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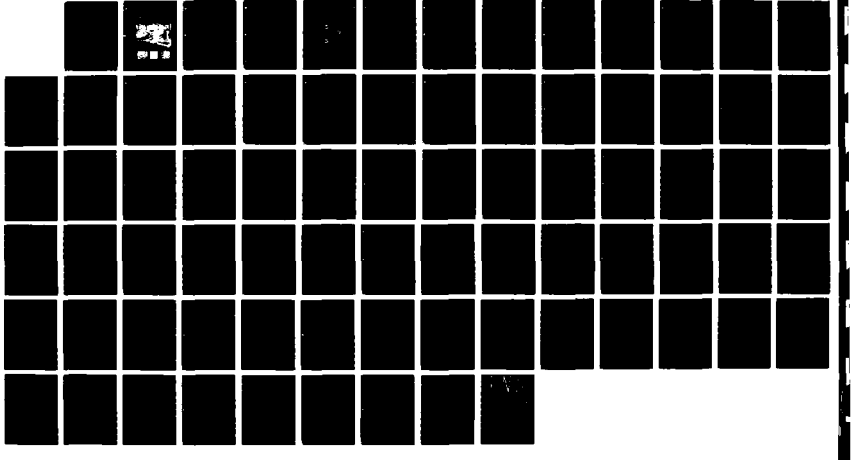

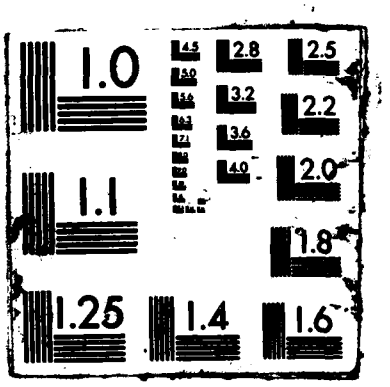
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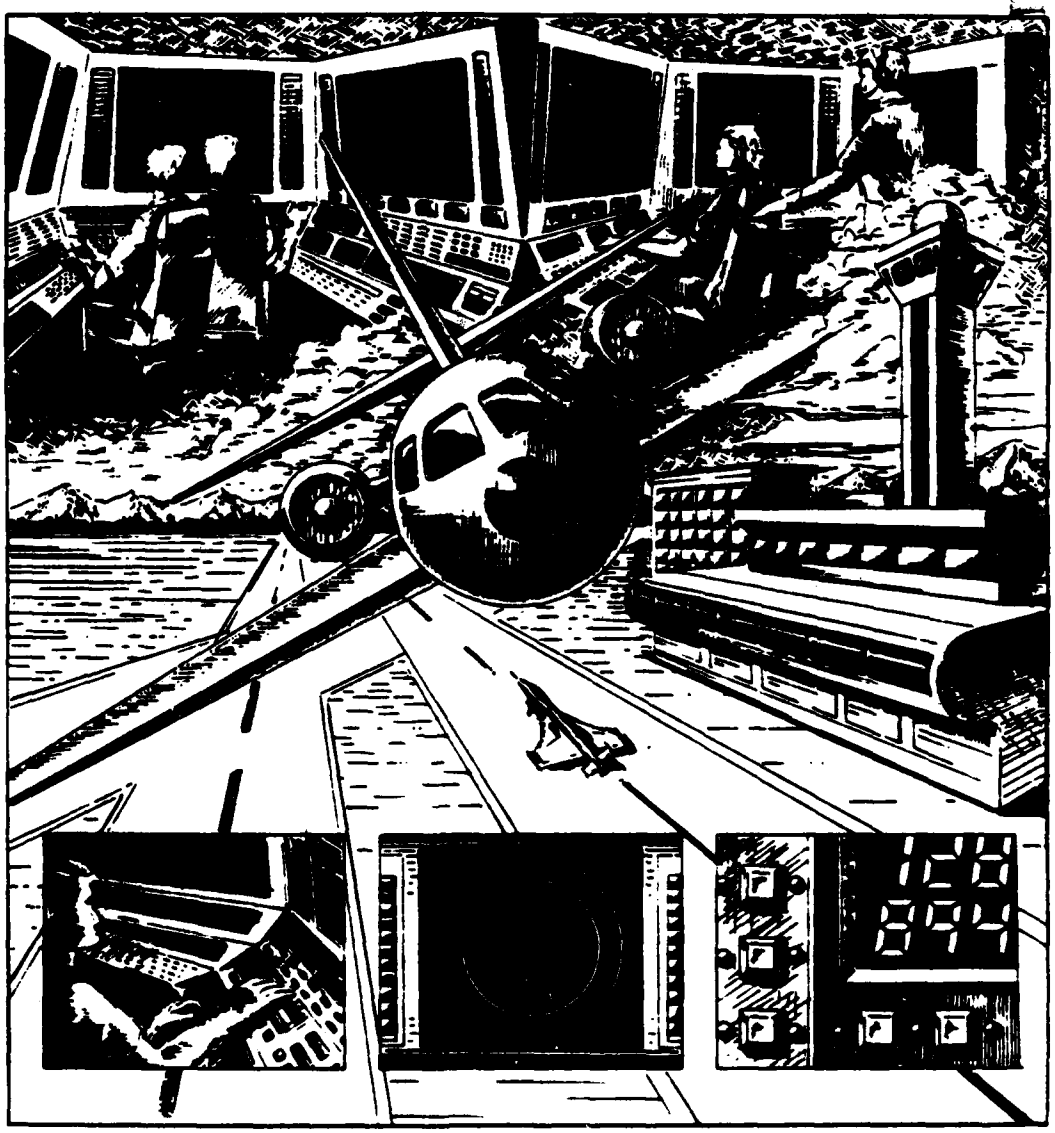
U.S. Department of Transportation
Federal Aviation Administration

Draft Sector Suite Console Requirements Specification

DOT/FAA/AP-84/17



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16. Abstract

The "Draft Sector Suite Console Requirements Specification" itemizes the physical and performance characteristics of the AAS Sector Suite. The purpose of this document is to provide specifications that will ensure that the Sector Suite will accommodate the anthropometric and psychophysical attributes of the controller population. Functional capabilities are specified which support the controller-machine interface.

Included topics in this specification are: definition of the SS workstation, input device requirements, output device requirements, physical characteristics, and environmental considerations. As such, these requirements address the operational controller-machine interface of the Sector Suite.

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Air Traffic Control, Anthropometry, Common Console, Controller-Machine Interface, Display Device, Sector Suite, Workstation

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FOREWORD

The "Draft Sector Suite Console Requirements Specification" is fifth in a series of seven Computer Technology Associates, Inc. contractual deliverables which will define the role of Sector Suite and the controller-machine interface (MMI) within the Advanced Automation System (AAS).

Figure i-1 illustrates the relationship between this document and the documents which define Sector Suite Man/Machine Functional Capabilities (CDRL A005), and the Operations Concept for the AAS Man/Machine Interface (CDRL A002). Together, these three documents form the core requirements for the AAS controller-machine interface (CDRL A019). Excerpts from "Sector Suite Man-Machine Functional Capabilities and Performance Requirements" and "Draft Sector Suite Console Requirements Specification", together with the proposed changes to the AAS System Specification comprise the "DCP MMI/Sector Suite Requirements Submittal Package" (CDRL A019). These documents will be provided to the Prime Contractors at the time of Design Competition Phase (DCP) Award in 1984. As such, these documents contain requirements for the Prime Contractor designs of Sector Suite hardware and software.

"En Route/Terminal ATC Operations Concept" (CDRL A001) documents current operations and as such defines the range of events which will influence operations in the Area Control Facility (ACF). "Sector Suite Functional Analysis and Trade Studies" (CDRL A004) provides a functional analysis of operational requirements, documents trade studies which recommend functional levels of controller vs. machine automation, and allocates and derives the functional requirements for the Sector Suite MMI. Sector Suite MMI subactivities identified in CDRL A004 form the basis for the analyses described in the "Operations Concept for the AAS Man/Machine Interface" (CDRL A002). Critical output of CDRL A002 includes a thorough controller task analysis. This task analysis provides the basis for development of the conceptual model of controller-machine interaction presented in CDRL A005, "Sector Suite Functional Capabilities and Performance Requirements". This report contains the functional capabilities, performance requirements, and user interface language requirements for the Sector Suite Subsystem. The "Draft Sector Suite Console Requirements Specification" (CDRL A003) is based upon the analysis presented in CDRL A005.

The "Analysis of Controller Requirements for the Initial Sector Suite Man/Machine Interface" (CDRL A006) represents an analysis of the draft specifications of the Initial Sector Suite System Man/Machine Interface (MMI) and is embodied in CDRL A019. CDRL A008 provides a definition of recommended user review and validation activities to be conducted during the Design Competition Phase (DCP).

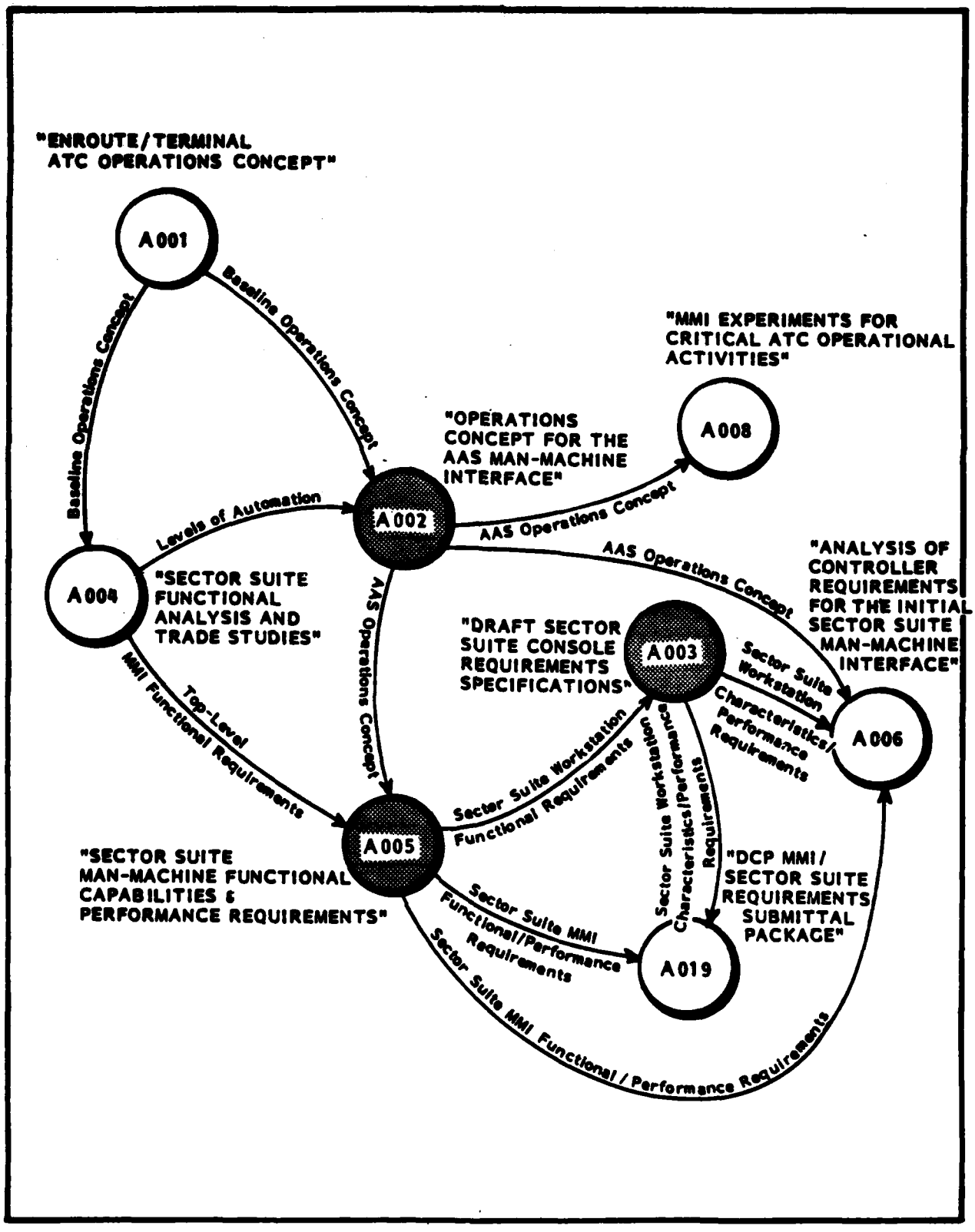

Figure i-1 Relationship of Documents

ACKNOWLEDGEMENTS

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Richard Banks	Denver ATCT
Rod Bourne	AAP-100
Richard Chavez	Albuquerque ARTCC
Carlisle Cook	Miami ARTCC
Ralph Cooper	AAT-100
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Max Hall	Salt Lake ARTCC
Don Fowler	Ontario TRACON
Thomas Lane	Anchorage ARTCC
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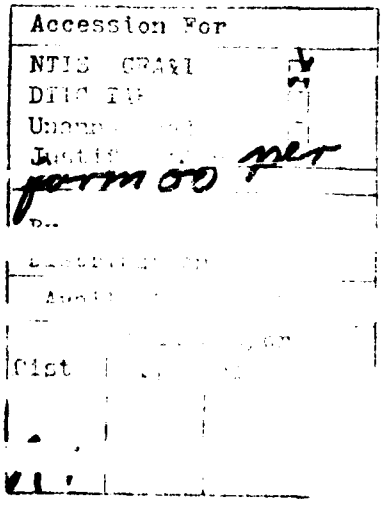
Marvin Perkins	Jacksonville ARTCC
Ralph Procaccini	Kansas City ARTCC
Courtney Sargent	AAT-100
Terry Schomburg	MIRAMAR TRACON
James Sheely	Charlotte ATCT
Del Weathers	AAP-100
Richard Wheaton	AGL-510
John White	Indianapolis ARTCC
John Williams	Portland ATCT
Ian Wolf	AEA-510
Andres Zellweger	AAP-100



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LIST OF ACRONYMS

ACRONYM	DEFINITION
AAS	Advanced Automation System
ACCC	Area Control Computer Complex
ACF	Area Control Facility
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
CPSD	Cursor Positioning/Selection Device
CRT	Cathode Ray Tube
CWP	Central Weather Processor
MMI	Man-Machine Interface
MPS	Maintenance Processing System
NADIN	National Data Interchange Network
NOTAMS	Notice to Airmen
RMMS	Remote Maintenance Monitoring System
VSCS	Voice Switching and Control System

1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 PURPOSE

The "Draft Sector Suite Console Requirements Specification" itemizes the physical, and performance characteristics of the AAS Sector Suite. Input and display device requirements, and console physical characteristics are specified. Area Control Facility (ACF) operational environment factors directly impacting the Sector Suite (e.g., illumination, noise) are also covered. The primary purpose of providing these specifications is to ensure that the Sector Suite optimally accommodates the anthropometric and psychophysical attributes of the controller population and provides the functional capabilities necessary to support the controller-machine interface described in CDRL A005, Sector Suite Man/Machine Functional Capabilities and Performance Requirements. A secondary purpose is to express baseline controller expectations concerning the operational environment of Sector Suite.

1.2 SCOPE

Requirements specified herein are derived from three primary sources:

A. Attachment M-2 to RFP DTFA01-83-R-21135, Advanced Automation System-System Level Specification, April 1983;

B. Operations Concept for the Advanced Automation System Man/Machine Interface, CDRL A002;

C. Sector Suite Man/Machine Functional Capabilities and Performance Requirements, CDRL A005.

Requirements are primarily intended to augment, rather than to replace, those stated in the System Level Specification.

Requirements have been derived with respect to the operational controller-machine interface characteristics of the AAS. As such, this document does not treat many of the areas which fall under the headings of 'integrated logistic support', 'product assurance' or 'reliability/maintainability/availability', commonly covered in a hardware requirements specification. These topics are only covered to the extent that they directly impact the AAS operational controller-machine interface. Specification of the essential set of Sector Suite workstation functional capabilities is contained in CDRL A005, Sector Suite Man/Machine Functional Capabilities and Performance Requirements.

Sector Suite console requirements specified herein are considered as minimum capabilities and do not exclude any Prime Contractor augmentation or capacity enhancements in their designs. Further, in no case should any requirement, textually or graphically depicted, be construed to recommend any particular

Sector Suite design. It is recognized that many potential designs are possible which meet the intent and performance of these requirements.

1.3 OBJECTIVES

This document is structured to fulfill the following objectives:

A. To specify input device functional and performance requirements which minimize controller workload and provide necessary speed and accuracy;

B. To specify visual display requirements which ensure that visual image quality and physical display size are appropriate for AAS controller task demands;

C. To explicitly define Common Console physical characteristics in terms of anthropometrics and biomechanical capabilities; and

D. To specify environmental variables and their expected values which directly impact the AAS controller MMI. These variables include: illumination, ambient noise, ventilation and smoke dissipation.

1.4 APPLICABLE DOCUMENTS

1.4.1 Standards and Specifications

DOCUMENT	TITLE
ANSI/IEEE Standard 344-1975 (Reaffirmed)	IEEE Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations
AT&T Bulletin 326-130, Pub 51001 Issue 2, March 1981	New Equipment-Building System (NEBS) General Equipment Requirements, March 1981
CTA CDRL A002	Operations Concept for the Advanced Automation System Man-Machine Interface
CTA CDRL A005	Sector Suite Man/Machine Functional Capabilities and Performance Requirements
FAA-ER-130-005D	Advanced Automation System, System Level Specification (April 1983)
FAA-G-2100	Electronic Equipment, General Requirements

DOCUMENT	TITLE
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-1472C	Human Engineering Design Criteria for Military Systems Equipment and Facilities
MTR 1669	Evaluation Procedures for a Cathode-Ray-Tube Display Designed for the NAS En Route System (March 1971)

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2.0 DEFINITION OF THE SECTOR SUITE WORKSTATION

2.0 DEFINITION OF THE SECTOR SUITE WORKSTATION

2.1 FUNCTIONAL DESCRIPTION

The Sector Suite workstation provides data entry and display capabilities for controllers, supervisors, meteorologists and metering/flow control personnel. This includes requirements for console hardware and related data processing for display/auditory device output management, interaction device input management, resource management and error detection and recovery. The Sector Suite workstation is the sole vehicle whereby the controller interfaces with the AAS.

The Sector Suite workstation is comprised of one to four Common Consoles. Common Consoles are physically identical. Primary components of the Common Console are a main display, a voice switching and control system panel (VSCS), an optional interactive entry and display device, an optional auxiliary display and support electronics. Additionally, each console shall be capable of accepting a keyboard, and a cursor positioning/selection device (CPSD). It shall be possible to configure Sector Suites so that any or all entry functions may be accomplished with any or all eligible entry devices within the Sector Suite.

The design and construction of each Common Console shall be sufficiently flexible to support in-line, semi-circular, or cluster configurations. The ability to readily reconfigure from an in-line Sector Suite using two or more controllers to a wrap-around Sector Suite using one controller (and vice versa) shall be built into the design. This reconfiguration may occur many times a day with changes in traffic loads, resectorization, staffing, and training.

2.2 INTERFACE DESCRIPTION

Data processing support for the Area Control Facility (ACF) will reside in some combination of the Area Control Computer Complex (ACCC) and its resident Sector Suites. The ACCC subsystems and interfacing systems which directly affect Sector Suite operations are the following:

- Maintenance Processing System (MPS) - Within each ACF is a co-located Maintenance Processor Subsystem (MPS). Each MPS, as part of the FAA's Remote Maintenance Monitoring System (RMMS), will be positioned in a central location for equipment performance monitoring, certification, and control of remotely located FAA facilities in a given geographic area. The ACF shall send system status, performance, and alarm messages to the MPS on a periodic basis. The MPS will send messages to the ACF requesting that system data be transmitted to the MPS. MPSs will be interconnected to the ACCC and each other in a nationwide network via NADIN.

- Central Weather Processor (CWP) - The Advanced Automation System shall be linked by local communications to obtain digital weather data and weather products and to provide PIREPs collected by the ACF Controllers. Three types of messages flow from the AAS to the CWP:

    1) requests for products and services,

    2) PIREPs collected by the sector, and

    3) temporary adaptation list changes.

  In addition to automatically disseminated data, the AAS may send request and reply messages to the CWP for any data not normally stored by the AAS. Temporary additions to the standard list of required weather data may be requested by the AAS.

- Voice Switching and Control Systems (VSCS) - The ACF Sector Suites include the integrated use of the Voice Switching and Control System. The VSCS is the primary means for establishing communications in the NAS Air Traffic Control System. Air traffic control communications consist of ground-to-ground links among ATC personnel in the same facility and in different facilities and ground-to-air links between air traffic controllers and pilots. The VSCS system can select, connect, and automatically reconfigure ground-to-ground and ground-to-air circuits as needed to meet operational, maintenance, and communication support requirements.

  Data exchanged between the AAS and the VSCS will permit control of the voice communications system configuration in response to changes in the ACF configuration. These changes will be made as a result of AAS inputs by supervisory personnel. The AAS shall provide to VSCS the data on the configurations themselves, commands to establish a given configuration, and inquiries about configurations and current system status. The VSCS will provide appropriate status and response information to the ACF.

  Another interface will be provided which permits VSCS to accept and display indirect access channel selection from appropriate Sector Suite input devices.

- National Automated Data Interchange Network (NADIN) - NADIN will be a national data communication network which will serve the various ACF computer complexes and equipment. NADIN will consist of a packet-switched network with sophisticated message routing and interface capabilities to enable transmission over one

of several paths and interoperability with a number of different networks. NADIN will control and route messages on the network through two or more national switches. NADIN concentrators co-located at selected ACF's will interface to all ACF's and provide access and interface to the network. It will add the appropriate communication information, format messages received from the ACF, and control the transmission of the messages to the destination facility/equipment.

- Mode S - The Mode S is an improved radar beacon system that is an evolutionary replacement for the existing surveillance systems. Mode S will also provide for a two-way data link between appropriately equipped aircraft and the ACF. Mode S and the ACF shall communicate via two interfaces, one for the transmission of surveillance and status data and the second interface for messages including data and requests for data over the air/ground data link.

- Airport Traffic Control Tower (ATCT) and Other Terminal Facilities - Tower facilities require the collection and display of data for direct use in controlling air traffic and monitoring status and control of various equipment, systems, and facilities. Routinely, each weather sensor, navigational aid, communications aid, and lighting aid was installed with its own monitor/control and display system. The ATCT computer system shall provide interfaces with these airport equipments in order to collect, process, and consolidate the display of information required by the air traffic controller and to provide a number of control features. The system shall also transmit the collected information to its ACF for display at Sector Suite control positions.

2.3 CONCEPTS FOR WORKSTATION OPERATION

The National Airspace System plan calls for the consolidation of en-route and terminal operations into the ACF. Common computers and Sector Suites shall be employed to control all sectors of airspace within an ACF's control.

The Advanced Automation System will have computer processing divided between common processing equipment and the individual Sector Suites. In a typical Sector Suite, multiple displays will provide a plan view of the air traffic and weather situation, alphanumeric flight and weather data, and other aeronautical information such as notices to airmen (NOTAMS), and traffic planning data (including the ability to probe the system for conflict-free, fuel-efficient flight paths). Sector Suite processing and the failsoft and emergency modes of the AAS will ensure that the required surveillance, flight data, and weather information are available at each controller position as required.

Increased operational flexibility will be achieved since the number of Controller operating positions can be reconfigured to meet changing demand based on day-to-day or hour-to-hour workload requirements. When traffic decreases, Sector Suites and associated communications can be configured into larger geographic sectors; and the total number of operating positions and associated staffing will be reduced.

Sector Suites can vary in size from one to four common consoles to respond to the operational requirements of a given sector of airspace. These operational requirements vary considerably within an ACF as a function of sector size, geometry and traffic as well as type of control position (e.g., en-route, radar approach, non-radar approach or oceanic). This freedom of configuration is enabled by the modularity and commonality of the Common Console Sector Suite building blocks and their ability to support in-line, semi-circular, cluster and other physical configurations as required.

3.0 INPUT DEVICE REQUIREMENTS

3.0 INPUT DEVICE REQUIREMENTS

3.1 KEYBOARD

3.1.1 Functional Characteristics

The keyboard shall accommodate right or left hand operations. It shall be easily removable for maintenance or replacement. The layout shall be QWERTY. A tab key shall be provided if needed to support the contractor's controller-machine dialog (e.g., to support "form filling dialogs). Special symbols shall be placed on dedicated keys. Sufficient fixed function keys shall be located on the keyboard, with function names (or abbreviations) permanently marked on the respective key tops, to support commonly invoked functions (e.g., CONFIRM, SCROLL). The number of these fixed function keys shall be adequate to support the contractor's man/machine dialog design. Keys shall be provided to permit momentary and lock shift. Keyboard layout shall minimize inadvertent activation or substitution errors of commonly used keys (e.g., "enter", "delete").

Cursor control keys shall be included in the keyboard. These dedicated keys shall control cursor movement up, down, left, right one character or symbol space per discrete keystroke. The cursor symbol displayed for the keyboard cursor shall be distinct from the cursor symbol displayed by the cursor positioning/selection device.

A dedicated number pad shall also be included in the keyboard. This number pad shall follow the telephone style layout but may include additional keys to accomplish "ENTER, TAB, SPACE, BACKSPACE" etc.

The keyboard shall be sealed against contamination from environmental dust, moisture, and liquid spills. Mean life of each keyswitch shall be not less than 3 X 10^7 actuations.

3.1.2 Human Engineering

3.1.2.1 Keyboard Thickness

Thickness of the keyboard is defined as the distance between the top of the work surface and the top of the home row of keys. If the keyboard is operated from a position on top of the work surface, this thickness shall be held to a minimum, i.e., less than 50mm is acceptable and 30mm is preferred.

3.1.2.2 Keyboard Slope

The slope of the keyboard shall be within the range of 15 degrees to 25 degrees. Ideally, this slope should be incrementally adjustable (either through tilt of the keyboard itself, or tilt of the Common Console shelf).

3.1.2.3 Palm Rest

The keyboard shall provide at least a 50mm deep space to rest the palms of the hands.

3.1.2.4 Key Characteristics

The following requirements address the individual keys on the keyboard:

A. Force for key activation shall be between 0.25 and 1.5N.

B. Key travel shall be between 0.8mm and 4.8mm.

C. Key activation shall be accompanied by a tactile "click". This feedback may be augmented optionally by an operator selectable auditory "click". A visual indication that any locking key (e.g., caps lock) is locked shall be provided.

D. Key tops shall be shaped to aid proper finger location, minimize reflections, and provide a suitable surface for legends. Keytop size shall be between 12-15mm square, with intercenter spacing of 18-20mm.

E. N-key roll-over shall be provided, such that regardless of the number of keys depressed near simultaneously, the keyboard is able to store all the keystrokes and generate characters in their correct sequence.

F. Automatic character repeat (repetitive operation when key is held down) shall be provided for cursor control, space bar and alphanumeric keys at a rate exceeding 10 characters per second, following a 0.5 to 0.75 second pause from initial key depression.

3.2 CURSOR POSITIONING/SELECTION DEVICE (CPSD)

3.2.1 Functional Characteristics

A random cursor positioning/selection device (CPSD) shall be provided as part of the common console. This device shall provide for left or right hand operation.

The CPSD must be able to support the controller-machine dialog as defined by Sector Suite Man/Machine Functional Capabilities and Performance Requirements, CDRL A005. Specifically, the CPSD must be able to support the classes of controller task elements defined in Table 3-1. Primary capabilities required to support the task elements listed in Table 3-1 are the ability to position the cursor over, point to select, or indicate any object on the main display, the ability to explicitly enter commands, function selections, locations, geometric parameters (for translation, scaling, drawing, etc.) and object selections.

TABLE 3-1

CONTROLLER TASK ELEMENT ACTIONS SUPPORTED BY THE CPSD

TASK ELEMENT VERB	DEFINITION
NAME	Give title to or attach label to for purposes of identification.
GROUP	Link together or associate for purposes of collective reference.
INTRODUCE	Originate or enter new data into the system.
AGGREGATE	Combine two or more components so as to form a new composite entity.
OVERLAY	Superimpose one entity on top of another so as to effect a composite appearance--while still retaining the separability of each component layer.
COPY	Reproduce one or more duplicates of an entity (no links to "master").
INSTANCE	Reproduce an original ("master") entity in such a way(s) to retain a strong definitional link to the master--i.e., such that any subsequent changes or modifications made to the master will automatically be reflected in each and every "instance" created therefrom.
INSERT	Make space for and place an entity at a selected location within the bounds of another such that the latter wholly encompasses the former, and the former becomes an integral component of the latter.
SELECT	Opt for or choose an entity (e.g., position or object) by pointing to it.
REFERENCE	Opt for or choose an entity by invoking its name.
DELETE	Remove and (irrevocably) destroy a designated portion of an entity.
CUT	Remove a designated portion of an entity and place it in a special purpose buffer.
SET-ASIDE	Remove entire contents of current (active) work area and store in a readily accessable buffer (for future recall).

TABLE 3-1 (Continued)

TASK ELEMENT VERB	DEFINITION
SUSPEND	Stop a process and temporarily hold in abeyance for future restoration.
TERMINATE	Conclude a process--such that it cannot be restarted from the point of interruption, except by complete reinitiation.
SUPPRESS	Conceal or keep back certain aspects or products of a process without affecting the process itself (appearance only).
RENAME	Change an entity's title or label without changing the entity itself.
UN-GROUP	Eliminate the common bond or reference linkage of a group of entities.
SEGREGATE	Partition and separate an entity into one or more component parts such that the structure and identity of the original is lost.
FILTER	Selectively eliminate one or more layer(s) of an overlayed composite.
TRANSFORM	Manipulate or change one or more of an entity's attributes (e.g., color, line type, character font, size, shape, orientation) without changing the essential content of the entity itself.
EXECUTE	Initiate or activate any of a set of predefined utility or special purpose functions (e.g., sort, merge, calculate, update, extract, search, replace).

Depending on the contractor's controller-machine dialog design, the capability may also be required to permit command selection via sketch recognition of simple patterns drawn on the main display with the CPSD.

The CPSD shall be capable of supporting cursor wraparound on the main display. If more than one cursor is being displayed on a single physical display, then the cursor symbols shall be uniquely identifiable.

3.2.2 Human Engineering

The CPSD shall allow the selection of every addressable point on the main display. Positioning of the cursor from one point to another on the main display using the CPSD shall not take more than 0.5 seconds for each 30cm of travel in any direction. The dynamic and physical characteristics of the CPSD shall comply with applicable paragraphs of MIL-STD-1472C.

3.3 INTERACTIVE ENTRY AND DISPLAY DEVICE

3.3.1 Functional Characteristics

The Common Console shall include an interactive entry and display capability that shall provide for controller interaction with the AAS. This capability may be provided in the form of a separate physical device or may be functionally integrated into the main display. Areas of the interactive display shall be used to initiate, compose, and verify messages for input to the system or to display computer-generated messages.

If the interactive entry and display device is implemented as a separate physical device, the area and shape of the viewing surface are left up to the system designer. The placement of the device shall comply with the reach envelopes specified in section 4.12. The device (if implemented separately from the main display) shall accommodate both left and right hand operators. The display surface shall be flat or shall be a section of a sphere with a radius greater than 60 inches.

3.3.2 Human Engineering

The following requirements apply if the interactive entry and display device is implemented as a physically separate touch entry and display device.

A. The entry and display device shall be capable of being activated by a human finger which falls within the size range defined by the anthropometrics of the 5th percentile female through the 95th percentile male. The area in which an object is selectable should be as large as possible, including at least the size of the displayed object plus one-half a character's distance all around the object.

B. The touch entry and display device shall produce no optical distortion of the display surface.

C. Horizontal and vertical resolution and accuracy shall be sufficient to insure that the touch position reported by the device is within 1/16 inch of the actual touch position center for all touchable areas of the display. The touch center is the center of a rectangle enclosing the touch area and tangent to that area on all four sides. Characters displayed on the device shall be formed in at least a 7x9 matrix (if dot matrix characters are used).

D. Symbol height shall be greater than or equal to Ø.12 inches.

E. Simultaneous multiple inputs (i.e., touching two points simultaneously) shall produce no more than one output message.

F. The entry and display device shall be immune to (i.e., not disturbed by):

1. Optical noise from fluorescent or incandescent lighting, and display light output.

2. Electrical noise of the display, fluorescent lamp transients, or other nearby equipment.

3. Audible noise in the vicinity (loud voices, equipment noise, etc.).

4. Sudden changes in temperature or pressure within the operating area (including a force of air directed across the surface).

5. Smoke or liquid spills.

G. Visual feedback capability shall be provided to verify touch position message output. The form of feedback is dependent on the display technology but could, for example, be reverse video, underlining, or steady brightness change, and shall provide for adapted horizontal and vertical offset from the reported touch point. This feedback shall be functionally consistent with the rest of the controller-machine dialog provided by the prime contractor.

H. The device shall be capable of reporting 1Ø touches per second, continuously.

I. At least three brightness levels shall be selectable by the operator: full, half full, and quarter full. The device shall be capable of the same brightness and contrast ratios as specified for the main display. If brightness codes are used (per F above) they shall be relative to the selected overall brightness level of the device.

3.4 OTHER INPUT DEVICES

The prime contractors may require input devices other than those specified above, to enable their controller-machine dialog design. If included, these devices (e.g., a valuator for altitude entries), shall conform to the functional and performance requirements indicated by the task elements they are designed to support as listed in Sector Suite Man/Machine Functional Capabilities and Performance Requirements CDRL A005. The physical and operating characteristics of these other input devices shall conform to applicable sections of MIL-STD-1472C. If speech recognition devices are used, their characteristics (continuous vs. discrete recognition) and vocabulary shall be carefully chosen through operational and human factors analyses. Performance requirements for speech recognition devices shall conform to MIL-STD 1472C, section 5.3.

4.0 OUTPUT DEVICE REQUIREMENTS

4.0 OUTPUT DEVICE REQUIREMENTS

4.1 FUNCTIONAL REQUIREMENTS

4.1.1 Main Display Equipment Functional Requirements

The Common Console main display shall provide symbol generation, graphics, and shading capabilities.

A. Symbol Generation--The main display shall provide the capability to display at least the symbols shown in Figure 4-1. The symbol set shall be easily changeable to any other set. The Console shall also provide the capability to independently modulate the brightness of each displayed symbol at a system-selected rate.

B. Graphics--The main display shall provide the capability to draw lines, circles, and arcs in five different linestyles:

1. A series of dots
2. A series of short dashes
3. A series of long dashes
4. A continuous line, circle, or arc
5. A series of dots and dashes

Selection of the linestyle to be used in drawing individual lines, circles, and arcs shall be under software control.

C. Shading--The main display shall provide the capability to present selective background shading in multiple levels. Provision shall be made to prevent background shading from interfering with the readability of symbols, lines, circles, or arcs superimposed on the shaded areas.

D. Brightness Levels--The main display shall present data in at least three individually adjustable brightness levels. Selection of the brightness level for each class of data shall be under program control.

4.1.2 Auxiliary Display

If necessary to meet capacity and performance requirements for displayed data, the AAS shall provide the capability to equip Common Consoles with an integrated Auxiliary Display. Selection of the information to be presented on the Auxiliary Display shall be accomplished by the controller using Common Console input devices.

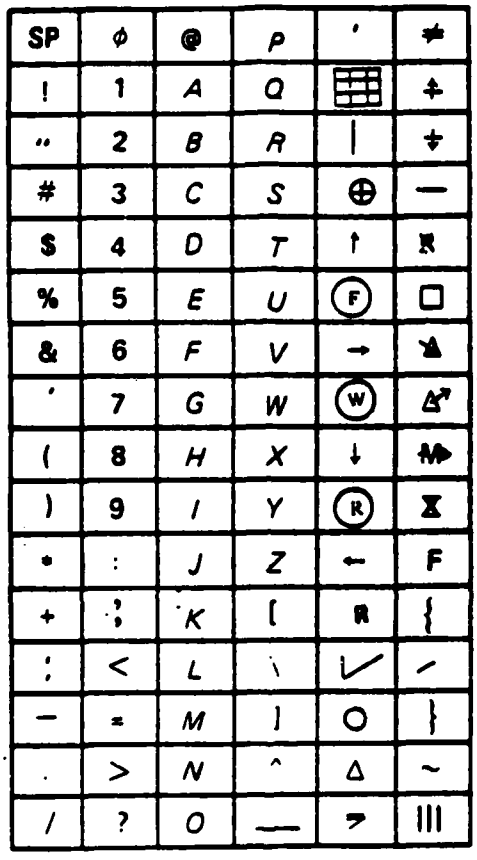


FIGURE 4-1 SYMBOL SET

4.2 PERFORMANCE CHARACTERISTICS

4.2.1 Accuracy

4.2.1.1 Common Console Main Display

The Common Console main display requirements are stated for Symbol Generation, Graphics, Shading, Brightness, Contrast, Specular Reflectance, Data Positioning and Color.

A. Symbol Generation

1. Symbol Set--The Common Console display(s) symbol set shall be changeable to any set containing up to 250 symbols.

2. Symbol Size--Symbol size is the vertical distance between the extreme upper and lower extensions of the symbol. Font size is the height of the alphanumeric symbols.

   The display shall be capable of simultaneous presentation of three font sizes. Each symbol shall be displayed in the font size selected. The size of each of the three program-selectable fonts shall be chosen by the operator from the following set of nominal sizes: 0.1 to 0.28 inch, in steps no greater than 0.02 inch. The actual font size shall be nominal $\pm$ 0.01 inch. Size variation between every two characters of a font shall not exceed 0.01 inch for characters within every 2-inch circle on the display surface.

   Size variation between every two characters of a font size shall not exceed 10 percent of character height over the entire display surface.

3. Symbol Width--This width is the distance between the extreme left and right displayed extensions of the symbol.

   Width of alphanumeric symbols (other than I and 1) shall be between two-thirds and three-fourths of symbol height.

   Width of special symbol matrix blocks shall equal symbol height.

4. Symbol Spacing--Horizontal spacing between successive symbols in a row shall be maintenance adjustable from zero percent to at least 25 percent of symbol nominal height. This control may be continuous or in steps of not more than 0.010 inch.

Vertical spacing between successive rows shall be adjustable by simple maintenance control from zero percent to at least 50 percent of symbol nominal height. This control may be continuous or in steps of not more than 0.010 inch.

Actual maximum spacing between symbols for each symbol size shall not exceed the minimum spacing by more than 10 percent for characters within a 2-inch circle at every point on the display surface.

5. Symbol Segment Closure--Relative to an ideal font, gaps within a symbol shall not exist. Any overwrite shall be minimized and shall be limited to a line width.

6. Baseline Variation--The base of each symbol in a 2-inch horizontal symbol sequence located at any position on the usable display surface shall not deviate by more than 0.005 inch from the base of the adjacent symbols and shall not deviate by more than 0.02 inch from a straight line through the base of the first and last symbol where the first and last symbols are alphanumerics.

7. Line Width--Maximum line width shall not exceed 0.025 inch at the 50 percent brightness points. The maximum line width of every symbol and every line segment of every size at any position on the usable display surface shall not be greater than twice the minimum line width of the same or every other symbol and every line segment of every size at every other position on the usable display surface.

8. Distortion--No point on any symbol of any size shall deviate from the ideal font by more than 3 percent of the symbol height.

9. Brightness Modulation--The Common Console shall provide the capability to time modulate the brightness of each displayed symbol independent of every other displayed symbol at every one of the following four approximate rates:

   (a) 720 cycles/min (flutter) 4:1 on/off ratio
   (b) 60 cycles/min (blink) 1:1 on/off ratio
   (c) 60 cycles/min (wink) 19:1 on/off ratio
   (d) maintenance adjustable 1:9 to 9:1 on/off ratio
       30-120 cycles/min

B. Graphics

The performance requirements for the generation of straight lines, circles and arcs shall be as follows:

1. Lines, Circles, and Arcs--The portion of a straight line between any two points on the display coordinate plane shall be displayable in the active display area. The portion of the following circles or arcs which is in the active display area shall be displayed:

   (a) A circle with center and radius in the display coordinate plane.

   (b) An arc with center, start point, and stop point in the display coordinate plane.

2. Line Width--Line width of all straight lines, circles, and arcs shall not exceed at any point: (1) 0.025 inch when measured at the 50 percent brightness points, and (2) 0.060 inch when measured at the 10 percent brightness points. The ratio of maximum to minimum line width shall not exceed 2:1 (50 percent point measurement).

   Segmented Lines, Circles, and Arcs--Each line, circle, and arc, independent of every other line, circle, and arc, shall be displayed in one of the following patterns when selected:

   (a) Dot (dashes under 0.031 inch long) at 0.062 ± 0.010 inch intervals.

   (b) Dashes of length 0.125 ± 0.010 with spacing of 0.062 ± 0.010 inch.

   (c) Dashes of length 0.375 ± 0.020 inch with spacing of 0.062 ± 0.010 inch.

   (d) Continuous

   (e) A series of alternate dots (a) and dashes (b) or (c).

4. Distortion and Positioning Error--No point on a displayed straight line, circle, or arc shall deviate from a true straight line, circle, or arc, having the same definitive points, by more than 0.015 inch. True straight lines, arcs, or circles are those which could be drawn on the data display surface (if accessible) with ordinary mechanical drafting tools using the same coordinates supplied to the display.

C. Shading

At least three easily differentated shading levels shall be provided: Levels 1, 2, and 3. Level 1 brightness shall be at least double the brightness of the background with 25 fc incident on the display face. Level 2 shall be at least double the brightness of level 1 and level 3 shall be at least double the brightness of level 2.

The shading level of each element of a 1/4-inch or smaller grid on the display surface shall be individually program controlled. Brightness variation within an element shall not exceed a 2:1 ratio. The average brightness of shading elements of each level shall vary no more than 10 percent over the entire display surface.

Provision shall be made to prevent background shading and color from interfering with the readability of symbols and lines super-imposed on the shaded areas.

D. Brightness

The main display shall provide the capability to present data in three discriminable simultaneously displayed brightness levels. The overall brightness of the display shall be continuously adjustable by the operator. The allowable range of such adjustments shall not preclude the discriminability of the three data brightness levels. The full data load shall be displayed at a full brightness of 30 footlamberts (fl) or more at the end of display surface life while meeting all other specified requirements. Brightness shall be measured using the techniques of MTR-1669, Revision 1.

Display surface life is the life used in reliability and maintainability calculations. Brightness variations with respect to display surface location or with respect to time are possible display defects. In either case, the variation is defined in percent as:

$$\frac{(B_{max} - B_{min}) \times 100}{B_{max}}$$

The brightness variation with respect to display surface location shall not exceed the following:

1. Twenty percent intrasymbol and intraline over the entire usable display surface.

2. Twenty percent intersymbol and interline within a 3-inch diameter circle over the entire usable display.

Time cycle brightness variations (flicker) at all locations on the display surface shall not be detectable by 99 percent or more of the general population.

Brightness of data discontinued from a particular display position shall decline to 10 percent or less of the brightness prior to discontinuance within 100 milliseconds of the discontinuance.

E. Contrast

Contrast Ratio is defined as:

$$\frac{Bd}{Bb}$$

where

Bd is the brightness of a symbol element or a line at the specified 30 foot lamberts full brightness. Bb is the background brightness measured 0.125 inch immediately adjacent to the specimen symbol in an unexcited area. The incident light falling on the display shall be from a room ambient of 25 foot candles.

Contrast ratio shall be a minimum of 8.

F. Data Positioning

The display surface shall be addressable (both horizontally and vertically) in increments of not more than 0.01 inch average. Physical display surface increments shall not vary from the address increment by more than 0.001 inch at any point on the display surface.

The absolute displayed location of a data item addressed to a single point anywhere on the display surface shall not vary by more than all of the following:

1. 0.004 inch/second
2. 0.010 inch/minute
3. 0.025 inch/hour
4. 0.05 inch/day
5. 0.1 inch/month

G. Color--If color capabilities are not initially provided, the capability shall be included within the Sector Suite to retrofit the monochrome displays with color displays with a minimum of hardware and software changes. The color displays shall be capable of displaying a minimum of four colors.

4.2.1.2 Auxiliary Display

The Auxiliary Display is optional equipment in the Sector Suite. The need for an Auxiliary Display may be established in human factors and design analyses done by the contractors. This display will be required if not enough display surface is available on the Common Console Main Display to present the required data. If an Auxiliary Display is used, each Common Console shall be capable of operating with or without it. A Sector Suite shall have one Auxiliary Display per Common Console if Auxiliary Displays are used.

If any Auxiliary Display is used, only the following logical displays shall be presentable on it: Static Information Display, System Status Display, Airport Environmental Data Display and Weather Display. Selection of the information to be presented on the Auxiliary Display shall be accomplished by the controller using Common Console input devices. The Sector Suite Auxiliary Display shall meet the performance characteristics specified below:

A. Symbol Generation

The performance for the Auxiliary Display's symbol generation capability shall be the same as specified for the Common Console Main Display (4.2.1.1-A) except for the following:

1. Nominal symbol sizes shall range from .15 to .35 inch, in steps no greater than .Ø3 inch.

2. Maximum line width shall not exceed .Ø3Ø inch at the 5Ø percent brightness points.

3. Brightness modulation requirement shall not apply.

B. Graphics

The performance for the Auxiliary Display's graphic capability shall be the same as specified for the Common Console Main Display (4.2.1.1.-B) except for the following:

1. Line width shall not exceed Ø.Ø3Ø inch when measured at the 5Ø percent brightness points.

2. The ratio of the maximum to minimum line width shall not exceed 2.5:1.

C. Shading

The Auxiliary Display shall provide at least six easily differentiated shading levels. The shading level of each element of a Ø.1 inch or smaller grid on the display surface shall be individually program

controlled. Provision shall be made to prevent shading from interfering with the readability of symbols and lines superimposed on shaded areas.

D. Brightness

The Auxiliary Display shall meet the brightness requirements specified for the Common console Main Display (4.2.1.1-D) except for the following:

1. The full brightness level shall be 20 footlamberts (fl) or more.

E. Contrast Ratio

Auxiliary Display shall meet the contrast ratio requirements specified for the Common console Main Display (4.2.1.1-E).

F. Data Positioning

The Auxiliary Display shall meet the positioning performance requirements specified for the Common Console Main Display (4.2.1.1-F).

G. Color

If the Auxiliary Display is included as a separate physical device it shall be capable of displaying at least four colors.

4.2.1.3 Interactive Data Entry and Display Device

If an interactive entry and display device is used, then the common console shall be capable of displaying one 0.12 inch high symbol per each 0.06 square inch of usable display area. If dot matrix characters are used, they shall be formed of at least a 7 x 9 matrix. The symbols displayed shall be those of Figure 4-1.

4.3 WORKLOAD/RESPONSE

4.3.1 ACCC

Display capacity requirements are addressed in this paragraph first for a complete Sector Suite and then separately for the individual display surfaces. The quantities of data specified below shall be displayed while meeting the requirements of paragraph 4.2.

The display capacity requirements are specified in Table 4-1 for each of the ACCC logical displays defined in CDRL A005. The ACCC shall be able to display all logical displays assigned to a control position as specified in CDRL A002, Operations Concept for the AAS MMI, simultaneously. These logical displays include both the ones to be displayed at all times and the ones to be

displayed upon controller request. The ACCC shall be capable of displaying each logical display with all display items presented simultaneously in at least the quantities in Table 4-1. The ACCC shall be capable of displaying the quantity of each individual item as specified in Table 4-1A at each control position. For items in the Situation Display, the quantities of lines and alphanumerics of other items in the display can be suitably reduced. For the Flight Data Display more than one physical device can be used to meet the total displayable alphanumerics specified in Table 4-1A and the oceanic control positions in Table 4-1.

4.3.1.1 Main Display

The Main Display of the Common Console shall be able to display Load A and alternatively Load B. This requirement shall be met with data (except shading) at full brightness.

Load A characterizes a tabular display and is defined as follows: With the display surface divided into at least 14,800 blocks 0.125 inch wide by 0.215 inch high, 8000 of these blocks randomly distributed shall be written with symbols approximately 0.12 inch wide by 0.15 inch high. The symbols shall be selected randomly from the total symbol set in such manner that 10 percent of the symbols displayed are special symbols and the remainder are alphanumerics.

Load B characterizes a Situation Display and is defined as follows: Single symbols, randomly selected from the total symbol set, shall be written in 1800 random positions on the display surface. Symbol size shall be 0.12 inch wide by 0.12 inch high. In addition, 500 lines shall be written with random starting point over the entire display surface, random orientation, length 1/2 inch to 20 inches and average length 3 inches. The entire usable display surface shall be checkerboard shaded as depicted in Figure 4-2.

4.3.1.2 Auxiliary Display

If an Auxiliary Display is provided in the Sector Suite, it shall accommodate the following loads, alternatively.

A. The same as Load A of the Main Display with the number of displayed symbols reduced to 2000.

B. Single symbols, randomly selected from the total symbol set, shall be written at 500 random positions on the display surface. Symbol size shall be 0.15 inch wide by 0.20 inch high. In addition, 500 lines shall be written with random starting points over the entire display surface, random orientations, length 0.25 inch to 10 inches, and average length 1.5 inches.

C. The entire usable display surface shall be checkerboard shaded as depicted in Figure 4-3. In addition, 100 alphanumerics shall be randomly positioned on the display with a symbol size of 0.15 inch by 0.20 inch and 100 lines shall be written with random starting points over the entire display surface, randomly orientated with, length 0.25 inch to 10 inches, and average length 1.5 inches.

4.3.1.3 Interactive Data Entry and Display Device

If the Interactive Data Entry and Display Device is implemented as a part of the Main Display, the Main Display shall meet the requirements of both the Main Display load and the Interactive Data Entry and Display Device simultaneously. Main Display load A may be suitably reduced to accommodate the Interactive Data Entry and Display Device requirements.

4.4 DISPLAY DEVICE PHYSICAL CHARACTERISTICS

The display device physical characteristics are specified in the following paragraphs.

4.4.1 ACCC Display Device Physical Characteristics

The physical characteristics of the display devices shall include a viewing screen specular reflectance which is not to exceed 0.2 average for all light incident from normal to ± 20 degrees. The surface of each display which will be physically touchable by the display user is the exterior display surface. This surface shall tolerate the acids and oils associated with skin contact without substantial degradation of display surface life, transmissivity, or anti-reflectivity. This surface shall also be able to be cleaned frequently (several times a day) without damage. Physical characteristics related to the individual display types are specified in the following paragraphs.

4.4.1.1 Main Display

The surface of the display on which the user's eyes focus is the viewing surface. The usable area of the main display viewing surface shall be 20" by 20" square. The usable viewing surface shall be flat or shall be a section of a sphere with a radius greater than or equal to 135 inches.

4.4.1.2 Auxiliary Display

If an Auxiliary Display is used in the Sector Suite, the usable area of the Auxiliary Display viewing surface shall be sufficient to have inscribed within it a rectangle (square corners) no less than 160 square inches in area. The inscribed rectangle shall have sides with a width to height ratio not greater than 4:3.

Table 4-1 MINIMUM LOGICAL DISPLAY DATA CAPACITY

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Situation Display		
Map Lines	300	Lines (average 2 inches)
	100	Lines (average 12 inches)
Map Symbols	75	Single Symbols
Tracked Targets	305	Single Symbols
Untracked Targets	60	Single Symbols
Target Histories	915	Single Symbols
Limited Data Blocks and Leader	40	10 Alphanumerics each (avg)
	40	Lines
Full Data Blocks and Leader	45	21 Alphanumerics each (avg)
	45	Lines
Velocity Vector	45	Lines
Strobe Lines	20	Lines
	18	Single Symbols
Weather Areas	32	Shaded Areas one-half display area
Conflict Resolution and MSAW Vectors	5	Lines
Time (hours, minutes, seconds, day)	12	Numerics
Route Display	40	Lines
Range Rings	10	Circles

* The total alphanumerics or alphanumerics per item stated in this table shall be the number of usable character positions available. The number of actual displayed characters will probably be less.

Table 4-1 MINIMUM LOGICAL DISPLAY DATA CAPACITY (Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Flight Data Display		
Flight Data Entries En Route or Approach Control Position	50 **	14,800 Alphanumerics Total
Oceanic Control Position	100 **	29,600 Alphanumerics Total
Flight Data Readout	2 ***	600 Alphanumerics Total (Parts Paged or Scrolled)
A&M Data Display		
A&M Data Entries	20	1000 Alphanumerics Total
Alert and Resolution Display	1	300 Alphanumercis Total
Special Lists		
Departure List Entries	15	20 Alphanumerics each entry
Inbound List Entries	15	20 Alphanumerics each entry
Hold List Entries	30	20 Alphanumerics each entry
Group Suppression List Entries	3	100 Alphanumerics Total
VFR Inhibit List Entries	10	30 Alphanumerics Total
Beacon Code List Entries	55	300 Alphanumerics Total
Auto Handoff Inhibit List Entries	5	25 Alphanumerics Total

** The size of the logical display shall be at least the size expressed in the remarks. Paging can be used to meet the quantity requirement.

*** The items shall be capable of being paged or scrolled when items exceed the number of characters specified in the remarks.

Table 4-1 MINIMUM LOGICAL DISPLAY DATA CAPACITY (Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY		REMARKS
Coast/Suspend Tracking List Entries	30		20 Alphanumerics each entry
Metering Advisory List Entries	30		30 Alphanumerics each entry
Emergency Airport List Entries	1		100 Alphanumerics Total
Message Composition and Response Display			
Preview Area	1	***	125 Alphanumerics Total
Menu Area	1		300 Alphanumerics Total
Response Area	1	***	100 Alphanumerics Total
Airport Environmental Data Display			
Data Entries	30	**	500 Alphanumerics Total
System Status Display	50	**	1000 Alphanumerics Total
Flow Control Situation Display			
Same as Situation Display			
Oceanic Situation Display			
Same as Situation Display Except:			
Full Data Block and Leader	100		32 Alphanumerics each entry (max) 15 Alphanumerics each entry (avg)
Metering Position Display			
Metering Entries	100		5000 Alphanumerics Total
Sector Workload Display			
Sector Entries	20	**	400 Alphanumerics Total

Table 4-1 MINIMUM LOGICAL DISPLAY DATA CAPACITY (Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Flow Control Flight Data Display		
Flight Data Entries	100 **	10,000 Alphanumeric Total
Static Information Display		
Graphic Entry	500	Lines
	50	200 Alphanumerics Total
Tabular Entry	2	1000 Alphanumerics Total
Weather Display	32	Shaded Areas Entire Logical Display Surface
	100	Single Symbols
	100	Lines

TABLE 4-1A MINIMUM LOGICAL DISPLAY INDIVIDUAL ITEM DATA CAPACITY

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Situation Display		
Map Lines	400 150	Lines (average 2 inches) Lines (average 12 inches)
Map Symbols	125	Single Symbols
Tracked Targets	450	Single Symbols
Untracked Targets	128	Single Symbols
Target Histories	2250	Single Symbols
Limited Data Blocks and Leader	125 125	10 Alphanumerics Lines
Full Data Blocks and Leader	90 90	32 Alphanumerics Lines
Velocity Vector	90	Lines
Strobe Lines	40 36	Lines Single Symbols
Weather Areas	100	Shaded Areas Total Display Surface
Conflict Resolution and MSAW Vectors	25	Lines
Time	20	Numerics
Route Display	100	Lines
Range Rings	20	Circles

* The total alphanumerics or alphanumerics per item stated in this table shall be the number of usable character positions available. The number of actual displayed characters will probably be less.

TABLE 4-1A MINIMUM LOGICAL DISPLAY INDIVIDUAL ITEM DATA CAPACITY (Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Flight Data Display		
Flight Data Entries En Route or Approach Control Sectors	100 **	29,600 Alphanumerics Total
Oceanic Control Sectors	150 **	44,400 Alphanumerics Total
Flight Data Readout	2 ***	600 Alphanumerics Total (Parts Paged or Scrolled)
A&M Data Display		
A&M Data Entries	20	3000 Alphanumerics Total
Alert and Resolution Display	1	500 Alphanumerics Total
Special Lists		
Departure List Entries	30	40 Alphanumerics each entry
Inbound List Entries	30	40 Alphanumerics each entry
Hold List Entries	30	40 Alphanumerics each entry
Group Suppression List Entries	3	300 Alphanumerics Total
VFR Inhibit List Entries	20	100 Alphanumerics Total
Beacon Code List Entries	100	500 Alphanumerics Total
Auto Handoff Inhibit List Entries	30	100 Alphanumerics Total

** The size of the logical display shall be at least the size expressed in the remarks. Paging can be used to meet the quantity requirement.

*** The items shall be capable of being paged or scrolled when items exceed the number of characters specified in the remarks.

TABLE 4-1A MINIMUM LOGICAL DISPLAY INDIVIDUAL ITEM DATA CAPACITY
(Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY		REMARKS
Coast/Suspend Tracking List Entries	50		40 Alphanumerics each entry
Metering Advisory List Entries	50		50 Alphanumerics each entry
Emergency Airport List Entries	3		200 Alphanumerics Total
Message Composition and Response Display			
Preview Area	1	***	125 Alphanumerics Total
Menu Area	1		500 Alphanumerics Total
Response Area	1	***	200 Alphanumerics Total
Airport Environmental Data Display			
Data Entries	30	**	500 Alphanumerics Total
System Status Display	50	**	1000 Alphanumerics Total
Flow Control Situation Display			
Same as Situation Display			
Oceanic Situation Display			
Same as Situation Display Except:			
Full Data Block and Leader	150		32 Alphanumerics each entry
Metering Position Display			
Metering Entries	150		7500 Alphanumerics Total

TABLE 4-1A MINIMUM LOGICAL DISPLAY INDIVIDUAL ITEM DATA CAPACITY (Continued)

DISPLAY ITEM	QUANTITY/LOGICAL DISPLAY	REMARKS
Sector Workload Display		
Sector Entries	40 **	1000 Alphanumerics Total
Flow Control Flight Data Display		
Flight Data Entries	150 **	10,000 Alphanumerics Total
Static Information Display		
Graphic Entry	1000	Lines
	50	500 Alphanumerics Total
Tabular Entry	2	2000 Alphanumerics Total
Weather Display	64	Shaded Areas Entire Logical Display Surface
	200	Single Symbols
	200	Lines

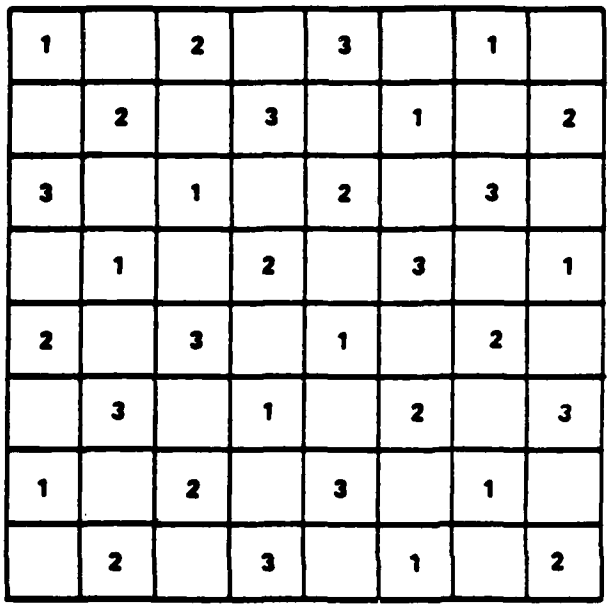


FIGURE 4-2 CHECKERBOARD SHADING FOR SITUATION DISPLAY, LOAD B

1	4	2	5	3	6	1	4
5	2	6	3	4	1	5	2
3	6	1	4	2	5	3	6
4	1	5	2	6	3	4	1
2	5	3	6	1	4	2	5
6	3	4	1	5	2	6	3
1	4	2	5	3	6	1	4
5	2	6	3	4	1	5	2

NUMBERS DESIGNATE SHADING LEVEL

FIGURE 4-3 CHECKERBOARD SHADING FOR AUXILIARY DISPLAY

4.5 AUDITORY OUTPUT

The requirements for interoperator communications, audible message transmission and receipt, audible alarms and speech synthesis (if provided) fall into the category of audible output. Audible output shall comply with section 5.3 of MIL-STD-1472C.

4.5.1 Audio Warning Signals

Caution alarms (indicating awareness) shall be readily distinguishable from warning alarms (indicating immediate action is required) if provided. Since audible alarms will be used in conjunction with a visual display, the audible alarm shall be supplementary to information coordinated on the visual display.

The frequency range of audible alarms shall be between 200 and 5000 Hz and preferably between 500 and 3000 Hz. The chosen frequency shall be readily discriminable from other spurious background signals (e.g., equipment vibration). The signal to noise ratio of the alarm should be at least 20 dB(A) in one octave band at the operator's position. Signal intensity should be great enough to gain the attention of the operator but should not be so great as to cause discomfort, ringing in the ears or to preclude appropriate responses.

In order to provide several levels of criticality, the use of discriminable characteristics of intensity, pitch, rhythm or harmonics shall be used. The maximum number of such coded dimensions shall be four. A "fast reaction" or highly critical signal shall be discriminable from all other audio signals within 0.5 seconds from onset.

4.5.2 Speech Synthesis Devices

If synthesized speech output devices are used, their speech characteristics (discrete vs. continuous output) and vocabulary shall be carefully chosen through operational and human factors analyses. The functional requirements of such devices shall conform to the task elements they are designed to support as listed in CDRL A005, Sector Suite Man/Machine Functional Capabilities and Performance Requirements. Performance capabilities shall conform to section 5.3.12.1 a of MIL-STD-1472C requirements for exceptionally high intelligibility.

5.0 PHYSICAL CHARACTERISTICS

5.0 PHYSICAL CHARACTERISTICS

5.1 COMMON CONSOLE HUMAN ENGINEERING

The AAS shall have human factors engineering design criteria and principles incorporated into the design of all equipment to achieve reliable, effective, and safe performance by personnel responsible for operation, maintenance, and control of the equipment. Particular emphasis shall be placed on assuring that human errors in operation, maintenance, and control of the equipment do not degrade system availability or performance. The design shall consider the use of ruggedized consoles to withstand accidental harsh treatment by operators. Equipment design shall be such as to minimize personnel skill requirements and training time and shall address the change in human roles with the introduction of automatic communications and automated decision making. Particular attention shall be given, but not limited, to the following general man/machine interface requirements.

A. Keys, pushbuttons, and other manual control devices shall be such that the potential for error in their use is minimized. The controls shall be easily reached from the specialist's normal operating position. The interactive display shall be located so that it can be reached without inducing operator fatigue. The placement of controls shall allow controllers to operate the Sector Suites without interfering with one another for each control position specified in CDRL A002, Operations Concept for the Advanced Automation System Man/Machine Interface. Exact placement shall be determined with regard to control function and required speed and frequency of access and sequencing of related activities.

B. Labels and indicators shall be readable from the normal operating position of specialists with normal and corrected vision (including bifocals). Light intensity of indicators shall be variable through a range ensuring readability under all conditions of brightness which will exist in the work area.

C. Data displays shall be sized and located to ensure the readability of the alphanumerics and graphics, without obstructions, from the normal operating position of specialists with normal and corrected vision. Brightness and contrast shall be adjustable through a range ensuring readability under all light conditions in the work areas, and reflectance and susceptibility of the display face to smudging shall be kept to the lowest level within the existing state-of-the-art. Movability of display surfaces to minimize light reflectance problems shall also be considered.

D. Equipments shall be designed such that they can be maintained in a safe, reliable, and efficient manner. Maintainability design factors including standardization, accessibility, handling, and mounting provisions shall be considered in the AAS design.

Additionally, the Sector Suite workstations shall conform to the physical characteristics described in sections 5.2 - 5.13.

5.2 LOADING AND WEIGHT LIMITATIONS

The loading conditions of each completed equipment cabinet and each Sector Suite for the ACCC shall not exceed 125 pounds per square foot. No removable component (including the display surface unit) shall weigh more than 50 pounds, unless system design provides mechanical devices for all necessary handling.

5.3 DIMENSIONAL LIMITATIONS

The maximum size of any individual crate or package entering a building which will contain an ACCC shall not exceed external dimensions that allow for ease of transportability through the building from the equipment delivery point to its final location. (See FAA standard drawings E5896). The minimum clearance en route to the control room floor and the computer equipment location is 71 inches wide by 80 inches high.

A Sector Suite comprising three Common Consoles and its associated chair roll space and rear maintenance area shall fit into an area of (TBD) square feet.

5.4 ACCESS FOR MAINTENANCE

The Common Console and Auxiliary Display shall be designed so that each module can be removed from the console by one technician. Removal and replacement of each module shall require no more than 5 minutes, excluding the display surface. When each module is in its rear maintenance position, all line replacement items (LRI) and test points shall be accessible. Modules shall remain physically stable when in their maintenance position. A transportable frame or cart shall be provided for maintenance and transport of ACCC equipment modules to and from a maintenance area at the building. Maintenance cabling to each module shall allow for complete hookup behind the Sector Suite so that all maintenance (including maintenance requiring viewing of the display) can be performed.

All equipment, including electronic equipment modules not housed within the Common Console of a Sector Suite but remotely located in the equipment room, shall be configured and located so that maintenance can be performed on the LRI and access is provided to all test points.

All newly developed equipment shall meet the design and maintainability requirements of MIL-STD-1472C unless otherwise specified. The accessability requirements of FAA-G-2100C shall be met for newly developed equipment.

5.5 HEALTH AND SAFETY CRITERIA

The ACCC equipment shall be designed to reflect applicable system and personnel health and safety factors, including minimization of potential human error in the operation and maintenance of the system, particularly under heavy workload, stressful conditions. Specific requirements for cathode ray tube (CRT) implosion protection (if CRTs are used), x-ray emission, and structural stability are provided in the following paragraphs.

5.5.1 Implosion Protection

If a direct-view CRT is used, the display shall be designed so that the high-velocity release of implosion-propelled particles is prevented. CRT fragments shall not be released into the operator's environment. All CRT fragments and all secondary fragments shall be contained by the display case, CRT outer faceplate, and associated seals.

5.5.2 X-Ray Emission

Total Sector Suite X-ray emission absorbed by operations and maintenance personnel shall not exceed the levels stated in MIL-STD-454, Requirement 1.

5.5.3 Structural Stability

To assure personnel safety, the Sector Suite consoles and all other equipment cabinets shall be designed and installed so that the equipment remains upright when subjected to the earthquake floor response spectra shown in AT&T Bulletin 326-130, PUB 51001, Issue 2. Equipment mounted to consoles or cabinets shall remain in place, and access panels, doors and drawers shall remain in their normal positions under the conditions specified above. The floor response spectra shall apply to installations located in earthquake zone 4 as defined in the above AT&T bulletin. For installations in zones 1, 2, and 3, the above requirments shall be met except that all accelerations should be reduced by 70 percent, 60 percent and 40 percent, respectively. These requirements may be accomplished by designing equipment to survive in the seismic environment or by employing add-on stiffeners, isolators, or braces. Similarly, a single design may be employed in all earthquake zones, or the design may be tailored to meet the expected earthquake threat. Equipment shall be designed and installed in accordance with ANSI/IEEE Standard 344-1975.

5.6 EQUIPMENT LAYOUT

All equipment shall be in accordance with the ground workspace design requirements of MIL-STD-1472C. Equipment layout shall provide clear and unrestricted access to any rack or equipment unit including Sector Suite Common Consoles in accordance with the requirements specified in the above paragraphs. This access shall permit maintenance or removal of part or all of the equipment at any rack, unit or console location. All equipment shall be maintainable by FAA personnel in accordance with the anthropometric requirements of MIL-STD-1472C and operable according to the anthropometric requirements of Section 5.12.

5.7 RELOCATION CAPABILITY

It shall be possible to remove, relocate, and install within a building a fully operational Sector Suite consisting of nominally three Common Consoles, and Auxiliary Display modules (if used) within 2 hours. AAS equipment shall be capable of being removed and relocated to another building in order to support building consolidation. Equipment cabinets and modules shall be relocatable from their operational position to a diagnostic and repair location.

5.8 DATA ENTRY AND DISPLAY DEVICE PHYSICAL CHARACTERISTICS

The data entry and display device physical characteristics shall conform to the requirements listed in sections 3.0 and 4.0.

5.9 SECTOR SUITE CONFIGURABILITY

Each Sector Suite shall consist of from one to four interlocking Common Consoles. The configuration of each Sector Suite shall be based upon the number and criticality of logical displays required to support the intended operational use of the suite. The nominal Sector Suite shall consist of three Common Consoles. The design and construction of each Common Console shall be sufficiently flexible to support in-line, semicircular or cluster configurations. The ability to readily reconfigure from an in-line Sector Suite using two or more controllers to a wrap-around Sector Suite using one controller (and vice versa) shall be built into the design and shall not require personnel to apply more than 5 lbs of force to accomplish. This reconfiguration may occur many times a day with changes in traffic loads, resectorization, staffing, and training.

5.10 COMMON CONSOLE PHYSICAL CHARACTERISTICS

The general physical characteristics of the Common Console shall be in accordance with the human engineering and design criteria established in the design and maintainability requirements of MIL-STD-1472C. Each Common Console shall contain physical devices to provide the functional entities described in

section 2.1. The console shall be capable of supporting a coordinator standing behind and monitoring controllers by allowing viewing of all displays and access to communication jacks and controls without disturbing the controllers. Each Common Console shall have a writing surface/shelf and sloping frontal display surfaces which shall meet the human engineering requirements set forth in Section 5.12. Common Console corners and seams which can come in contact with operations or maintenenance personnel shall be rounded or protected in some other manner to avoid injury. The console shelf shall provide for an area to place beverage containers (e.g., coffee cups, soda cans) and ash trays. Attention shall be paid to safe dissipation of spillage from beverage containers to protect VSCS, and data entry and display equipment. The edge of the console shelf shall be padded to protect elbows and forearms. The VSCS equipment shall be positioned in such a manner that the VSCS controls can be easily operated by controller personnel. VSCS equipment dimensions will not exceed an 8-inch height, 22-inch width and 8-inch depth. The communication jack panel will not exceed a 1 inch by 4 inch area.

Common Consoles shall conform to the AAS design and construction requirements listed in the AAS System Level Specification.

5.11 SMOKE DISSIPATION

The air traffic controller work force is comprised of smokers and non-smokers. To ensure the comfort of both of these groups, a smoke dissipation capability shall be provided within the Common Console. The smoke dissipation device must conform to the requirements of section 6.3.1.

5.12 ANTHROPOMETRIC REQUIREMENTS

5.12.1 General

All external edges and corners of the workstation which could come in contact with the user or bystander must have a minimum radius of .2". This includes the chair but excludes such items as switches, knobs, buttons, etc.

All adjustments at the workstation and chair must be able to be made quickly and easily from the standing or seated (seated preferred) position. Such adjustments shall require less than five pounds of force in any direction. More than one motion in series or sequence is acceptable but feedback (results of the motion) must be immediate. Two-handed adjustments are acceptable. The anthropometric requirements that follow are graphically depicted in Figures 5-1 through 5-8.

5.12.2 Work Surface

The contractor shall furnish a work surface adjustable through a range of 22.4" to 31.0" from the floor. The work

surface must have a maximum thickness of 1.0" at the edge, the bottom surface of which must extend a minimum of 16.0" in from the edge to provide knee clearance. The bottom surface may be angled down from the edge as much as 7°. The edge must be padded but firm enough to provide hand and wrist support. The work surface must be large enough to accommodate a movable keyboard, a CPSD, a minimum 5 inch by 7 inch writing surface, one beverage container and one ash tray. The work surface should be level, or if adjustable may be angled down toward the operator to a maximum of 7°.

Plug-in jacks for the keyboard, CPSD and headphone etc. are to be placed in the area of the work surface so that they can be accessed from a seated position and so that the wires from these devices do not interfere with normal operation. Headphone jacks shall be placed so that they can be seen from a seated position.

5.12.3 Leg Room

From the edge of the work surface to the surface in front of the operator's feet must be 27.0" minimum (see Figure 5-1). A minimum of 4.0" above this, the surface can be 23.0", (in other words a minimum 4" x 4" toe clearance must be provided the full width of this surface). As a design goal, the knee/leg area should be as open as possible to facilitate the operator's side-to-side movement.

5.12.4 VSCS

The common console shall accomodate a VSCS panel surface of 8.0" x 22.0". All control devices must be within reach of the 5th percentile female as determined by the reach diagrams in figures 5-5 and 5-6 with the seat reference point 8.0" behind the padded edge of the work surface. None of the control devices can be higher than the shoulder height of the operator. If placed at the height of the work surface, the surface of the VSCS must be within a 30° to 60° angle from the horizontal.

5.12.5 Input Devices

Keyboard physical characteristics shall conform to the requirements stated in section 3.1. The contractor shall consider making the keyboard, number pad and the CPSD (if applicable) as modular units which can be re-arranged for optimum left or right hand use without tools. The keyboard (or control assembly just described) must be easy to move about on the work surface but must resist unwanted movement in use. The cords as well as the plugs should be able to resist breakage under rough handling or dropping. The wires and plugs from the keyboard and CPSD must be secured and reinforced to prevent damage if the device were to fall or even to be jerked accidently. None of the control devices should be able to reach the floor. The keyboard in its highest adjusted position shall at no time restrict visibility or access to any controls or any part of the display.

The interactive data entry and display device is described in section 3.3. The location for this device will not be higher than the shoulder height of the operator. The device may be moveable but must not interfere with the visibility or function of any other part of the workstation. If it is moveable, its travel must be limited to ensure that it does not interfere with the visibility or functions of the adjacent workstation regardless of how the consoles are configured.

5.12.6 Display Screen

The display screen shall provide 20.0" x 20.0" of usable display area. Since this screen size is larger than most commercially available displays, the top of the screen will exceed heights normally recommended for optimum viewability. Therefore, the center of the screen should be placed as close as possible to the recommended 40.0" from the floor. Common console design should reference a main display optional viewing range from the eye to the center of the screen of within 20.0" to 30.0", measured from an erect but comfortably seated position. This viewing distance takes into account the larger than normal screen, character size and eyeglass correction. Therefore, these dimensions are greater than is normally recommended for VDT workstations.

The contractor shall consider an easily adjustable angle through the range of 83° - 105° as measured from the surface of the screen to a horizontal plane. If a fixed screen is used, it must be within 100° - 105° tilted away from the operator. The adjustable tilt feature is preferred because of the expected 10.0" or more difference in eye heights, the likely problem of reflectance and glare, as well as operator preference.

5.12.7 Auxiliary Display

If a separate, overhead Auxiliary Display is included in the contractor's design, it shall be for occasional reference use only. It may be as wide as the console limit will allow and up to 20.0" in height. The viewing surface shall be tilted down toward the operator within a range of 50° - 60° measured off a horizontal plane.

5.12.8 Overall Size

The total width of the console structure shall be between 30.0" - 36.0". Height and depth dimensions are limited by dimensions in section 5.3.

5.12.9 Wrap-Around Feature

Section 5.9 outlines the configurability of multiple consoles. The preferred pivot centerline will be at the intersection of the work surface and the console main structure as seen in the side view of Figure 5-1. The contractor can consider a point closer to the operator but must consider the

resulting overall increase in floor area. A wrap-around configuration is primarily intended for use by only one operator using one chair and one active set of input devices. A three console wrap-around shall not require movement of the center console. Also, a four console wrap-around shall not require movement of the 2 center consoles.

The angle between adjacent consoles must be continuously variable between 0° and 45°.

The contractor must insure that no disturbing light or glare is transmitted between the consoles in any configuration and must minimize the possibility of items falling through any gaps that may open beween work surfaces when the consoles are angled.

5.12.10 Chair Roll Space

The minimum clear floor space required at the console is represented by a surface perpendicular to a line projected out from the "work surface reference point" in Figure 5-1. Table 5-1 lists this dimension for one to four Common Consoles. This space provides controllers access to the workstations but does not include the necessary additional walk space behind them. More space may be required for wheelchairs, see 5.12.13.

Table 5-1 Minimum Common Console Chair Roll Space

	1 Console	2 Consoles	3 Consoles	4 Consoles
Straight, Max. 2 Controllers	45.0"	45.0"	45.0"	45.0"
Straight, 3 or More Controllers	--	--	54.0"	54.0"
Maximum Wrap Around	--	45.0"	*45.0"	*62.0" (based on a 36.0" Wide Common Console)

* Based on one of the center most consoles remaining stationary and others moving around hinge points located as stated in 5.12.9

5.12.11 Maintenance

The contractor shall consider the use of cover plates, escutcheons and panels with self attachments to make access quick and easy as well as to reduce visible hardware. The contractor shall also maximize maintenance from the back to the extent that most or all replaceable components can be replaced and adjusted from the back. The aim is to reduce the maintenance interruptions and maintenance personnel from the controller's area since the adjacent consoles are in constant use 24 hours a day. A secondary aim is to simplify the appearance of the console, to reduce the chance for dirt and debris to collect and encourage an appearance which will look contemporary into the 1990's.

5.12.12 Color And Finish

Surfaces of the console shall be within the range of 30 percent to 50 percent reflectivity. Strong or bright colors must be limited to caution and warning functions. Exposed surfaces must be finished to resist wear and scuffing. Textures must be chosen to minimize the appearance of scratches and are cleaned easily. Surfaces that come in contact with operators or their clothing shall be free of rough, ragged or sharp protrusions; surfaces shall not be capable of injuring the operator or damaging the operator's clothing.

5.12.13 Wheel Chairs

The Common Console shall accommodate a controller in a wheel chair of commonly used design; that is, having overall dimensions no greater than: arm height of 29.0", footrest to waist of occupant (5th percentile female) of 22.0", and total width 25.0".

The contractor's design need not accommodate more than one wheel chair at a sector. Specifications listed elsewhere aid in the accommodation of wheel chair operators. Refer to Figure 5-1 and:

5.12.2	Worksurface Height
5.12.3	Toe Clearance
5.12.4	Reach Limits
5.12.3	Leg Clearance

Contractor and FAA facility engineers should ensure that there is adequate clear space for a wheel chair to approach and turn around near the Sector Suite (72.0" diameter, minimum).

5.12.14 Seating

A chair which will comfortably and properly support air traffic controllers is of great importance. It must be fully adjustable as described below and these adjustments must be made quickly and easily while seated. (See adjustments in 5.12.1). While seating is not currently included in the AAS procurement, these specifications are included here for completeness.

5.12.14.1 Seat Height

To accommodate operators of 5th percentile female to 95th percentile male, compressed seat surface height must adjust through a range of 12.5" low setting to 20.6" at the high setting. Adjustments are to be infinitely variable or are to use settings of no greater than .5" each. Note: if a gas or spring type elevating mechanism is used, the highest setting is to be measured with the weight of a 95th percentile male. Height dimensions are to be taken at the lowest part of the compressed seat surface.

5.12.14.2 Seat Cushion

The seat surface shall be essentially flat with the front edge curved down slightly or shall have reduced support with less dense foam or other means to reduce the pressure on the bottom of the front part of the thigh which could cause loss of circulation in this part of the leg. Foam density and thickness will ensure that the user will not feel the seat pan. The pad must not loose resiliancy. No other contours in the front or side view are called for. This is to aid the user in changing positions occasionally. The seat surface can slope back from the forward edge 0° - 6° in its normal position. Seat depth as measured from the seat surface to the front edge, should adjust through a range of 16.0" to 19.0".

5.12.14.3 Seat Back

The seat back must have a minimum height of 18.0" above the seat cushion and swivel to automatically conform to a user's position. It should move from 90° to 120° measured from the seat cushion. The seat back must be contoured and padded with a padding the same as or less dense than used in the seat cushion. A lumbar support must be incorporated, the most protruding part of which should adjust vertically through a range of 3.5" to 7.0" from the surface of the seat cushion.

5.12.14.4 Arms

Arms shall adjust up and down with the seat cushion. The highest point shall be no higher than 9" above the seat cushion. Arm rests are primarily to support the elbows and they should conform to the lower arms in a horizontal position.

The minimum distance between the arms shall be 20.0" at the closest point. The minimum width of each arm shall be 2.0", and the minimum length 9.0". The forward extreme of each arm is to be 10.0" from the reference point at a maximum. The top and front of the arms are to be padded and covered with cloth or soft vinyl at least as durable as that of the seat cushion. The surface is not to be of unusually coarse textured material.

5.12.14.5 Covering Material

The covering material must be breathable and at least as durable as 100% woven nylon. For cleanability and stain resistance, the contractor shall consider a teflon or similar treatment. Covering material must be easily changed on site; use of special tools is permitted. This change may include a change of the entire component part such as the seat cushion assembly, backrest, or arm rest. The chair should not be out of service for more than 60 minutes.

5.12.14.6 Tilt Motion

A tilt motion shall be incorporated with a spring return. The angular limit from normal to full back is 15°. The pivot point for the tilt shall be no further back than the supporting shaft. The supporting shaft of the chair must be at the center of gravity of the user with the seat in the normal position. The spring preload must be adjustable while seated.

5.12.14.7 Base

Five casters shall be used and they shall be selected to be of the proper type for the floor covering where they will be used. The centerline of the casters will be on a 24.0" diameter circle, minimum.

5.12.15 Anthropometry

The anthropometric models that can be developed from the dimensions in MIL-STD-1472C are inadequate considering the unique requirements of the controller's task, the unusually large display, and the constrained control area. Other often used sources of two dimensional anthropometric models are Humanscale (Diffrient, Tilley, & Bardagjy 1981) and a study for the U.S. Air Force (Kennedy 1977). The Air Force study, while locating the joints in a realistic way, uses a model which is generalized in outward shape and is largely compromised to make the rivited joints work. The figures presented in Humanscale lack many critical dimensions and do not have a realistic stance. Therefore, two mannequins were developed (Figures 5-3 and 5-4) using joint locations based on the work by Kennedy and body dimensions from data compiled by NASA (Laubach, McConville & Tebbetts 1978). Additional data for the extremeties were derived from Humanscale. Several body dimensions were derived from a recent anthropometric study of U.S. Army women and comparative data for U.S. Army men (E. Churchill, T. Churchill, McConville,

and White 1977; McConville, E. Churchill, T. Churchill and White 1977). The mannequins, 5th percentile female and 95th percentile male represent the extremes of the general population projected to the mid 1980's. The contractor shall use these mannequins (presented in Figures 5-3 and 5-4) as tools to test the common console and Sector Suite workstation designs for anthropometric accommodation.

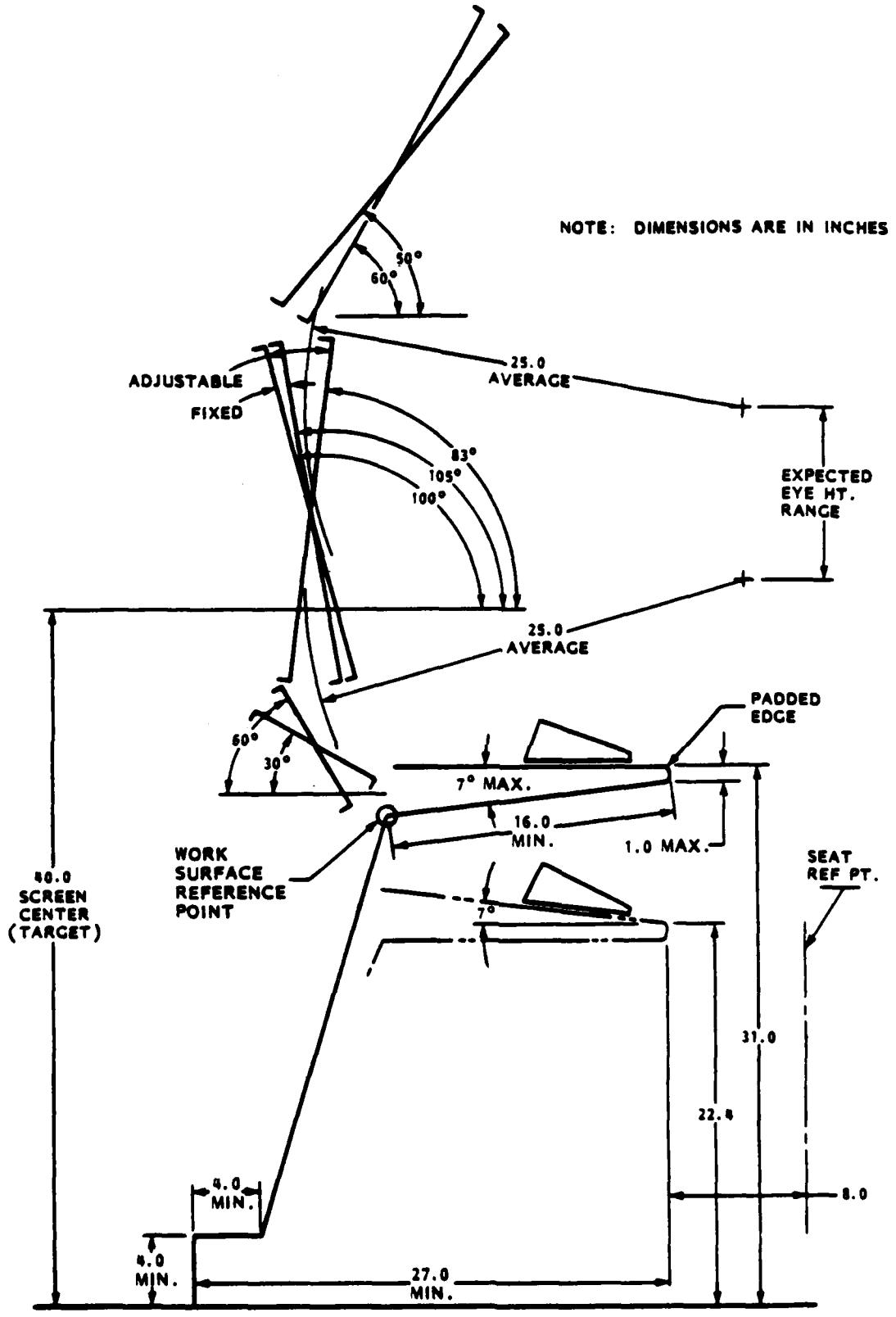


FIGURE 5-1 COMMON CONSOLE DIMENSIONAL REQUIREMENTS

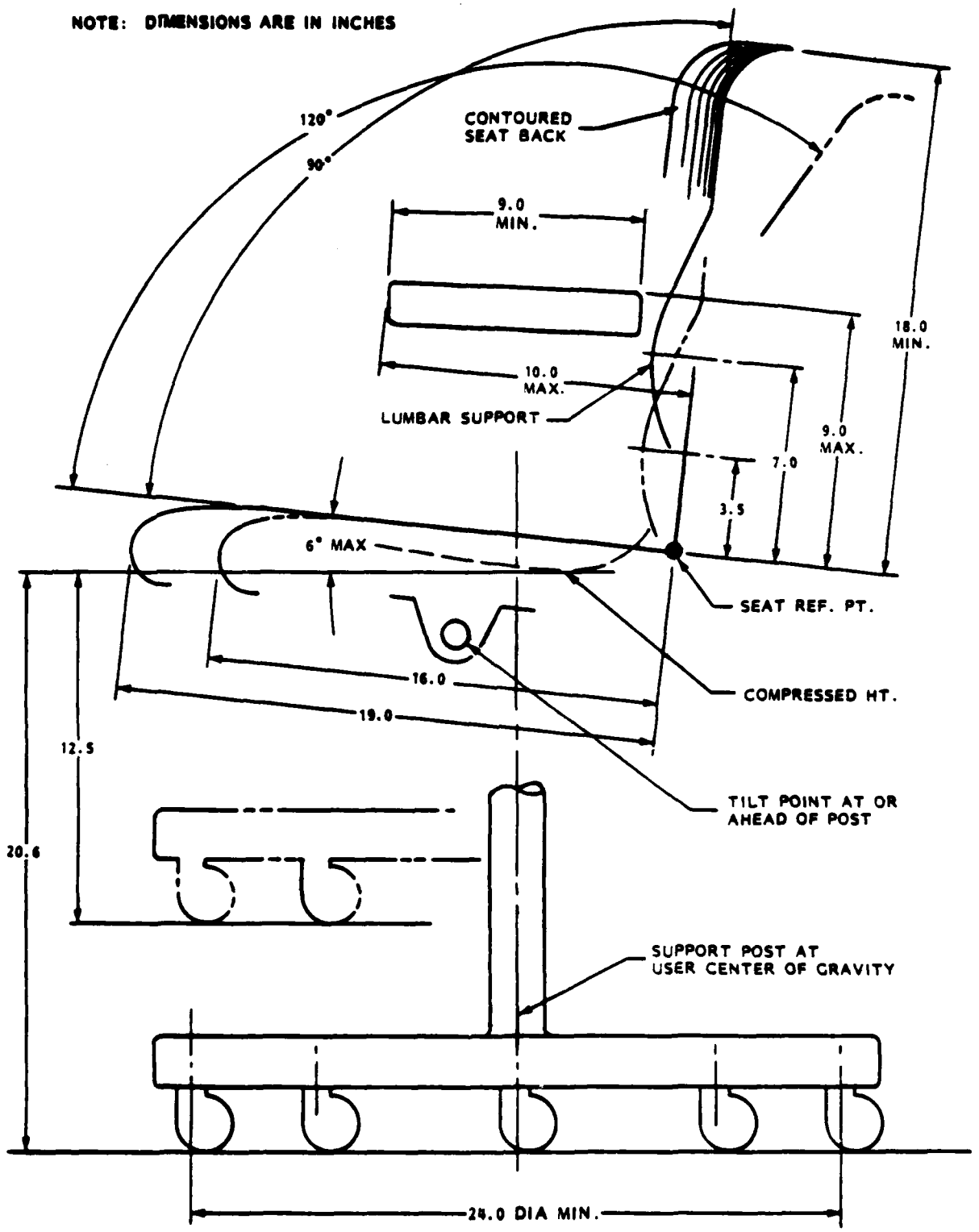


FIGURE 5-2 CHAIR DIMENSIONAL GUIDELINES

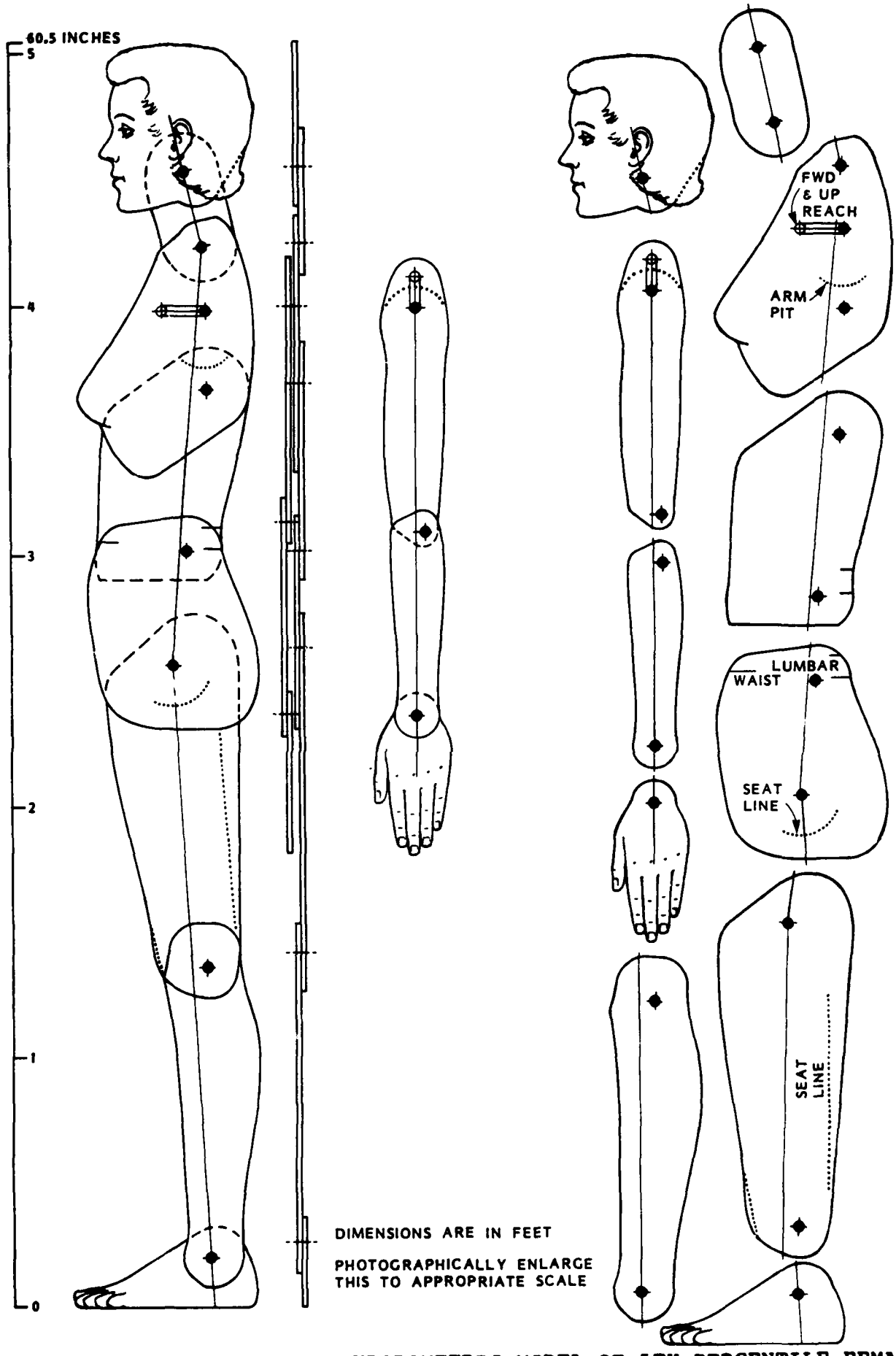


FIGURE 5-3 ANTHROPOMETRIC MODEL OF 5TH PERCENTILE FEMALE

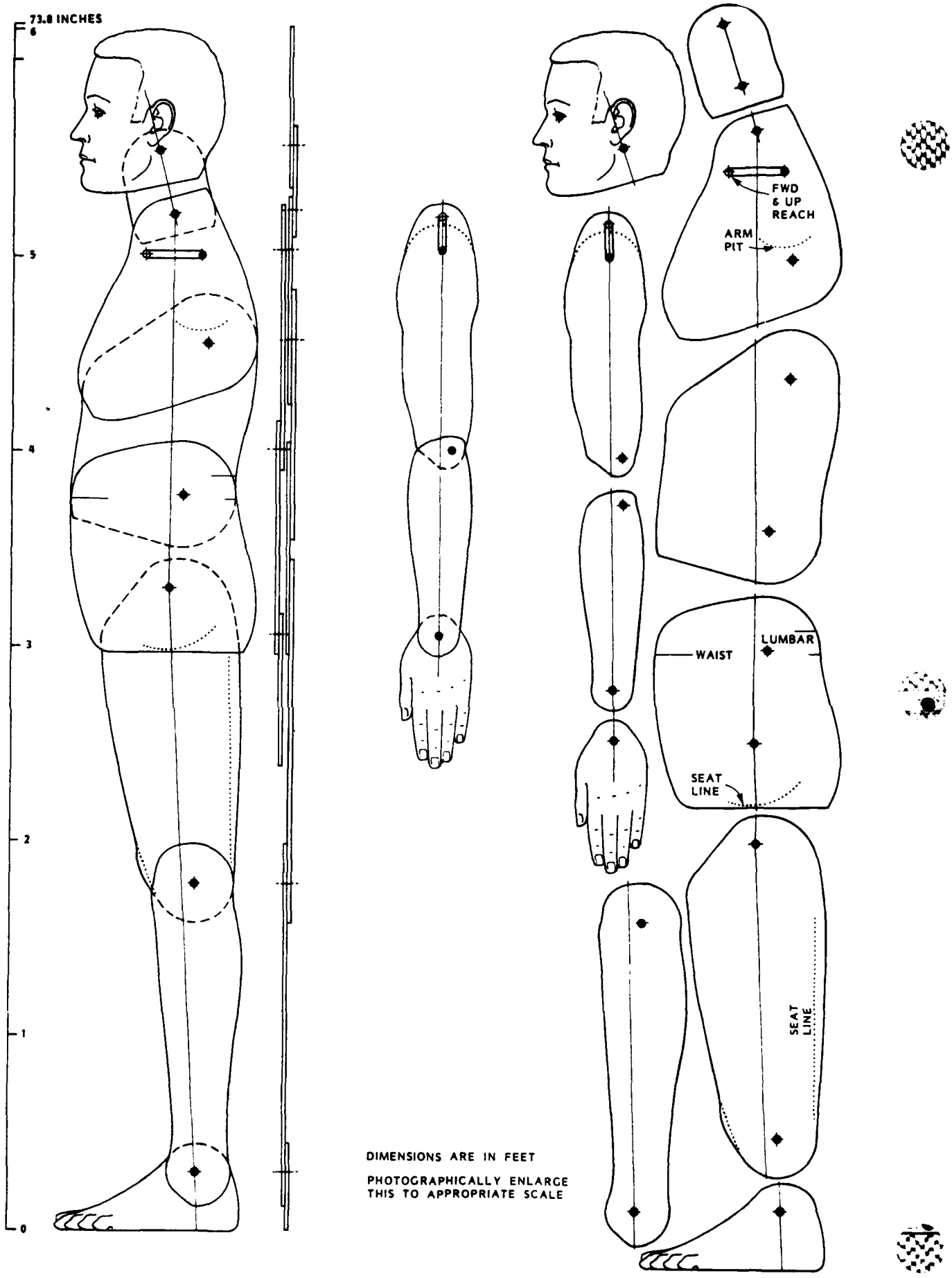


FIGURE 5-4 ANTHROPOMETRIC MODEL OF 95TH PERCENTILE MALE

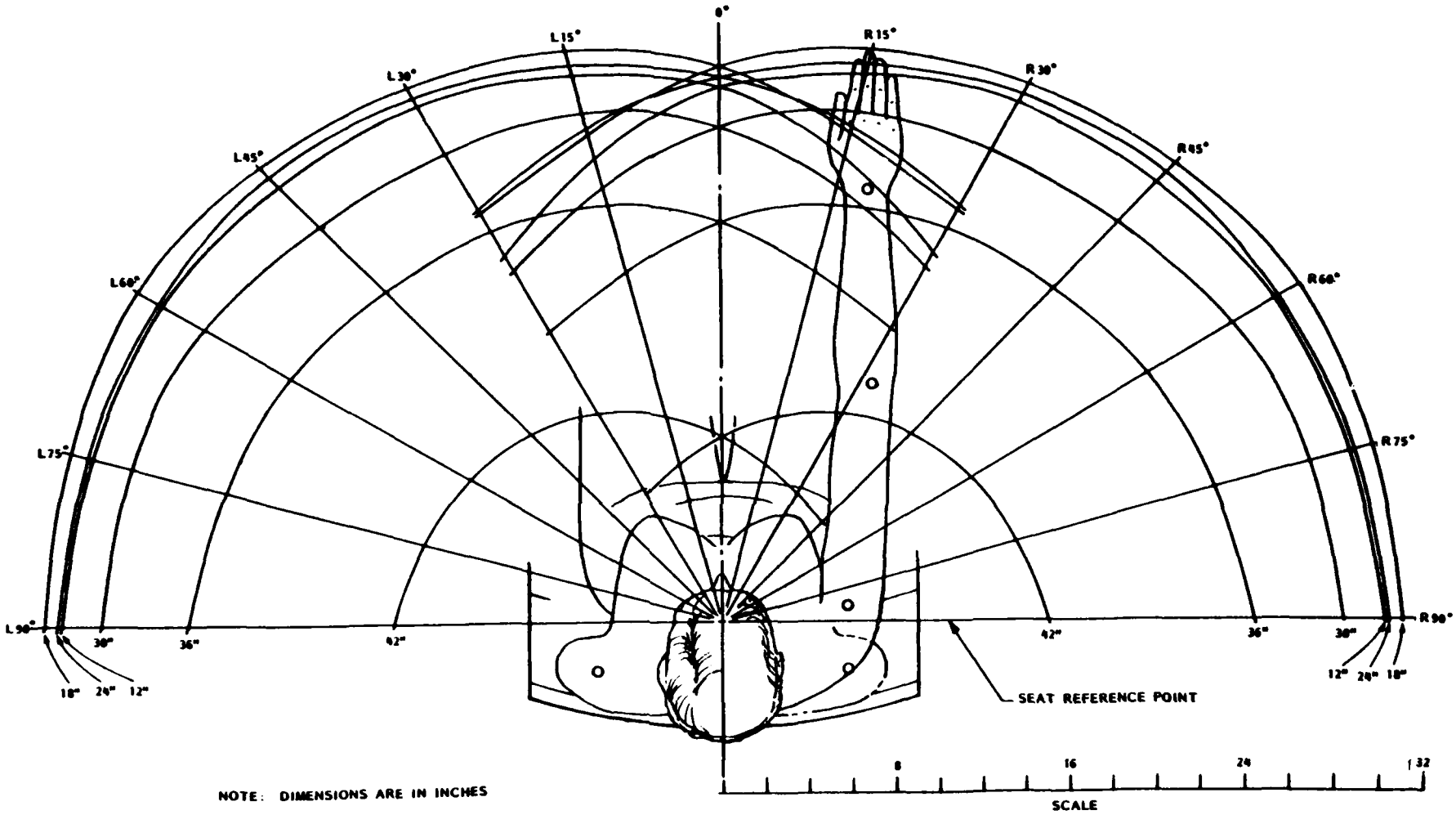
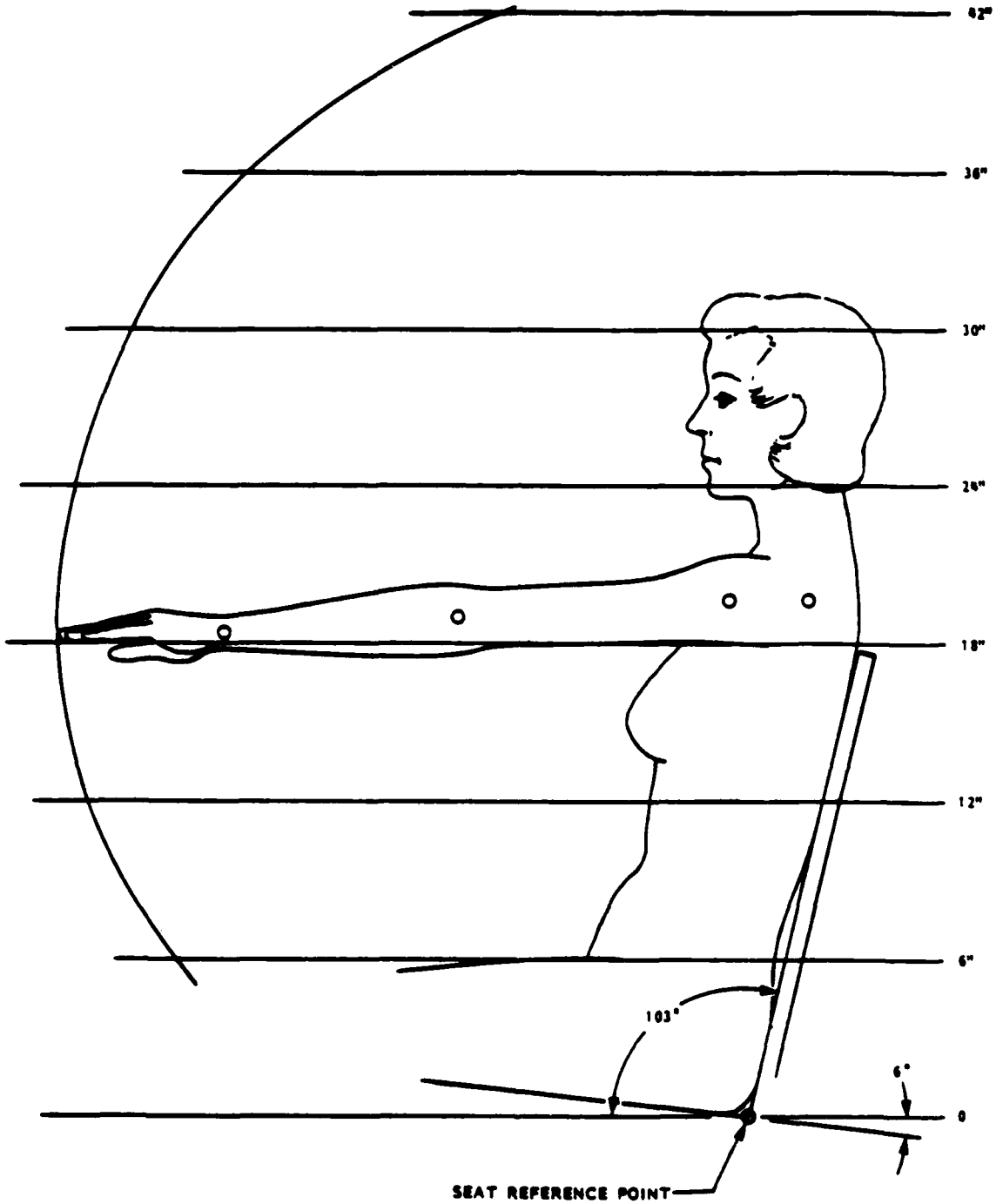


FIGURE 5-5 REACH ENVELOPE FOR 5TH PERCENTILE FEMALE, TOP VIEW



NOTES:

1) The arc shown represents the forward most reach of each level which occurs at 4.0" to 6.0" from the centerline of the controller.

2) The seat configuration is based on the study from which this data was taken. It does not relate to controller seating.

3) It is presumed that reach requirements for all of the controllers will be met if the minimums are met for the 5th percentile female

4) Level 6" has been omitted from the top view - Figure 5-5.

FIGURE 5-6 REACH ENVELOPE FOR 5TH PERCENTILE FEMALE, SIDE VIEW

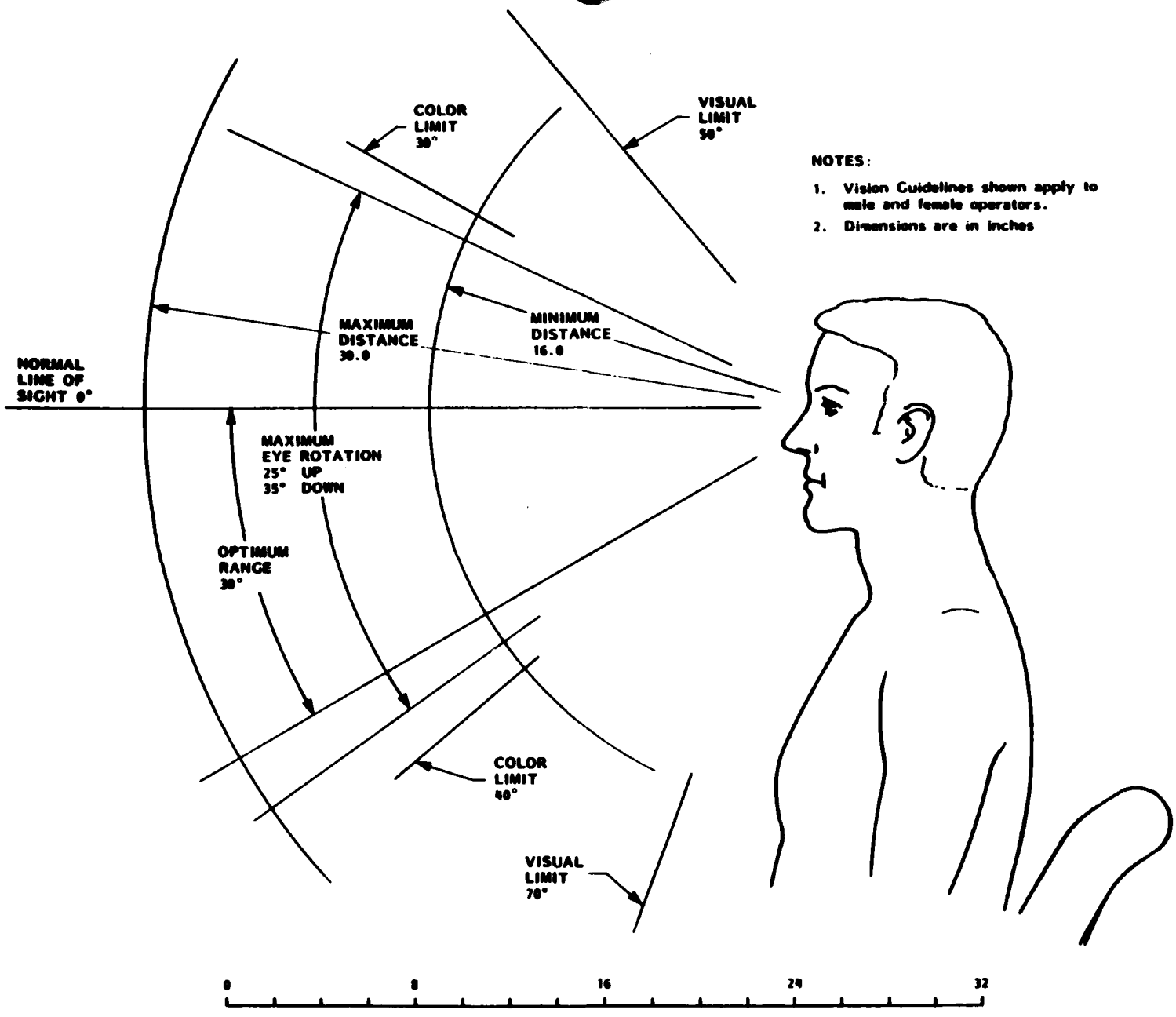
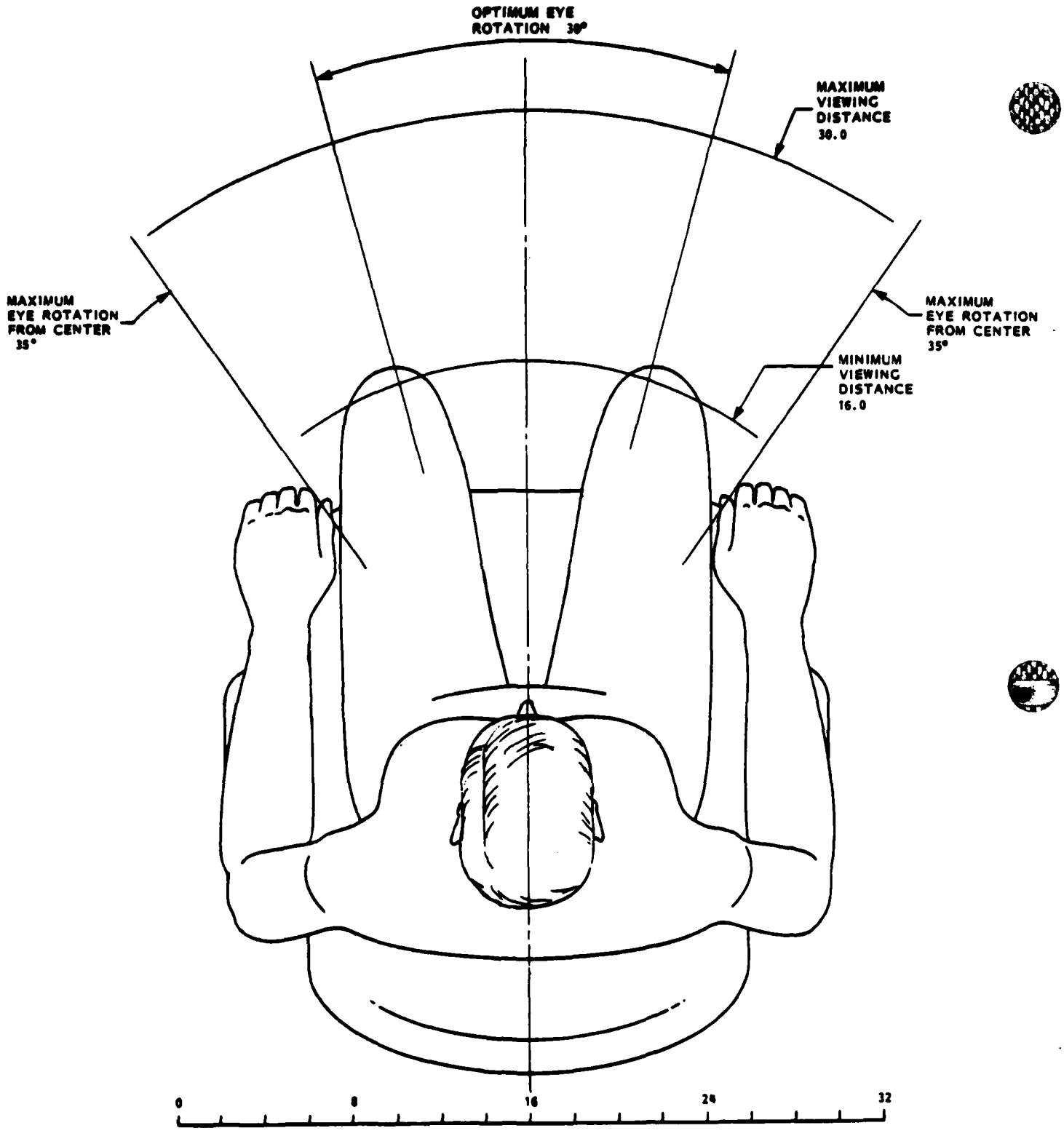


FIGURE 5-7 VISION REQUIREMENTS, SIDE VIEW



NOTES:

1. Vision Guidelines shown apply to male and female operators.
2. Dimensions are in inches.
3. The new controllers chair is shown approximately to scale.

FIGURE 5-8 VISION REQUIREMENTS AND TOP VIEW OF SEATED 95TH PERCENTILE MALE

6.0 ENVIRONMENT

6.0 ENVIRONMENT

6.1 EQUIPMENT OPERATING ENVIRONMENTAL CONDITIONS

The equipment shall meet all functional and performance requirements while operating under the conditions specified in Table II of FAA-G-2100 for equipment installed in attended facilities.

6.2 EQUIPMENT NON-OPERATING ENVIRONMENTAL CONDITIONS

The equipment shall survive any combination of the conditions specified in Table II of FAA-G-2100 for storage, shipping, or transporting, and shall be capable of being returned to operation without degraded performance if subjected to these conditions.

6.3 ACF ENVIRONMENTAL IMPACT

The scope of this draft requirements specification is ostensibly limited to the Sector Suite workstation itself. In a computer based command-control-communications center such as the ACF, however, certain environmental variables directly impact console requirements. Other environmental variables may indirectly effect system performance by impacting operator acceptance or comfort.

The factors detailed in this section reflect assumptions or expectations of the interaction of the Sector Suite MMI with the ACF environment. While it is not possible to allocate these requirements to either the Sector Suite workstation or the ACF, it important to state them to ensure completeness of the MMI specification. These requirements, therefore, may not be binding on the Common Console per se, but may rather reflect recommendations germane to the total ACF environment.

6.3.1 Noise

Speech communication remains a critical component of the AAS. Depending on the contractor's design, auditory information and alerts may also significantly impact the ACF acoustical environment. Ambient noise in the control room will not interfere with voice or any other acoustic information, cause fatigue or in any other way degrade system effectiveness. The combined ambient noise output of equipment located in the ACF shall not exceed the following limits, measured at any controller, supervisor, meteorologist or metering/flow control position.

NOISE LEVEL LIMITS

FREQUENCY BANDS (Hz)	NOISE LIMITS (dB)
37.5 - 75	69
75 - 150	62
150 - 300	56
300 - 600	50
600 - 1200	47
1200 - 2400	45
2400 - 4800	43
4800 - 9600	42
9600 - 19200	41

The Common Consoles shall also conform to the environmental safety requirements of the AAS System Level Specification.

6.3.2 ACF Illumination

Lighting in the ACF will interact with computer generated display legibility and controller task demands. Depending on the contractor's design, adequate lighting may be required for hardcopy viewing tasks of some charts or manuals. In this case, the contractor shall consider the use of adjustable localized directional lighting in the Common Console to support these tasks.

Even if the contractor's design calls for no hardcopy viewing, ACF lighting will directly impact display contrast and glare (specular reflectance). ACF lighting should be distributed and diffuse to minimize glare. Common Console display brightness, contrast ratios, and glare reduction features should be designed to anticipate an ACF lighting environment which is adjustable from 20 to 50 ftc.

6.3.3 Other ACF Environmental Factors

The ACF facility design, heating, ventilating and air conditioning environment should conform to applicable requirements stipulated by MIL-STD-1472C, Section 5.8.

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