required	Vibration or Acceleration Conditions	S Display CL to Ball CL	C Around Ball	F Ball to Shelf Front
Min.	50 mm (2")	1745 mrad (100°)			0	50 mm (2")	120 mm (403/4")
Max.	150 mm (6")	2445 mrad (140°)	1.0 N (3.6 oz.)	1.7 N (6 oz.)	320 mm (12-5/8")		250 mm (9-3/4")
Pref'd	100 mm (4")	2095 mrad (120°)	0.3 N (1.1 oz.)				

mm - millimeter
N - Newton
mrad - milliradian

Figure 4. Trackball Design

From *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities* (MIL-STD-1472D), Department of Defense, 1989.

Notes

E. Control Grip Devices

1. Any input device meant to be held and operated by a standing controller can be held comfortably for a period of three to four hours (7.4.3).

S	U	N/A

F. Mice

1. If a mouse is part of the design, it can be used compatibly with all of the tasks the controller is supposed to perform (7.4.3).

S	U	N/A

2. Controllers can easily and smoothly position the cursor with the mouse (7.4.3).

S	U	N/A

3. Movement of the mouse produces cursor movement in the same direction on the display. For example, if the mouse is moved to the left, the cursor moves to the left on the display (7.4.3).

S	U	N/A

4. The mouse is equally usable with the left or right hand (7.4.3).

S	U	N/A

Notes

	S	U	N/A
E 5. The mouse has no sharp edges and meets standards for width (1.6 to 2.8 in.), length (2.8 to 4.7 in.), and thickness (1.0 to 1.6 in.) (7.4.3).			

G. Graphics Tablets

	S	U	N/A
1. Movement of the stylus in any direction on the tablet surface produces smooth movement of the cursor in the same direction (7.4.3).			
2. When the stylus is placed at any point on the tablet, the cursor appears at the associated coordinates on the display screen and maintains that position until the stylus is moved (7.4.3).			
3. If the stylus and tablet are to be used for free-hand drawing, the device generates a continuous line as the stylus is moved (7.4.3).			
4. If a graphics tablet is used, frequent switching to the keyboard is not necessary (7.4.3).			
5. The graphics tablet can be located on the workstation within a comfortable distance from the controller (7.4.3).			

Notes

H. Pushbuttons (Actual and Virtual)

	S	U	N/A
1. Mechanical pushbuttons are sized and spaced to support activation but to prevent accidental activation (7.4.3). (See Figure 5.)			
2. The surfaces of "hard" pushbuttons are rough or concave (7.4.3).			
3. Labeling of virtual pushbuttons is consistent (7.4.3).			
4. The active and inactive states of virtual pushbuttons are visually distinct (7.4.3).			
5. The on-off status of software-generated togglebuttons is made clear through the use of labels and graphic indicators (7.4.3).			
E 6. Mechanical pushbutton resistance and separation are in the ranges recommended for single-finger operations (7.4.3).			

Notes

	DIMENSIONS D		RESISTANCE		
	Fingertip	Thumb or Palm	Single Finger	Different Fingers	Thumb or Palm
Min.	9.5 mm (3/8 in.)	19 mm (3/4 in.)	2.8 N (10 oz.)	1.4 N (5 oz.)	2.8 N (10 oz.)
Max.	25 mm (1 in.)		11 N (40 oz.)	5.6 N (20 oz.)	23 N (80 oz.)

	DISPLACEMENT A	
	Fingertip	Thumb or Palm
Min.	2 mm (5/64 in.)	3 mm (1/8 in.)
Max.	6 mm (1/4 in.)	38 mm (1-1/2 in.)

	SEPARATION S			
	Single Finger	Single Finger Sequential	Different Fingers	Thumb or Palm
Min.	13 mm (1/2 in.)	6 mm (1/4 in.)	6 mm (1/4 in.)	25 mm (1 in.)
Max.	50 mm (2 in.)	13 mm (1/2 in.)	13 mm (1/2 in.)	150 mm (6 in.)

N = Newton

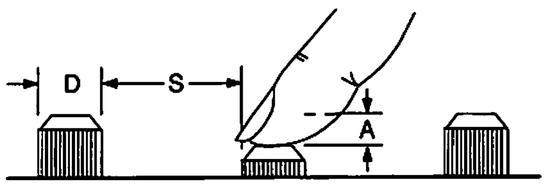


Figure 5. Design Criteria for Mechanical Pushbuttons

From *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities* (MIL-STD-1472D), Department of Defense, 1989, p. 91.

I. Foot Switches and Pedals

1. Positive feedback is provided to indicate activation of the foot switch (7.4.3). S U N/A

2. The controller is not required to operate more than one switch or pedal with the same foot (7.4.3). S U N/A

Notes

3. Foot switches are positioned for operation by the toe or ball of the foot (7.4.3).

S	U	N/A

E 4. Foot switches/pedals meet requirements for dimensions, resistance, and displacement (7.4.3).

S	U	N/A

	DIAMETER (D)	RESISTANCE		DISPLACEMENT (A)		
		Foot Will Not Rest On Control	Foot Will Rest On Control	Normal Operation	Ankle Flexion Only	Total Leg Movement
Min.	13 mm (0.5 in.)	18 N (4 lb.)	45 N (10 lb.)	13 mm (0.5 in.)	25 mm (1 in.)	25 mm (1 in.)
Max.		90 N (20 lb.)	90 N (20 lb.)	65 mm (2.5 in.)	65 mm (2.5 in.)	100 mm (4 in.)

mm - millimeter
N - Newton

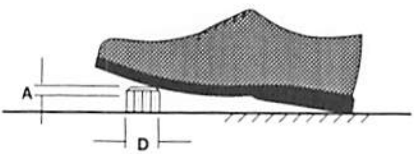


Figure 6. Foot Switch Operations

Adapted from *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities* (MIL-STD-1472D), Department of Defense, Figure 12, p. 93.

Notes

Notes

VII.

ERGONOMICS AND WORKSTATION DESIGN

A. User-Centered Workstation Design

1. Controls are designed and arranged to be consistent with the controller's natural sequence of operational actions (9.3.3).

S	U	N/A

2. Frequently used controls are easy to see and to reach (9.2.2).

S	U	N/A

3. High-priority controls are centrally located and placed as close as possible to the controller (9.3.4).

S	U	N/A

4. Workstation dimensions are adequate for the extremes of the controller workforce (i.e., the 5th to the 95th percentile on applicable dimensions) (9.3.1, 9.4.1).

S	U	N/A

5. Keyboards and workstation controls are consistently backlit if necessary (9.2.2).

S	U	N/A

Notes

		S	U	N/A
6.	Adjacent controls are arranged so that sufficient space is between them to operate them easily and minimize the chances of accidental activation (9.3.3, 9.3.4).			
7.	Controls are spaced far enough apart that they can be easily grasped and manipulated (9.3.4).			
8.	Workstation controls are sufficiently visible to the controller while seated and standing (9.3.3).			
9.	Controls are equally accessible and usable by left- and right-handed controllers (9.3.3).			
10.	Controls can be reached without excessive shoulder movement or back bending/stretching (9.3.3, 9.3.4).			
11.	Controls used in sequence are located close to each other (9.3.3).			
12.	Controls used to adjust visual displays are located near the display set (9.3.3).			

Notes

13. The workstation provides sufficient space for three-person teams (9.3.2). S U N/A ☐☐☐

14. The workstation design concept considers the operational needs of the particular ATC environment for which it is intended (ATCT, TRACON, ARTCC) (9.3.2). S U N/A ☐☐☐

15. Workstations are arranged and spaced to allow ready access by Airway Facilities personnel (9.3.2). S U N/A ☐☐☐

16. It is easy to open or remove equipment covers on racks (9.3.2). S U N/A ☐☐☐

17. Easy access is provided to workstation components (9.3.2). S U N/A ☐☐☐

18. Mirror-image layouts are avoided within and across ATC facilities (9.3.3). S U N/A ☐☐☐

19. The needs of individual facilities have been considered in determining space requirements (9.3.3). S U N/A ☐☐☐

Notes

		S	U	N/A
3.	There are no noticeable squeal problems or echo effects (9.5.1).			
4.	Listeners can differentiate between multiple channels fed into headphones (9.5.2).			
5.	Communication is unaffected by delays due to satellite transmission (9.5.2).			
6.	The speaker is not distracted by his/her own side tone (9.5.2).			
7.	Headset design helps to maximize intelligibility (9.5.2).			
8.	No bare metal parts of the headset come into contact with the controller's skin (9.5.4).			
9.	Controllers who wear glasses can comfortably wear headphones or other communication equipment (9.5.4).			
10.	Hands-free operation of communication equipment is possible under normal working conditions (9.5.4).			

Notes

11. Telephone handsets are readily accessible (9.5.4). S U N/A ☐☐☐

12. For multiple telephone handsets, the most frequently used or the most urgently needed handset is the most readily accessible (9.5.4). S U N/A ☐☐☐

13. Volume/gain controls are separate from on-off controls (9.5.5). S U N/A ☐☐☐

14. Volume/gain controls are limited to an audible level (9.5.5). S U N/A ☐☐☐

15. Squelch control is provided to suppress channel noise during inactive periods (9.5.5). S U N/A ☐☐☐

16. The controller can manually deactivate the squelch control (9.5.5). S U N/A ☐☐☐

17. Foot pedals are provided as alternatives to hand-activated microphone switches (9.5.5). S U N/A ☐☐☐

E 18. Appropriate provision has been made for the calibration of microphones and headphones (9.5.1). S U N/A ☐☐☐

Notes

		S	U	N/A
E	19. The location of the foot pedal's fulcrum, placement of the foot pedal in relation to other controls, and placement of the foot pedal in relation to the seated controller are satisfactory (9.5.5).			
E	20. System-input devices are designed for optimal response to the range of frequencies between 200 and 6,100 Hz (9.5.1).			
E	21. Across the frequency response bandwidth, amplitude variation is at or below plus or minus 3 dB (9.5.1).			
E	22. Microphones used with amplifiers have a dynamic range that permits them to pick up variations of at least 50 dB in signal input (9.5.1).			
E	23. Appropriate techniques are used to minimize the effects of noise during speech transmission (9.5.1).			

Notes

E 24. If intelligibility testing is conducted, scores are at or above the following cutoff points for the various testing methods (ANSI phonetically balanced (PB) - 90%; Modified Rhyme Test - 97%; Articulation Index - 0.7) (9.5.2).

S	U	N/A

E 25. When two earphones are in use, sound pressure level can be increased to at least 100 dB overall (9.5.5).

S	U	N/A

D. Environmental Design

1. Ambient lighting of the workstation is adequate (9.6.1).

S	U	N/A

2. The controller can easily recognize all key labels on the keyboard, electronic display keypads, and trackball (9.6.1).

S	U	N/A

3. Lighting at the console shelf is adequate for reading and writing (9.6.1).

S	U	N/A

4. Under the proposed lighting conditions, the controller can readily locate switches, controls, headset jacks, connectors, handles, and display recess mechanisms (9.6.1).

S	U	N/A

Notes

	S	U	N/A
5. Control labels are readable (9.6.1).			
6. The controller is not distracted by shadows, glare, or reflections (9.6.1, 9.6.2).			
7. Adequate display contrast is maintained for textual and graphic information (9.6.1).			
8. Lighting is adequate for emergency and maintenance purposes (9.6.1).			
9. Maintenance lighting does not interfere with controller tasks at the ATC console (9.6.1).			
10. Design of the work environment limits sources of distraction (5.2.4).			
E 11. The brightest area in the workplace is no more than three times brighter than the darkest area (9.6.1).			
E 12. Ambient noise is at or below 65 dB (9.6.4).			
E 13. Provisions have been made to reduce ambient noise caused by vibration (9.6.4).			

Notes

VIII.

HUMAN FACTORS PLANNING AND EVALUATION

A. Human Factors Plan

1. Responsibilities for who will develop and control the human factors work are specifically designated (2.3.1). S U N/A ☐☐☐

2. Methods for coordinating human factors concerns and considerations among integrated product team members and contractor personnel are established (2.3.1). S U N/A ☐☐☐

3. The processes and procedures for how the government will direct, control, and monitor the human factors efforts are described (2.3.1, 2.4.1, 2.5.1). S U N/A ☐☐☐

4. The operators and maintainers of the system are described in the plan (2.3.1). S U N/A ☐☐☐

5. The user functions/tasks are described in detail (2.3.1). S U N/A ☐☐☐

Notes

6. The system objectives for personnel resources, training, workload, ergonomics, and safety are identified (2.4.1). S U N/A ☐☐☐

7. Key design goals are operationally defined (i.e., described in terms of how they will be measured and evaluated) (2.3.1). S U N/A ☐☐☐

8. Parameters to be used as criteria against which the system will be evaluated are identified (2.3.1, 2.4.1). S U N/A ☐☐☐

9. The tasks and analyses that need to be conducted to support the definition and evaluation of system performance requirements are specified (2.4.1). S U N/A ☐☐☐

10. The system constraints on personnel resources, training, ergonomics, and safety are described (2.5.1) S U N/A ☐☐☐

11. Critical known issues and work to be done to address system performance requirements are identified (2.4.1, 2.5.1). S U N/A ☐☐☐

Notes

12. Critical "unknowns" are listed (to be answered/assessed as more information becomes available) (2.3.1, 2.5.1).

S	U	N/A

13. A feasible schedule is proposed for accomplishing the human factors work (2.5.1).

S	U	N/A

B. Test Methods

1. The proposed method of testing is appropriate (10.4.1).

S	U	N/A

2. If field observations are used, they are obtained under conditions that are representative of the full scope of actual operations (10.4.1).

S	U	N/A

Notes