

Report No. FAA-RD-80-73
FAA-CT-80-20

LEVIN

12

**CONSOLIDATED CAB DISPLAY: A SUMMARY REPORT OF THE PROCESS AND
THE RESULTS OF THE CONSOLIDATION OF CRITICAL AND SUPPLEMENTARY
TERMINAL AREA AIR TRAFFIC CONTROL INFORMATION FOR
DISPLAY PRESENTATION**

GERARD SPANIER

**FEDERAL AVIATION ADMINISTRATION TECHNICAL CENTER
Atlantic City Airport, New Jersey**



FINAL REPORT

SEPTEMBER 1980

Document is available to the U.S. public through
the National Technical Information Service,
Springfield, Virginia 22161.

**DTIC
ELECTE
DEC 4 1980**

Prepared for

**U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D. C. 20590**

80 12 01 24

AD A092450

DDC FILE COPY

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

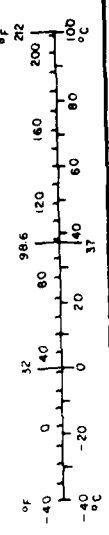
The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No. FAA-RD-80-73		2. Government Accession No. AD-A093 450		3. Recipient's Catalog No.	
4. Title and Subtitle CONSOLIDATED CAB DISPLAY: A SUMMARY REPORT OF THE PROCESS AND THE RESULTS OF THE CONSOLIDATION OF CRITICAL AND SUPPLEMENTARY TERMINAL AREA AIR TRAFFIC CONTROL INFORMATION FOR DISPLAY PRESENTATION.				5. Report Date	
7. Author(s) 10. Gerard/Spanier				6. Performing Organization Code	
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405				8. Performing Organization Report No. FAA-CT-80-20	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. 219-151-120	
				13. Type of Report and Period Covered Final - t. January 1978-June 1979	
15. Supplementary Notes				14. Sponsoring Agency Code	
16. Abstract <p>This report describes the work performed within the Systems Simulation and Analysis Division, ACT-200, to produce an engineering requirement for a terminal area display system for field implementation by the Airway Facilities Service. The report details the basic project efforts to define a data display system to consolidate many of the Terminal Radar Approach Control Facility (TRACON) and tower cab controller's indicators, displays, alarms, controls, status lights, weather data presentations, etc., to reduce physical size, improve work station efficiency, and enhance the management and use of Air Traffic Control (ATC) oriented data. The report covers the data collection process; the requirements determination process; the technology assessment performed; the design, development, and validation of certain hardware/software components; a risk assessment of the unique aspects of the system design; and the engineering requirement form. The end product of this portion of the project was FAA-ER-500-007, which led to selection plan No. 11-78 (FAA Order 4405.10A), "Consolidated Cab Display (CCD)."</p>					
17. Key Words Air Traffic Control Consolidated Cab Displays Terminal Display Systems Flexible Format Displays			18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 42	22. Price

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures			Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	
LENGTH						
in	inches	2.5	centimeters	cm	millimeters	0.04
ft	feet	30	centimeters	cm	inches	0.4
yd	yards	0.9	meters	m	feet	3.3
mi	miles	1.6	kilometers	km	yards	1.1
					miles	0.6
AREA						
m ²	square inches	6.5	square centimeters	cm ²	square inches	0.16
ft ²	square feet	0.09	square meters	m ²	square yards	1.2
yd ²	square yards	0.8	square meters	m ²	square miles	0.4
mi ²	square miles	2.6	square kilometers	km ²	square miles	2.5
	acres	0.4	hectares	ha	acres	
MASS (weight)						
oz	ounces	28	grams	g	ounces	0.035
lb	pounds	0.45	kilograms	kg	pounds	2.2
	short tons (2000 lb)	0.9	tonnes	t	short tons	1.1
VOLUME						
teaspoon	teaspoons	5	milliliters	ml	fluid ounces	0.03
Tablespoon	tablespoons	15	milliliters	ml	pints	2.1
fl oz	fluid ounces	30	milliliters	ml	quarts	1.06
c	cups	0.24	liters	l	gallons	0.26
pt	pints	0.47	liters	l	cubic feet	35
qt	quarts	0.95	liters	l	cubic meters	1.3
gal	gallons	3.8	liters	l		
ft ³	cubic feet	0.03	cubic meters	m ³		
yd ³	cubic yards	0.76	cubic meters	m ³		
TEMPERATURE (exact)						
F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	C	Celsius temperature	9/5 (then add 32)
					Fahrenheit temperature	



Copyright © 1988 by The McGraw-Hill Companies, Inc. All rights reserved. Printed in the United States of America. This book is a trademark of The McGraw-Hill Companies, Inc.

PREFACE

Acknowledgement is made to the contributions of D. Stone, L. Czekalski, K. House, P. Rempfer, G. Bishop, and to others from the Airway Facilities Service, Air Traffic Service, System Research and Development Service, Transportation Systems Center, and the FAA Technical Center, who, in the spirit of interservice cooperation, enabled this effort to reach a successful conclusion.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability	
Availability	
Dist	Specif
A	

DTIC
ELECTE
S DEC 4 1980 D
D

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Objective	1
Background	1
TECHNICAL APPROACH	3
Major Areas	3
Basic Philosophies	4
Engineering Requirements	4
Requirements Establishment	4
Technology Assessment	5
Operations Analysis	5
Associated Programs Review	5
Developmental Effort Level	6
Integration Philosophy	6
RESULTS	7
Final Configuration	7
Special Operational Software Philosophy	10
CONCLUSIONS	12
RECOMMENDATIONS	13
REFERENCES	13
APPENDICES	
A—FAA-ER-500-007, Part 1, Appendix 1-20, Table of Contents	
B—FAA-ER-500-007, Part 2, Appendix 2-1, Table of Contents	

LIST OF ILLUSTRATIONS

Figure		Page
1	Critical Display—Front Panel Layout (Full Scale)	14
2	Supplementary Display (Full Scale)	15
3	TRACON Display—Panel Layout (Full Scale)	16
4	Lighting Control Panel (Full Scale)	17

INTRODUCTION

OBJECTIVE.

The objective of this project was to prepare an engineering requirement for an Air Traffic Control Tower (ATCT)/ Terminal Radar Approach Control Facility (TRACON) consolidated information processing and display system for certain types of air traffic control and status information, including information for maintenance purposes.

Federal Aviation Administration (FAA) Technical Center responsibility included the preparation of the complete engineering requirement which included the display and data entry subsystem, the central processing subsystem, the remote sensing and processing subsystem, and the interface subsystem. In addition, a detailed operational description in the form of requirements was to be incorporated as part of the engineering requirement.

The Systems Integration Branch, ACT-230, was specifically responsible for (1) the development and documentation of the requirements for the display and entry functions, (2) the display and entry subsystem hardware, (3) the assurance of operational performance integrity, (4) the determination of which one of the present functions, operations, and data were to be included in the system, and (5) the establishment of pertinent central processor requirements necessary for the assurance of the operational performance.

BACKGROUND.

In accordance with a letter of agreement among the directors of the Airway Facilities Service, Systems Research and Development Service, and the Technical Center, dated March 1978, the 1978 SRDS-sponsored program effort in 219-151-100, Advanced Concept Development Program, was redirected from advanced tower development studies to a near

term, fast response effort to apply available tower and TRACON developments to the problem of consolidation: to determine, recommend, and detail a "best" system solution for problems of console space, multiplicity of display devices, alarms, indicators, controls, and data availability for towers and TRACON's.

Most navigation, communication, meteorological, and lighting aid equipment and facilities have been developed, installed, and maintained independently. As such, each has had its own operational monitoring and display hardware, as well as its own dedicated cabling. As a result, the available air traffic control tower cab and TRACON work surface and console surface areas have become saturated with a variety of instruments and displays. Because of such a proliferation of different indicators, alarms, controls, and displays required to be monitored or referenced continuously, the Air Traffic Service (AAT) has expressed great concern over the impact on present workload and operations activity, as well as concern over the impact of the installation of the expected near-term new tower and TRACON hardware.

Similarly, in the area of collecting, distributing, and acting on the required certification and maintenance data, the Airway Facilities Service (AAF) personnel are becoming inundated with additional equipment, systems, and operations parameters that also have significant impact on maintenance service efficiency.

In an effort to address these air traffic and airway facilities problems, AAF-400 and AAF-500 proposed a program (reference 1) in the FY-79 Facilities and Equipment (F&E) budget to (1) consolidate the air traffic operational status displays in the air traffic control tower cab and TRACON, and (2) centralize airway facilities maintenance monitoring at several major hub airports.

This was to be accomplished in three stages: (1) a conceptual design and documentation phase, (2) a selection of one of several requested technical proposals to accomplish the engineering requirements, and (3) an implementation phase at selected sites.

The first phase proposed to utilize the expertise at the Technical Center in two areas: (1) to develop a system mockup or prototype where possible, and (2) to evaluate over a short period of time a number of concepts for the consolidation of Air Traffic Service status information and Airway Facilities Service maintenance monitoring information. The Technical Center was to focus its efforts on the development of a display and data entry system to demonstrate operational characteristics, hardware options, software flexibility, human engineering, and human factors of a practical solution for the terminal controllers.

In addition, the Technical Center was to "determine (1) the optimum Air Traffic Service and Airway Facilities Service display format, (2) the most suitable display hardware, based on the constraints of a particular operational environment, (3) the flexibility required of the associated hardware, and (4) the method of providing redundancy."

The initial draft of the work effort to be accomplished included the following list of items to be incorporated:

Instrument Landing System (ILS) Status
Digital Altimeter Setting Indicator (DASI) Status
Weather Information
Clocks (Time)
Runway Lighting System (RLS)
Approach Lighting System (ALS)

Automated Terminal Information Service (ATIS)

Runway Visual Range (RVR)

Airport Surveillance Radar (ASR)

Distance Measuring Equipment (DME)

Vortex Advisory System (VAS)

Surface Winds Information Monitoring System (SWIMS)

Visual Approach Slope Indicator (VASI)

It was anticipated by Airway Facilities Service that the initial air traffic data consolidation would involve only the status information currently being remoted to the cab and TRACON, with the addition of VAS and SWIMS. Attached to the initial draft documents was a detailed list of specific data envisioned to be included on such a display system. This list was prepared by the various Airway Facilities Service divisions for purposes of discussion. These forms of information would constitute part of the consolidation basis for the Air Traffic Service operational data.

In addition, a very extensive list of technical equipment status in the form of voltages, power, temperature, channel-in-use, and similar parameters was to be accumulated for maintenance data display purposes.

During the course of the program, additional F&E funding limitations resulted in a reduction of the scope of the initial implementation in the areas of site data communications, remote data communications, and quantity of sites included. Subsequent reviews of the estimates for anticipated contract costs resulted in a further reduction. Only two sites, Boston and Atlanta, would receive the systems for evaluation and use, and only signals that already exist

in the tower/TRACON complexes would be interfaced to the system. No remote site sensing would be included, but enough microprocessor-controlled sensing would be included to verify the remote sensing design. However, the central processing subsystem would be required to be capable of handling the entire consolidation, display, control, and monitoring system as originally configured. This would permit rapid expansion of the initial system to include remote maintenance monitoring and other specialized signal processing and control. No changes to the display subsystem and its related requirements were made.

TECHNICAL APPROACH

MAJOR AREAS.

Eleven major areas of effort were established in conjunction with the Airway Facilities Service and Technical Center program management personnel and with the Technical Center Engineering Management Staff:

1. Determine, validate, establish, and verify the data presentation requirements.
2. Conduct detailed technology reviews and assessments to determine the specific state-of-the-art for display, entry, and processing hardware and software.
3. Conduct detailed measurements, make recordings, and perform compilations of the pertinent air traffic control operations being performed in representative tower/TRACON complexes to establish a comprehensive characterization of level 4/5 towers, to determine site peculiarities, to validate operational requirements, and to aid in the project functions of data integration at the work station.

4. Research related existing, scheduled, or planned programs, and conduct studies to find and analyze systems in use which perform similar display, entry, processing, and control functions, to determine systems and design applicability.

5. Perform display and entry device development to incorporate unique air traffic control requirements, existing technology, and off-the-shelf hardware into specific FAA-oriented devices and/or specifications.

6. Collect, analyze, and determine various techniques, philosophies, and systems approaches to integrate the various forms of information and data required for presentation to the controller.

7. Establish a selection of configurations for information displays and entry devices in a cluster for a work station that incorporates all of the other devices necessary for the proper operation of the work station and the controller. Demonstrate and evaluate the various configurations using operational personnel.

8. Select a final configuration for specification purposes, validate that all functions are performed, and secure Air Traffic Service concurrence.

9. Prepare an engineering requirement describing the system, hardware and software, and operational performance to the maximum degree possible.

10. Prepare a detailed operational specification of all the operational functions to be performed by a computer-controlled data display system, by the display devices, by the entry devices, and by the operators of the system to achieve or receive all the specific operational data and information desired. This is to support item 9.

11. Prepare, under contract, suitable software to be implemented in the Technical Center's Computer Controller Interface Laboratory (CCIL) to demonstrate simulated dynamic data display for Air Traffic Service and Airway Facilities Service review. This is to support item 6.

BASIC PHILOSOPHIES.

Within each of the activity areas listed above, work efforts were performed that were guided by several basic philosophies.

1. The proposed system shall perform only the limited number of functions designated by Air Traffic Service and Airway Facilities Service, and shall include expansion only as indicated.

2. The system shall be required to operate only in the designated FAA environments and under the real-time, safety-critical conditions demanded of dynamic, concurrent air traffic control operations.

3. The system shall be required to be an application of current, existing, validated, and implemented technologies, with a limited amount of custom hardware packaging and applications software.

4. The shortest time period possible shall be utilized to produce the final documentation.

5. Techniques, hardware, and device technology shall be evaluated in detail in the lab only if they present a risk in the form that they would be applied, or create a question of functional applicability that has not been addressed in prior pertinent program efforts.

ENGINEERING REQUIREMENTS.

Because of its size, a final copy of the Engineering Requirement (ER) is not included in this report, but is available through AAF-700 (reference 2). The

specific sections of the ER resulting from this effort include Part 1, Appendix 1-20, "The Operational Requirements for Entry, Display, and Display Information Processing," and Part 2, "Display Subsystem Engineering Requirements." The tables of contents for these sections are provided in the appendices. In addition, extensive input was provided to Part I, "General"; Part 3, "Central Processing Subsystem"; and Part 7, "Tower Interface Subsystem."

REQUIREMENTS ESTABLISHMENT.

In order to determine the data presentation requirements, written contact was established with all of the divisions in Air Traffic Service concerned with air traffic control procedures, activities, planning, operations, facilities, etc. Similarly, Airway Facilities Service divisions were queried concerning equipments, status types, procedures, and operations (references 3 and 4).

As part of a larger study of tower/TRACON operations, Transportation Systems Center (TSC) project support personnel in the Operations Analysis Branch, DTS-522, assembled and organized operational requirements from a number of field sites, including Boston and Atlanta.

Air traffic control personnel from the facilities and the two regions (New England and Southern) were interviewed; interests, requirements, and desires were discussed.

Written procedures, from both standard manuals and facility documents, were reviewed; and correlation was achieved with other requirements' inputs.

Factors such as ambient light conditions and physical space were reviewed using descriptions of facilities, information from prior tower and TRACON environmental studies, references from the Illuminating Engineering Society Handbook on ambient light ranges in the United States, and human factors

principles for space and visibility conditions.

From this information, basic data content, priorities, data timeliness, general format, and data groupings were determined. Human factors considerations influenced such determinations throughout the process.

TECHNOLOGY ASSESSMENT.

Review and assessment of a broad range of technologies is a continuing process that has been a part of this project, as well as preceding projects, within this program. Continuing contact was maintained with many of the major development companies in the field of displays; technical journals were reviewed both for products and indications of emerging technologies; extensive inquiries were directed to many of the computer manufacturing companies with regard to hardware, software, and firmware; seminars and symposiums were attended to maintain currency in the developmental efforts and applications engineering advances pertinent to the project which emanated from industry, academic institutions, and from the Department of Defense.

In two areas, computer architecture and computer operating systems software, detailed compilations and performance analysis were undertaken to become parts of another technical formal report. The specific details of the requirements for performance by the processors, the software, and the system as a whole, as described explicitly in Parts 1, 2, and 3 of the ER, were derived from the studies in these two areas.

Where necessary to validate specific display performance relative to special FAA requirements, individual devices were purchased and integrated into the CCIL for evaluation. These included incandescent segmented indicators, projection legend switches, plasma matrix displays, and infrared finger-touch switches.

OPERATIONS ANALYSIS.

A detailed study of Boston Logan Airport was undertaken by the Operation Analysis Branch, Transportation Systems Center. The study, documented, described, analyzed, and measured the air traffic control and airport operations performed by the facility personnel; their use of and requirements for the various supporting hardware; and their interactive activities and responsibilities for the use of certain forms of information. This study resulted in an extremely detailed and extensive report (reference 5), which helped to establish a baseline for the collection of data about terminal facilities' operations. In order to prepare a characterization of all the level 4 and 5 towers (and associated TRACONS) as part of the continuing SRDS-sponsored program effort in 219-151-100, similar studies were planned for additional sites. Atlanta's airport study (reference 6) has been underway since the spring of 1979. As more airports are studied in similar detail, the characterization of terminal facilities will become more comprehensive. Denver and Albuquerque are scheduled for FY-80.

ASSOCIATED PROGRAMS REVIEW.

A review of Engineering and Development programs and Airway Facilities Service implementation plans, which could conceivably have any bearing on the subject program, was conducted specifically to:

1. Inform program personnel of potential conflict areas.
2. Allow for early establishment of externally influenced requirements.
3. Minimize parallel program efforts.
4. Gain additional supportive information on system requirements based on the experiences of other programs.

A separate survey was conducted through selected government sources—the Technical Center library, the Department of Defense, the National Weather Service, and selected industrial systems manufacturers to find and analyze data display and processing systems that already are in use performing similar functions, in whole or in part. Applicability, in part, to the subject program requirements was reviewed to determine risk reduction, reproducibility, maintainability, cost, specific display performance level, and software pertinence.

The following FAA programs and documentation were reviewed for applicability to this program:

1. 084-752-540, Wake Vortex Avoidance System Evaluation.
2. 142-173-500, Terminal Information and Processing System.
3. 143-102-530, ASDE Controller Operational Tests.
4. 143-152-400, VICON In-Service Operational Evaluation, Phase II.
5. 144-170-820, Terminal Sustaining Engineering.
6. 154-751-160, Airport Low Level Wind Shear System Field Test.
7. 161-020-160, Impact of Cockpit Display of Traffic Information on Controller Workload.
8. 219-151-110, Terminal Weather Integrated Display System Development.
9. Subprogram 131-401, Mass Weather Dissemination.
10. Subprogram 132-402, Flight Service Station Specialist Automation.

11. Subprogram 153-451, Automatic Weather Observation System, technical data package, Interagency Agreement DOT-FA-78WAI-872.

12. Contract FA-74WA-1489, Meteorological Aeronautical Presentation System (MAPS) reports.

13. Report NA-77-75-LR, Improved Displays for Air Traffic Control Towers.

14. Report FAA-RD-77-190, Feasibility Study for Simulation of an Airport Tower Control Environment.

DEVELOPMENTAL EFFORT LEVEL.

Because of the time constraints imposed on the program and the funding limitations, no significant hardware development was undertaken. However, the development of the form of the hardware, the incorporation of various and special diverse requirements, the development of unique and detailed performance requirements, and the development of detailed methods to test the ability to meet such requirements were all developmental activities based on knowledge of the state-of-the-art in system capabilities.

This developmental activity actually produced the final expected form of those portions of the system that were not strictly "off the shelf," or had certain technological, physical, or human factors risks that needed to be assessed and minimized.

INTEGRATION PHILOSOPHY.

The process of integrating the information and controls required in the system into a small number of display devices (one device, in the limit) included a review of various methods and methodologies to accomplish this integration, followed by mockups, pasteups,

simulation, and informal and formal evaluation by subjective and objective means.

Concepts of data integration, including full tabulation, graphic portrayal, paging, display by exception, overlay, multiple display, multiple device, and composite display, were reviewed and studied. The advantages and benefits of each were selected as part of the integration process, and the concepts they represented were incorporated based on compatibility, ability to meet requirements, adaptability to the air traffic control functions, performance assurance, and human factors limitations.

An iterative process was followed that permitted the form of the hardware to be gradually tailored to the data necessary to be presented, and permitted the data to be modified, ordered, prioritized, or expanded to meet the capabilities and limitations of the hardware. The anticipated costs of the resultant end products, as well as the cost-free benefits, accomplishments and capabilities of the processing, display and entry system, due to integration, were important considerations. They were not, however, the primary factors. ATC operational utility remained as the primary, overriding consideration.

Several approaches and methods for meeting the information needs of the controller were formulated and presented to operating controllers from the Technical Center and from two FAA Regions where installations are planned, and to representatives of the Air Traffic Service in Washington. These methods were determined to be the ones that satisfied the technical, environmental, and operational requirements, though still in varying degrees. Since several contained technologies that had not been implemented in ATC systems, it was desirable to expose ATC personnel to the new device technologies in a non-prejudicial manner so that each could be evaluated in its proper environment and performing at its expected level.

Evaluations were conducted on:

1. A single cathode-ray tube (CRT) display with 24 and 36 lines of 64 and 80 characters per line. Multiple functions were portrayed, and multiple pages of data were utilized.
2. Multiple CRT displays, with contents as in item 1, each dedicated to specific functions and each capable of being paged.
3. Dedicated function/information displays utilizing a CRT, discrete character indicators with segmented incandescent filaments, light-emitting diodes, liquid crystal segments, rear projection displays, and segmented and dot matrix gas discharge indicators.
4. A programmable, multifunction array display, specifically a dot matrix green plasma device that is physically small in size.
5. An up/down preprogrammed counter/display.
6. A computer controlled multiple legend, rear projected display indicator integrated with an entry switch.
7. A finger-point, data-select action on a CRT.

Using these devices in various combinations, simulated work stations were evaluated by stepping through the routine processes and procedures that require the use of such information. Also, the nonroutine and especially critical events and activities were simulated, and the ability to obtain the data in the form required was determined.

RESULTS

FINAL CONFIGURATION.

A final configuration of displays and entry devices was selected, implemented, and validated.

The configuration included the following (with a synopsis of the rationale for the choice made):

1. Critical data which are required to be viewed, scanned, utilized for other decisions, and often conveyed to the pilot, are sufficiently "critical" in importance that they must be available all the time, cannot be paged for, and cannot require any action by the controller to get the data. They must not require extrapolation, interpolation, conversion, modification, or partial deletion. They must be rapidly and clearly visible under all ambient conditions, from night blackness to direct sunlight or skylight reflections. They must be legible across the tower (15 to 20 feet). They must clearly indicate alert conditions of specific critical data. These major requirements and numerous minor ones are best met in a fixed format, segmented character, incandescent filament display. No other device type can satisfy the operational needs as determined. Hence, a "critical" display of the this type is made part of the work station for the listed critical functions and data listed below (see figure 1):

a. Hours, minutes, and seconds of real time.

b. Barometric pressure.

c. Center-field wind direction, velocity, and gusts.

d. Runway designations for up to three active runways.

e. A safe approach distance spacing from the Vortex Advisory System for three runways.

f. The failure status of the prime or backup approach lighting system and the instrument landing system (and its component parts such as the markers) for three runways.

g. The runway visual range (RVR) visibility figures for up to three RVR's per runway for each of the three runways, and the coded status of the units.

h. The setting level of the approach lights.

i. The setting controls for and the numbers that indicate the RVR thresholds for each of the RVR's.

j. Low level wind shear boundary location, velocity, and direction.

k. Space for short weather messages (50 to 60 characters) in the National Weather Service (NWS) message format, but without meteorological information already displayed as above. This message would normally be equivalent to selected portions of Service A local weather.

2. Almost all other forms of information that might be necessary or desirable to present to the tower controller are to be presented on a "supplementary" display. This supplementary display would have sufficient flexibility to permit alphanumeric and symbols to be displayed at all character locations, and would be adequately legible at reference viewing distances of 2 to 3 feet in tower cab ambients.

In order to eliminate problems of clutter and data location, multiple pages of data with 512 characters per page (16 lines of 32 characters each) were determined to be more useful than 1,920 characters per page (24 lines of 80 characters each) or more.

The smaller character quantity enables the use of larger characters which enhances legibility and allows higher refresh rates on the display (up to 100 hertz (Hz) noninterlaced, with no excessive bandwidth requirements) to enhance high ambient viewing. The small

size television rectilinear raster display is the best device for this purpose, and the 9-inch diagonal size results in 0.25-inch high characters, a very desirable size (see figure 2).

The information to be presented on the various pages can include, as a minimum:

- a. Notice to Airman (NOTAM)
- b. Satellite weather
- c. Navaid status for all runways
- d. RVR for all runways
- e. Special messages
- f. Phone numbers
- g. Reconfiguration sequences
- h. A backup page of critical data
- i. Indexes

The ability of the CRT to be enhanced to provide adequate contrast has been established in several of the Technical Center programs, which the author has been involved in, that dealt with display development for high ambient use. One was for the development of the bright radar indicator tower equipment (BRITE) systems' CRT, another was for the development of the display for the Flight Data Distribution System for flight data handling in a tower, and a third was for the development of high contrast supplemental displays for Air Route Traffic Control Center (ARTCC) use.

For larger quantities of data than a "critical" display can properly handle and for the described ambient, the raster scan proved to be the most advantageous.

3. The TRACON environment demanded a display of rather exceptional properties:

- a. Very good legibility
- b. Ease of reading in a dark environment
- c. Minimum area and minimum depth
- d. High reliability
- e. Flexibility of character display
- f. A green display color for minimum fatigue

In addition to the display requirements as listed, the device has to provide most of the critical data as determined for the "critical" display, plus permit a portion of the display to be paged to display supplementary information.

While a very small CRT might be utilized (approximately 6 to 7 inches diagonal), the character legibility and display reliability of such a device is not adequate for the rapid reference use of the display in the TRACON.

A green-emitting gas discharge ("DC" plasma) dot matrix display was selected as the best display device. With a display package size of approximately 7 by 7 by 3 inches, including electronics, and capable of displaying 16 lines of 32 characters (512) in a 6- by 6-inch display area, it can safely be placed in numerous locations in and about a TRACON work station. The front surface is glass covered with plastic, and it can be used as a writing surface if the display is mounted horizontally in a console ledge.

Character height is nominally 0.21 inch (5 millimeters) and evaluation indicated superior legibility for the TRACON viewing requirements of up to 10 feet.

Industry tests and commercial applications indicate a useful display life of at least 30,000 hours. With low power requirements, component life and

reliability appears well assured. As with CRT displays, the plasma panel itself is plug-in and replaceable (see figure 3).

4. The supervisory and maintenance activities required to be performed through the use of a data terminal (enter, delete, alter, or monitor data for operational use) will require a terminal that is moderately sophisticated but essentially identical to many devices already marketed for computer input/output (I/O) and control purposes. The only requirement that has been added relates to the front surface treatment of the CRT in the terminal. This treatment is for antireflectivity and can be accomplished at minimal cost with no impact to the terminal's electronic operation. The antireflectivity turns the marginally unacceptable contrast levels into comfortably adequate and acceptable performance levels for use especially in the cab ambient.

5. The analysis of work functions and their frequency indicated that the requirements for "control" of navigation and approach lights by the local controller should not be integrated into any of the other display/entry devices because of adverse performance interference. The combination of all the controls for all the pertinent lights for three runways, with a status indication of each of the lighting systems, was determined to provide, in a concise package, all the associated functions in a noninterfering, nondegrading form. In accordance with the concept of providing information on only three runways per operating position, three sets of status and control buttons are provided as rapid I/O devices (see figure 4). A two-button sequence—one for the level of action to be taken (lighting level) and one for the device or system to be affected—is utilized. This is a practical, human engineered design that is deemed to provide optimum performance, chosen between the two limits: (1) fixed format, with one button for every single kind of action

possible—numerous buttons (reference 7), and (2) totally selectable format, with many button presses in a sequence—very few buttons.

By system design, an action to be accomplished is keyed into the computer with one or two key strokes. The legends on the key caps are computer controlled and do not indicate a change to the desired condition until the condition is achieved and sensed as achieved.

The combination of the entry switch button and the computer-controlled legend is accomplished in a commercially available product called a PROSWITCH™, which is a nonmechanical, high reliability, high legibility indicator designed to offer 12, 24, or 48 digitally selectable legends in a 1- by 1- by 4-inch package.

As conditions demand, runway use undergoes reconfiguration; runway and lighting designations are automatically changed on the controllers displays and control panels via automatic reconfiguration sequences in the computer, initiated by a choice of the appropriate runway usage configuration. In addition to automatically modifying the meaning of data at the working positions, the computer can provide a time-ordered prompting list on one of the supplementary display pages for the actual sequence to accomplish the reconfiguration.

SPECIAL OPERATIONAL SOFTWARE PHILOSOPHY.

One of the requirements that emerged through most of the operational discussions was that the CCD system user (the air traffic controller), aside from updating displayed data, needed to be able to make certain changes in the format, content, importance, priority, and value of the information routinely in use through the display system and as presented to him by the computer. The changes would be partially adaptive, partially preferential, partially

convenience, partially corrective, and partially experimental. The point made, however, was that without a routine, easy way to reformat certain types of data as daily or even hourly demands changed, a psychological barrier to user flexibility would seriously inhibit the confidence development, and user acceptability, of this critical system.

In 1975, the FAA's System Research and Development Service sponsored a project at Washington ARTCC called MAPS, to provide supplemental data to en route controllers. Part of this effort was to investigate, develop, and program limited capability to allow the controller to make simple modifications of his display formats based on his own preferences. The contractor individual who prepared the software for the MAPS system, K. Dilkes, subsequently became a subcontractor through the Small Business Administration and Mandex, Incorporated, on contract DOT-FA-78NA-5505 (reference 8). The contract was awarded to help develop, to a high detail level, the operating system requirements, including "flexible format display" for the CCD Engineering Requirements.

The extensive flexibility, both for the user/controller and for the tower/TRACON complex, comes from a software program that handles incoming data in an innovative way, filters and stores data, extracts it in a proper and rapid fashion, and reassembles it for display purposes. But, it also includes the ability and the special interactive capability for computer aided and prompted data manipulation for display purposes. It is not the controller's choice as to whether or not certain forms of data must appear on his displays, but only where, how, and with what forms of alert indication it will appear. This flexibility is not designed to destroy site-to-site uniformity for the Air Traffic Service; on the contrary, it encourages data "content" uniformity while allowing data "format" flexibility on a safe, fast,

convenient, and control-position-adaptation basis. Another aspect of this flexibility is the inherent software ability to accept new terminal-related expansions, such as runways, equipment, procedures lists, weather sources, navigation aids, and other data sources that would require modification of a data display. New items can be added by the user, without a programmer's entries, at any time with the computer's help. This capability is intended as a vital parallel for the expandability of the computer and other hardware.

By requirement, the system must be expandable to handle the data display from those operational functions which were "undefined" as of the ER date; this would appear as an impossibility, especially with respect to computer sizing, speed, and performance, and display and control system performance. By proper choice of system architecture, however, this requirement can be and is being met (reference 9, par. 3.2.1, 3.4.1, and 3.5 of Integrated Potential Requirements for En Route ATC Computer System, A006, AAF-700).

By expanding on the original MAPS experiences, it became possible to provide, within the CCD ER, a complete, detailed set of operational specifications which covered the following: exactly what performance was to be expected for specific input stimuli and how to test for this performance achievement, what priority and order was to be followed, what software mnemonics were to be applied, what sequences of work input were to be used, etc. The entire set of ATC operational performance requirements for the whole CCD was divided into 15 demonstrable units (DU's), each of which tested and demonstrated completely the performance of the entire CCD system as far as the ATC user would be concerned. The orderly, sequential completion of the 15 "DU's" was both a measure of the technical performance of the CCD system and a contractual indication for the ATC user that all the operational functions,

including the use of flexibility formatting, were performed properly.

In its simplest form, the detail of the ER, and especially of the "Operational Specifications" (as witnessed by the content of the Appendix 1-20 to Part 1 of the ER) resulted from an FAA knowledge of the exact performance, in great detail, that its own operating services required. To leave much of this detail up to a contractor, who could never be as experienced in ATC system operational performance as the FAA, was deemed unnecessarily risky and uneconomical. By benefiting from specific prior FAA experiences, the authors of the ER could validly include such details and requirements and, in effect, remove much of the research and development risk that a contractor would be exposed to in dealing with the design of an ATC data management and display system.

Because of its size (170 pages), Appendix 1-20 to FAA-ER-500-007/1 is not an enclosure to this report, but is readily available through normal documentation sources, as well as Airway Facilities Service (AAF-740). It serves as an embodiment of the operational specifications and places them, as a complete set, in the form of requirements to be met by the contractor. The arbitrary aspects of contractor responsibility in the ATC operational performance of the CCD are removed.

CONCLUSIONS

It is concluded that:

1. The Engineering Requirement (ER) prepared as the official output of the project is, in both form and substance, a document suitable for the purpose of system procurement, as witnessed by the signatory approvals of the appropriate Service Directors, including the Associate Administrator of Air Traffic and Airway Facilities (ATF-1), and the

approval by the Administrator of the Federal Aviation Administration (AOA-1) of Selection Plan No. 11-78 (reference 10) for the implementation of Consolidated Cab Display (CCD) systems.

2. The process used to establish, develop, validate, and verify the requirements for the CCD system is a viable, responsible, thorough, and necessary process to follow when a system is to be designed for air traffic control (ATC) operational use.

3. The use of detailed operational specifications, expressly prepared to describe the methods, forms, procedures, and expected results of operational utilization of all the operational functions of a human-operated display and control system, is the most satisfactory method of assuring operator approval, contractor comprehension and compliance, and completed system functional integrity.

4. The use of different types of display devices, as described, is not to be regarded casually, especially when logistics, maintenance, and training aspects emphasize commonality. However, since technology permitted it, cost did not prohibit it, and operational performance requirements left little room for compromise, the design choices had to be made in favor of the system user—in this case the ATC specialist.

5. The state-of-the-art of computer systems for fail-safe, real-time use with no loss of data is comfortably and adequately high for FAA's needs.

6. The concept of a system design that permits uninterruptable system expansions, both in hardware and software, is very viable, and has been implemented in commercially available computer systems.

7. Implementation of the concept of a fully flexible format capability to be utilized by an ATC specialist is critical to controller acceptability of data management and display systems.

8. The interservice agreement process that was used enabled close cooperation, planning, work efforts, and approvals by the participants of the project. The timely completion of the documentation resulted in a high level of appropriate service approvals.

RECOMMENDATIONS

It is recommended that:

1. The interservice agreement process be utilized and encouraged under the guidelines and example of the Consolidated Cab Display (CCD) effort.
2. The requirements determination process that was followed be encouraged and recommended for other programs that relate to man-machine systems integration.
3. Detailed operational specifications, similar to those utilized in the CCD Engineering Requirement (ER), be required as part of any ER or specification that relates to man-machine systems, as both an indication of the detail of the Federal Aviation Administration's (FAA's) knowledge of its requirements and an indication of the reduced risk role of the contractor.
4. The CCD ER, in form and substance, be the basis for a terminal data management system for FAA implementation.
2. DOT/FAA, Consolidated Cab Display/Remote Maintenance Monitor System, FAA-ER-500-007, SI7-79.
3. Data Display Requirements for ATCT's and FSS's, 9550.1, AAF-440-077-003.
4. Terminal ATCT Display Consolidation and Remote Maintenance Monitoring, Staff Study, AAF-510, Revision A, February 23, 1979.
5. Bishop, G., et al, Preliminary Consolidation Display Designs, DTS-522, FAA-RD-79-24.
6. Atlanta Terminal Information Processing System (TIPS) and Consolidated Cab Display (CCD) Installation/Integration Analysis Draft Report, DTS-541.
7. Grambart, J. E., Human Engineering Analysis of Airport Lighting Control Panels, and Proposal for a New Design, FAA-RD-72-93.
8. Detailed Operational System Requirements Preparation, (Statement of Work), DOT-FA78NA-5505.
9. Integrated Potential Requirements for En Route ATC Computer Systems, A006, AAF-700.
10. Selection Plan No. 11-78, FAA.

REFERENCES

1. Proposed Joint Effort Between the Airway Facilities Service and FAA Technical Center for Development of a Remote Status and Performance Evaluation System, AAF-400/500.

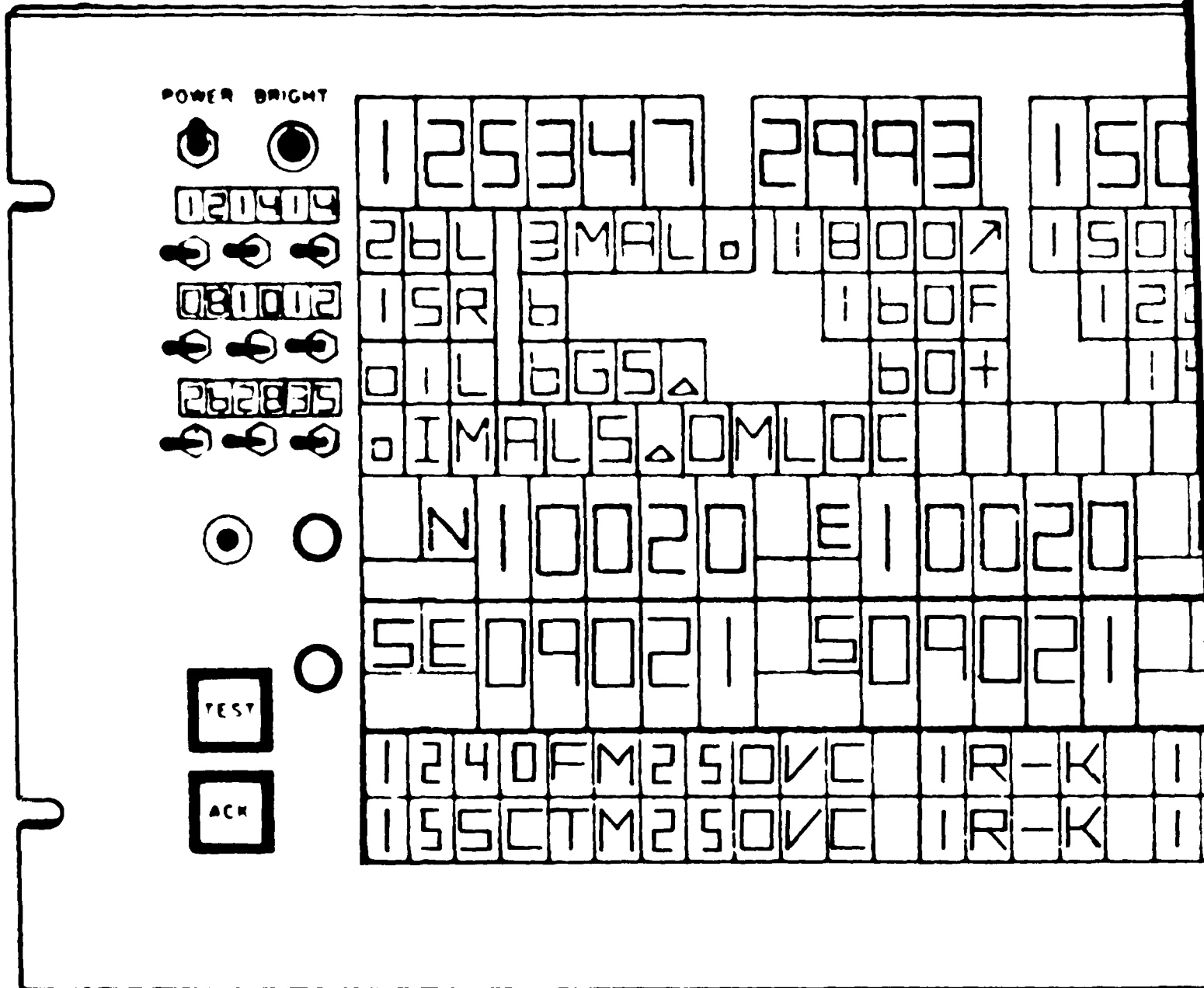


FIGURE 1. CRITICAL DISPLAY—FRONT PANEL LAYOUT (FULL SC

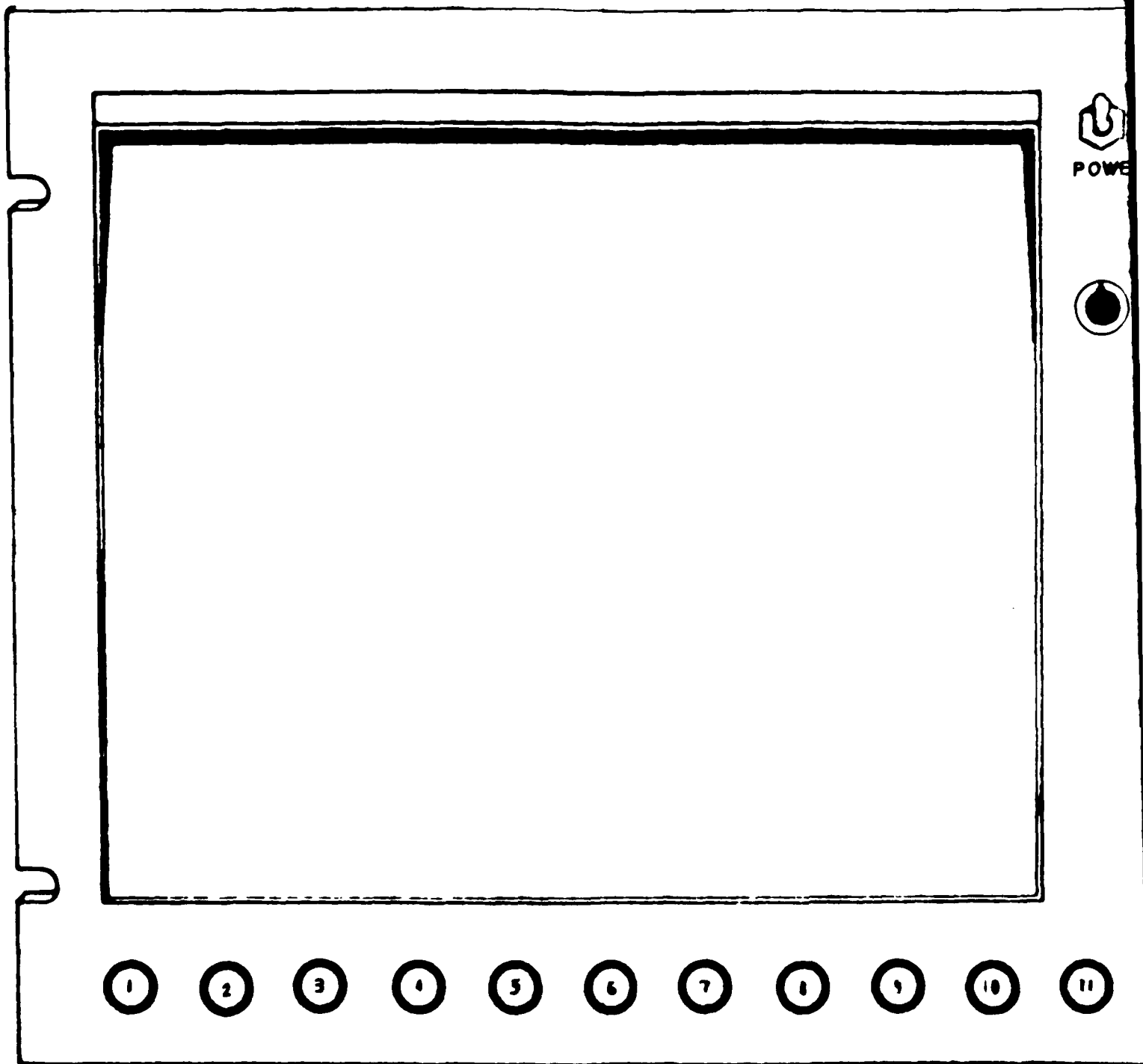
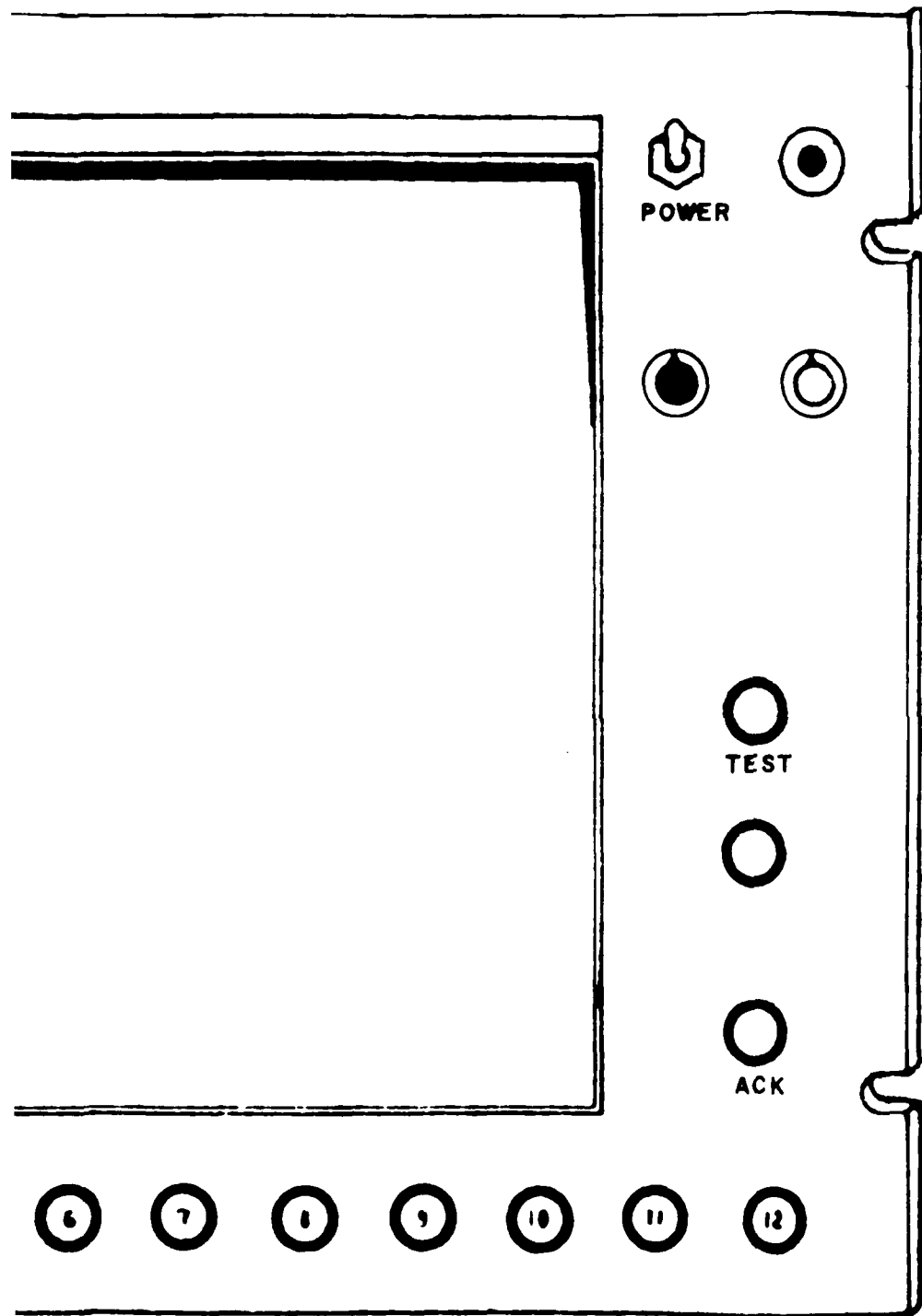


FIGURE 2. SUPPLEMENTARY DISPLAY (FULL SCALE)



80-20-2

SUPPLEMENTARY DISPLAY (FULL SCALE)

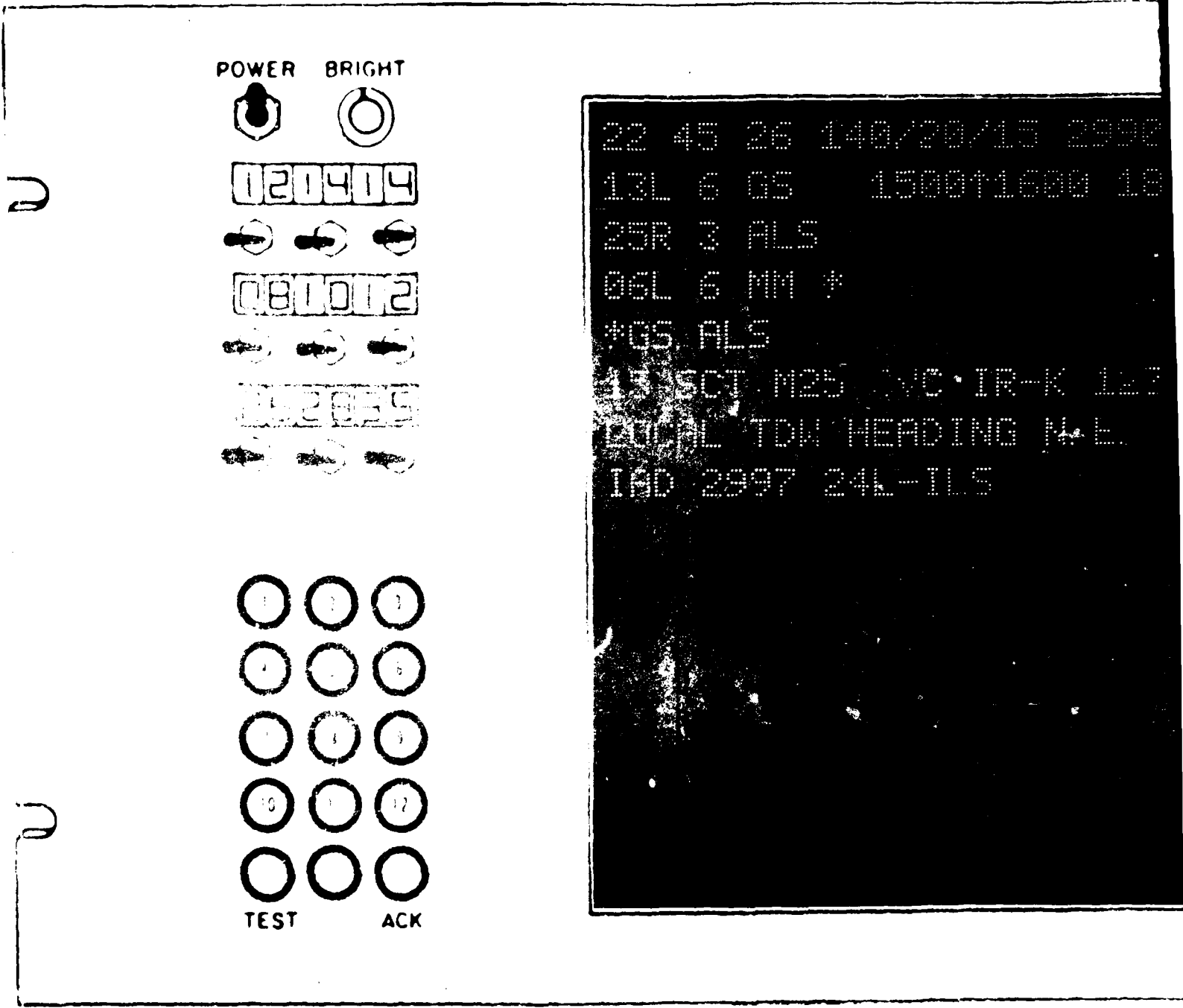
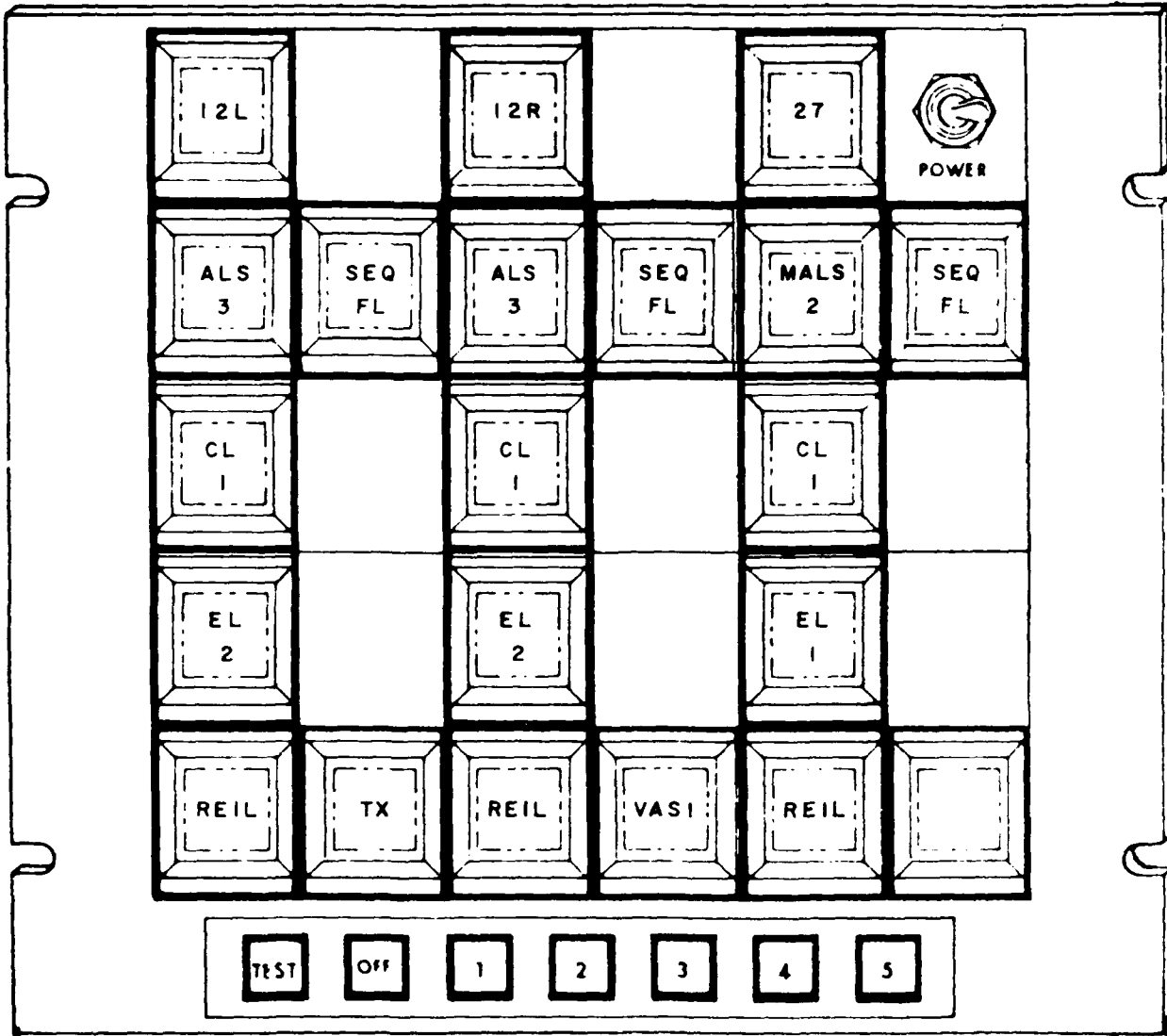


FIGURE 3. TRACON DISPLAY—PANEL LAYOUT (FULL SCALE)

22 45 26 140/20/15 2990 ATIS-D
13L 6 GS 1500+1600 1800+ST-4
25R 3 ALS
06L 6 MM *
*GS ALS
45 DT M25 VC IR-K 123/10/56
200 L TDW HEADING N. E. ID 5
IAD 2997 24L-ILS

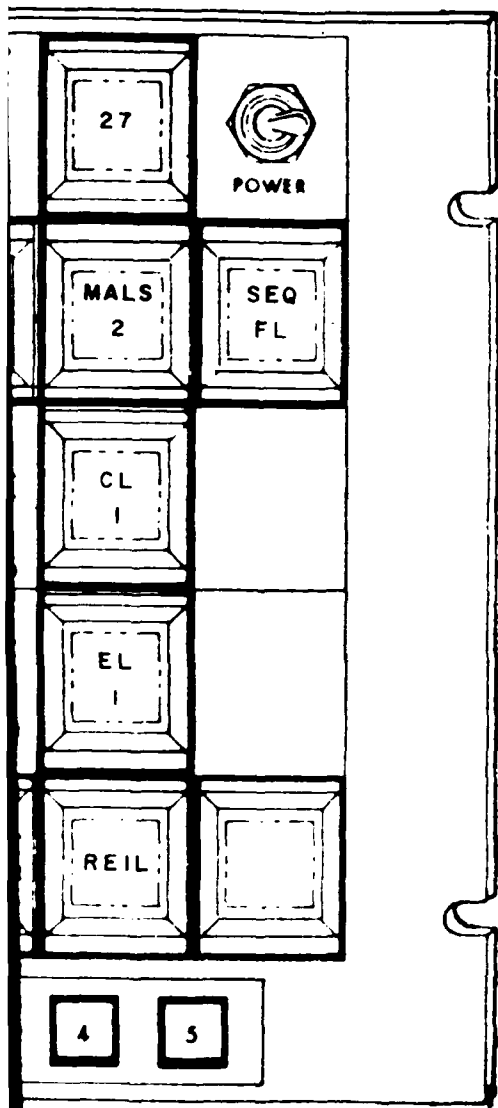
ACON DISPLAY—PANEL LAYOUT (FULL SCALE)



12
C
E
RE
SE
TX
VA
AL
MA

80-20-4

FIGURE 4. LIGHTING CONTROL PANEL (FULL SCALE)



80-20-4

LEGEND

- I2L I2R 27 - RUNWAY NUMBERS
- CL - CENTERLINE (RUNWAY)
- EL - EDGE LIGHTS
- REIL - RUNWAY EDGE ILLUMINATION LIGHTS
- SEQ FL - SEQUENCE FLASHER
- TX - TAXIWAY LIGHTS
- VASI - VISUAL APPROACH SLOPE INDICATOR
- ALS - APPROACH LIGHTING SYSTEM
- MALS - MANUAL LIGHTING SYSTEM

FIGURE 4. LIGHTING CONTROL PANEL (FULL SCALE)

APPENDIX A

FAA-ER-500-007, PART 1, APPENDIX 1-20, TABLE OF CONTENTS

APPENDIX 1-20 TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.1	INTRODUCTION	45
1-20.1.1	Purpose	45
1-20.1.2	Scope	45
1-20.1.3	Background	45
1-20.1.3.1	Position Description	45
1-20.1.4	Concept of Operation	47
1-20.1.5	Functional Capabilities	48
1-20.1.5.1	Define/Modify Data Element	49
1-20.1.5.2	Edit/Modify the Contents of Data Element	51
1-20.1.5.3	Define/Modify Page	51
1-20.1.5.4	Supplementary Display Assignment	51
1-20.1.5.5	Display Time Function	51
1-20.1.5.6	Display Barometric Pressure Function	51
1-20.1.5.7	Display Center Field Wind Function	51
1-20.1.5.8	Display Assigned Runway Data Function	51
1-20.1.5.9	Display ATIS Character Function	52
1-20.1.5.10	Surface Observations (SA)	52
1-20.1.5.11	Change of Data Alert Display-Surface Wind Display	52
1-20.1.5.12	Request Runway Visual Range Alarm	52
1-20.1.5.13	Log On/Log Off	53
1-20.1.5.14	Entry of Adaptation Data	53
1-20.1.5.15	Assign Runways Function	53
1-20.1.5.16	Configuration Control Function	53
1-20.1.5.17	Display of Supplementary Pages Function	54
1-20.1.5.18	Acknowledgement Function	54
1-20.1.5.19	Control Time Function	54
1-20.1.5.20	Control Barometer Pressure Function	54
1-20.1.5.21	Control Center Field Wind Function	54
1-20.1.5.22	Control VAS Separation Distance Function	55
1-20.1.5.23	Control Runway Alert Data Function	55
1-20.1.5.24	Input ATIS Character	55
1-20.1.5.25	Display of Sensor Display Inhibition Page	55
1-20.1.5.26	Re-enable Critical Sensor Display Function	55
1-20.1.5.27	Control Lights Function	56
1-20.1.5.28	Data Recording Function	56
1-20.1.5.29	Backup Critical Display Function	56
1-20.1.5.30	Generate Simulation Data Tape	57
1-20.1.5.31	Simulation Execution	57

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.1.5.32	Event Reconstruction	57
1-20.1.5.33	Device Control Function	58
1-20.1.5.34	On-Line Fault Detection	58
1-20.1.5.35	Resource Monitoring Function	58
1-20.1.5.36	Cyclic Redundancy Check Function	58
1-20.1.5.37	Manual Initiated Recording System State	58
1-20.1.5.38	Maintenance Hardcopy Report	60
1-20.1.5.39	Message Definition Function	60
1-20.2	Applicable Documents	60
1-20.3	Operational Requirements	60
1-20.3.1	General	60
1-20.3.2	Overview	60
1-20.3.2.1	Operational Capability	61
1-20.3.2.1.1	Full Capability Description	61
1-20.3.2.1.2	Reduced Capability Description	62
1-20.3.3	Demonstrable Unit 1 - Data Base	66
1-20.3.3.1	System Components Required	66
1-20.3.3.2	Other Demonstrable Units Required	66
1-20.3.3.3	Function 1 - Command Input	66
1-20.3.3.3.1	Procedure 1 - Display of SMD Header Message	66
1-20.3.3.3.1.1	External Inputs	66
1-20.3.3.3.1.2	Functional Processing	66
1-20.3.3.3.1.3	External Outputs	66
1-20.3.3.3.1.4	Error Processing	67
1-20.3.3.3.1.5	Quality Assurance Provisions	67
1-20.3.3.3.2	Procedure 2 - Input Prompting and Escape Modes	67
1-20.3.3.3.2.1	External Inputs	67
1-20.3.3.3.2.2	Functional Processing	68
1-20.3.3.3.2.3	External Outputs	68
1-20.3.3.3.2.4	Error Processing	69
1-20.3.3.3.2.5	Quality Assurance Provisions	69
1-20.3.3.3.3	Procedure 3 - Command String Interpretation	69
1-20.3.3.3.3.1	External Inputs	69
1-20.3.3.3.3.2	Functional Processing	73
1-20.3.3.3.3.3	External Outputs	73
1-20.3.3.3.3.4	Error Processing	73
1-20.3.3.3.3.5	Quality Assurance Provisions	74
1-20.3.3.4	Function 2 - Data Base Definition	75
1-20.3.3.4.1	Procedure 1 - Specify Data Element Families	75
1-20.3.3.4.1.1	External Inputs	76
1-20.3.3.4.1.2	Functional Processing	78
1-20.3.3.4.1.3	External Outputs	78
1-20.3.3.4.1.4	Error Processing	78

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.3.4.1.5	Quality Assurance Provisions	78
1-20.3.3.4.2	Procedure 2 - Sepcify a List Data Element	78
1-20.3.3.4.2.1	External Inputs	78
1-20.3.3.4.2.2	Functional Processing	81
1-20.3.3.4.2.3	External Outputs	81
1-20.3.3.4.2.4	Error Processing	81
1-20.3.3.4.2.5	Quality Assurance Provisions	81
1-20.3.3.4.3	Procedure 3 - Modify a List Data Element	81
1-20.3.3.4.3.1	External Inputs	82
1-20.3.3.4.3.2	Functional Processing	82
1-20.3.3.4.3.3	External Outputs	83
1-20.3.3.4.3.4	Error Processing	83
1-20.3.3.4.3.5	Quality Assurance Provisions	84
1-20.3.3.4.4	Procedure 4 - Display a List Data Element	84
1-20.3.3.4.4.1	External Inputs	84
1-20.3.3.4.4.2	Functional Processing	84
1-20.3.3.4.4.3	External Outputs	85
1-20.3.3.4.4.4	Error Processing	85
1-20.3.3.4.4.5	Quality Assurance Provisions	85
1-20.3.3.4.5	Procedure 5 - Specify Structured Family Members	85
1-20.3.3.4.5.1	External Input	86
1-20.3.3.4.5.2	Functional Processing	87
1-20.3.3.4.5.3	External Outputs	87
1-20.3.3.4.5.4	Error Processing	87
1-20.3.3.4.5.5	Quality Assurance Provisions	88
1-20.3.3.5	Function 3 - Manual Data Entry	88
1-20.3.3.5.1	Procedure 1 - Enter Data Element Value	88
1-20.3.3.5.1.1	External Inputs	88
1-20.3.3.5.1.2	Functional Processing	88
1-20.3.3.5.1.3	External Outputs	89
1-20.3.3.5.1.4	Error Processing	89
1-20.3.3.5.1.5	Quality Assurance Provisions	89
1-20.3.3.5.2	Procedure 2 - Display Data Element Content	90
1-20.3.3.5.2.1	External Inputs	90
1-20.3.3.5.2.2	Functional Processing	90
1-20.3.3.5.2.3	External Outputs	90
1-20.3.3.5.2.4	Error Processing	90
1-20.3.3.5.2.5	Quality Assurance Provisioning	90
1-20.3.4	Demonstrable Unit 2 - Display Definition	90
1-20.3.4.1	System Components Required	90
1-20.3.4.2	Other Demonstrable Units Required	90

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.4.3	Function 1 - Page Description	90
1-20.3.4.3.1	Procedure 1 - Page Characteristics Specification	90
1-20.3.4.3.1.1	External Inputs	91
1-20.3.4.3.1.2	Functional Processing	91
1-20.3.4.3.1.3	External Outputs	91
1-20.3.4.3.1.4	Error Processing	91
1-20.3.4.3.1.5	Quality Assurance Provisions	93
1-20.3.4.3.2	Procedure 2 - Content Description	93
1-20.3.4.3.2.1	External Inputs	93
1-20.3.4.3.2.2	Functional Processing	93
1-20.3.4.3.2.3	External Outputs	94
1-20.3.4.3.2.4	Error Processing	94
1-20.3.4.3.2.5	Quality Assurance Provisions	95
1-20.3.4.3.3	Procedure 3 - Format Description	95
1-20.3.4.3.3.1	External Inputs	95
1-20.3.4.3.3.2	Functional Processing	95
1-20.3.4.3.3.3	External Outputs	96
1-20.3.4.3.3.4	Error Processing	96
1-20.3.4.3.3.5	Quality Assurance Provisions	97
1-20.3.4.4	Function 2 - Page Displays	97
1-20.3.4.4.1	Procedure 1 - Display Page	97
1-20.3.4.4.1.1	External Inputs	97
1-20.3.4.4.1.2	Functional Processing	97
1-20.3.4.4.1.3	External Outputs	98
1-20.3.4.4.1.4	Error Processing	98
1-20.3.4.4.1.5	Quality Assurance Provisions	99
1-20.3.4.4.2	Procedure 2 - Multiple Page Displays	99
1-20.3.4.4.2.1	External Inputs	99
1-20.3.4.4.2.2	Functional Processing	99
1-20.3.4.4.2.3	External Outputs	100
1-20.3.4.4.2.4	Error Processing	100
1-20.3.4.4.2.5	Quality Assurance Provisions	100
1-20.3.5	Demonstrable Unit 3 - Supervisory/Maintenance Display	100
1-20.3.5.1	System Components Required	101
1-20.3.5.2	Other Demonstrable Units Required	101
1-20.3.5.3	Function 1 - Log On/Log Off	101
1-20.3.5.3.1	Procedure 1 - SMD Log On	101
1-20.3.5.3.1.1	External Inputs	101
1-20.3.5.3.1.2	Functional Processing	101
1-20.3.5.3.1.3	External Outputs	101
1-20.3.5.3.1.4	Error Processing	102
1-20.3.5.3.1.5	Quality Assurance Provisions	102

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.5.3.2	Procedure 2 - User ID/Password Assignment	102
1-20.3.5.3.2.1	External Inputs	103
1-20.3.5.3.2.2	Functional Processing	103
1-20.3.5.3.2.3	External Outputs	103
1-20.3.5.3.2.4	Error Processing	103
1-20.3.5.3.2.5	Quality Assurance Provisions	103
1-20.3.5.3.3	Procedure 3 - SMD Log Off	103
1-20.3.5.3.3.1	External Inputs	103
1-20.3.5.3.3.2	Functional Processing	103
1-20.3.5.3.3.3	External Outputs	103
1-20.3.5.3.3.4	Error Processing	103
1-20.3.5.3.3.5	Quality Assurance Provisions	103
1-20.3.5.4	Function 2 - Alarms and Alerts	104
1-20.3.5.4.1	Procedure 1 - Definitions of Alert and Alarm Conditions	104
1-20.3.5.4.1.1	External Inputs	104
1-20.3.5.4.1.2	Functional Processing	105
1-20.3.5.4.1.3	External Outputs	105
1-20.3.5.4.1.4	Error Processing	105
1-20.3.5.4.1.5	Quality Assurance Provisions	105
1-20.3.5.4.2	Procedure 2 - Display of Console Alarms and Alerts	106
1-20.3.5.4.2.1	External Inputs	106
1-20.3.5.4.2.2	Functional Processing	106
1-20.3.5.4.2.3	External Outputs	106
1-20.3.5.4.2.4	Error Processing	106
1-20.3.5.4.2.5	Quality Assurance Provisions	106
1-20.3.5.4.3	Procedure 3 - Acknowledgements of Console Alarms and Alerts	106
1-20.3.5.4.3.1	External Inputs	106
1-20.3.5.4.3.2	Functional Processing	107
1-20.3.5.4.3.3	External Outputs	108
1-20.3.5.4.3.4	Error Processing	108
1-20.3.5.4.3.5	Quality Assurance Provisions	108
1-20.3.5.4.4	Procedure 4 - Display of Supplementary Display Alarms and Alerts	109
1-20.3.5.4.4.1	External Inputs	109
1-20.3.5.4.4.2	Functional Processing	109
1-20.3.5.4.4.3	External Outputs	109
1-20.3.5.4.4.4	Error Processing	109
1-20.3.5.4.4.5	Quality Assurance Provisions	109
1-20.3.5.4.5	Procedure 5 - Acknowledgement of Supplementary Alarms and Alerts	110

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.5.4.5.1	External Inputs	110
1-20.3.5.4.5.2	Functional Processing	110
1-20.3.5.4.5.3	External Outputs	110
1-20.3.5.4.5.4	Error Processing	110
1-20.3.5.4.5.5	Quality Assurance Provisions	110
1-20.3.5.5	Function 3 - Page and Device Assignment	110
1-20.3.5.5.1	Procedure 1 - Assign SD Data Pages	111
1-20.3.5.5.1.1	External Inputs	111
1-20.3.5.5.1.2	Functional Processing	111
1-20.3.5.5.2.3	External Outputs	111
1-20.3.5.5.1.4	Error Processing	112
1-20.3.5.5.1.5	Quality Assurance Provisions	112
1-20.3.5.5.2	Procedure 2 - Select Supplementary Display Configuration	112
1-20.3.5.5.2.1	External Inputs	112
1-20.3.5.5.2.2	Functional Processing	112
1-20.3.5.5.2.3	External Outputs	112
1-20.3.5.5.2.4	Error Processing	113
1-20.3.5.5.2.5	Quality Assurance Provisions	113
1-20.3.6	Demonstrable Unit 4 - Data Recording and Simulation	113
1-20.3.6.1	Functional Capabilities Description	113
1-20.3.6.2	System Components Required	114
1-20.3.6.3	Other Demonstrable Units Required	114
1-20.3.6.4	Function 1 - Maintenance Hardcopy Reports	114
1-20.3.6.2	System Components Required	114
1-20.3.6.4	Function 1 - Maintenance Hardcopy Reports	114
1-20.3.6.4.1	External Inputs	114
1-20.3.6.4.2	Functional Processing	114
1-20.3.6.4.3	External Outputs	114
1-20.3.6.4.4	Error Processing	114
1-20.3.6.4.5	Quality Assurance Provisioning	115
1-20.3.6.5	Function 2 - Generate Simulation Data File	115
1-20.3.6.5.1	External Inputs	115
1-20.3.6.5.2	Functional Processing	116
1-20.3.6.5.3	External Outputs	116
1-20.3.6.5.4	Error Processing	117
1-20.3.6.5.5	Quality Assurance Provisions	118
1-20.3.6.6	Function 3 - Manually Initiated Recording of System State	118
1-20.3.6.6.1	External Inputs	118
1-20.3.6.6.2	Functional Processing	118
1-20.3.6.6.3	External Outputs	119
1-20.3.6.6.4	Error Processing	119

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.6.6.5	Quality Assurance Provisions	119
1-20.3.6.7	Function 4 - Data Recording	119
1-20.3.6.7.1	External Inputs	119
1-20.3.6.7.2	Functional Processing	120
1-20.3.6.7.3	External Outputs	121
1-20.3.6.7.4	Error Processing	122
1-20.3.6.7.5	Quality Assurance Provisions	123
1-20.3.7	Demonstrable Unit 5 - Critical Display Functions	123
1-20.3.7.1	Functional Capabilities Description	123
1-20.3.7.2	System Components Required	124
1-20.3.7.3	Other Demonstrable Units Required	124
1-20.3.7.4	Function 1 - Display Time	124
1-20.3.7.4.1	External Inputs	124
1-20.3.7.4.2	Functional Processing	128
1-20.3.7.4.3	External Outputs	128
1-20.3.7.4.4	Error Processing	128
1-20.3.7.4.5	Quality Assurance Provisions	128
1-20.3.7.5	Function 2 - Display Barometric Pressure	129
1-20.3.7.5.1	External Inputs	129
1-20.3.7.5.2	Functional Processing	129
1-20.3.7.5.3	External Outputs	129
1-20.3.7.5.4	Error Processing	129
1-20.3.7.5.5	Quality Assurance Provisions	129
1-20.3.7.6	Function 3 - Display Centerfield Wind	130
1-20.3.7.6.1	External Inputs	130
1-20.3.7.6.2	Functional Processing	130
1-20.3.7.6.3	External Outputs	130
1-20.3.7.6.4	Error Processing	130
1-20.3.7.6.5	Quality Assurance Provisions	131
1-20.3.7.7	Function 4 - Display ATIS Character	131
1-20.3.7.7.1	External Inputs	131
1-20.3.7.7.2	Functional Processing	131
1-20.3.7.7.3	External Outputs	131
1-20.3.7.7.4	Error Processing	131
1-20.3.7.7.5	Quality Assurance Provisions	131
1-20.3.7.8	Function 5 - Assign Runways	132
1-20.3.7.8.1	External Inputs	132
1-20.3.7.8.2	Functional Processing	132
1-20.3.7.8.3	External Outputs	132
1-20.3.7.8.4	Error Processing	132
1-20.3.7.8.5	Quality Assurance Provisions	133

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.7.9	Function 6 - Configuration Control	133
1-20.3.7.9.1	External Inputs	134
1-20.3.7.9.2	Functional Processing	134
1-20.3.7.9.3	External Outputs	134
1-20.3.7.9.4	Error Processing	134
1-20.3.7.9.5	Quality Assurance Provisions	134
1-20.3.7.10	Function 7 - Display Assigned Runway Data	134
1-20.3.7.10.1	External Inputs	134
1-20.3.7.10.2	Functional Processing	135
1-20.3.7.10.3	External Outputs	138
1-20.3.7.10.4	Error Processing	138
1-20.3.7.10.5	Quality Assurance Provisions	139
1-20.3.7.11	Function 8 - Surface Wind Display	140
1-20.3.7.11.1	External Inputs	140
1-20.3.7.11.2	Functional Processing	140
1-20.3.7.11.3	External Outputs	140
1-20.3.7.11.4	Error Processing	141
1-20.3.7.11.5	Quality Assurance Provisions	141
1-20.3.7.12	Function 9 - Surface Observations	141
1-20.3.7.12.1	External Inputs	141
1-20.3.7.12.2	Functional Processing	141
1-20.3.7.12.3	External Outputs	142
1-20.3.7.12.4	Error Processing	142
1-20.3.7.12.5	Quality Assurance Provisions	142
1-20.3.7.13	Function 10 - Request Runway Visual Range Alarm	143
1-20.3.7.14	Function 11 - Backup Critical Display Data Page	143
1-20.3.8	Demonstrable Unit 6 - Input Message Processing	143
1-20.3.8.1	System Components Required	143
1-20.3.8.2	Other Demonstrable Units Required	143
1-20.3.8.3	Function 1 - Input Message Definition	143
1-20.3.8.3.1	Procedure 1 - Message Format Definition	144
1-20.3.8.3.1.1	External Inputs	144
1-20.3.8.3.1.2	Functional Processing	145
1-20.3.8.3.1.3	External Outputs	145
1-20.3.8.3.1.4	Error Processing	145
1-20.3.8.3.1.5	Quality Assurance Provisions	146
1-20.3.8.3.2	Procedure 2 - Look Up Table Definition	146
1-20.3.8.3.2.1	External Inputs	146
1-20.3.8.3.2.2	Functional Processing	146
1-20.3.8.3.2.3	External Outputs	146
1-20.3.8.3.2.4	Error Processing	146
1-20.3.8.3.2.5	Quality Assurance Provisions	146

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.8.3.3	Procedure 3 - Device Message Attribute Definition	147
1-20.3.8.3.3.1	External Inputs	147
1-20.3.8.3.3.2	Functional Processing	147
1-20.3.8.3.3.3	External Outputs	147
1-20.3.8.3.3.4	Error Processing	147
1-20.3.8.3.3.5	Quality Assurance Provisions	148
1-20.3.8.4	Function 2 - Input Message Conversion	148
1-20.3.8.4.1	External Inputs	148
1-20.3.8.4.2	Functional Processing	148
1-20.3.8.4.3	External Outputs	149
1-20.3.8.4.4	Error Processing	149
1-20.3.8.4.5	Quality Assurance Provisions	149
1-20.3.8.5	Function 3 - Simulation/Recording Tape Input Processing	149
1-20.3.8.5.1	Procedure 1 - Simulation/Recording Tape Input Definition	149
1-20.3.8.5.1.1	External Inputs	150
1-20.3.8.5.1.2	Functional Processing	150
1-20.3.8.5.1.3	External Outputs	150
1-20.3.8.5.1.4	Error Processing	150
1-20.3.8.5.1.5	Quality Assurance Provisions	150
1-20.3.8.5.2.1	External Inputs	150
1-20.3.8.5.2.2	Functional Processing	152
1-20.3.8.5.2.3	External Outputs	152
1-20.3.8.5.2.4	Error Processing	153
1-20.3.8.6.2.5	Quality Assurance Provisions	154
1-20.3.9	Demonstrable Unit 7 - FPU Polling	154
1-20.3.9.1	System Components Required	154
1-20.3.9.2	Other Demonstrable Units Required	154
1-20.3.9.3	Function 1 - Definition of FPU Poll List	154
1-20.3.9.3.1	External Inputs	154
1-20.3.9.3.2	Functional Processing	155
1-20.3.9.3.3	External Outputs	155
1-20.3.9.3.4	Error Processing	155
1-20.3.9.3.5	Quality Assurance Provisions	155
1-20.3.9.4	Function 2 - FPU Poll Generation	155
1-20.3.9.4.1	External Inputs	155
1-20.3.9.4.2	Functional Processing	156

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.9.4.3	External Outputs	156
1-20.3.9.4.4	Error Processing	156
1-20.3.9.4.5	Quality Assurance Provisions	156
1-20.3.9.5	Function 3 - FPU Response Checks	156
1-20.3.9.5.1	External Inputs	157
1-20.3.9.5.2	Functional Processing	157
1-20.3.9.5.3	External Outputs	157
1-20.3.9.5.4	Error Processing	157
1-20.3.9.5.5	Quality Assurance Provisions	157
1-20.3.10	Demonstrable Unit 8 - Process Service A Messages	157
1-20.3.10.1	Functional Capabilities Description	157
1-20.3.10.2	System Components Required	157
1-20.3.10.3	Other Demonstrable Units Required	157
1-20.3.10.4	Function 1 - Process Service A Messages	158
1-20.3.10.4.1	Procedure 1 - SA Group Processing	158
1-20.3.10.4.1.1	External Inputs	158
1-20.3.10.4.1.1.1	External Input for Weather Messages	159
1-20.3.10.4.1.1.2	External Input for NOTAM Messages	161
1-20.3.10.4.1.1.3	External Input for NOTAM Cancellation Messages	161
1-20.3.10.4.1.2	Functional Processing	161
1-20.3.10.4.1.3	External Outputs	163
1-20.3.10.4.1.4	Error Processing	163
1-20.3.10.4.1.5	Quality Assurance Provisions	163
1-20.3.10.4.2	Procedure 2 - NOSUM Group Processing	166
1-20.3.10.4.2.1	External Inputs	166
1-20.3.10.4.2.2	Functional Processing	167
1-20.3.10.4.2.3	External Outputs	167
1-20.3.10.4.2.4	Error Processing	167
1-20.3.10.4.2.5	Quality Assurance Provisions	167
1-20.3.10.4.3	Procedure 3 - FDC NOTAM Group Processing	168
1-20.3.10.4.3.1	External Inputs	168
1-20.3.10.4.3.2	Functional Processing	169
1-20.3.10.4.3.3	External Outputs	169
1-20.3.10.4.3.4	Error Processing	170
1-20.3.10.4.3.5	Quality Assurance Provisions	170
1-20.3.10.4.4	Procedure 4 - CARF CNTM Group Processing	171
1-20.3.10.4.4.1	External Inputs	171
1-20.3.10.4.4.2	Functional Processing	171
1-20.3.10.4.4.3	External Outputs	172
1-20.3.10.4.4.4	Error Processing	172
1-20.3.10.4.4.5	Quality Assurance Provisions	172
1-20.3.10.4.5	Procedure 5 - UB Group Processing	173
1-20.3.10.4.5.1	External Inputs	173
1-20.3.10.4.5.2	Functional Processing	174

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.10.4.5.3	External Outputs	175
1-20.3.10.4.5.4	Error Processing	175
1-20.3.10.4.5.5	Quality Assurance Provisions	175
1-20.3.10.4.6	Procedure 6 - AC Group Processing	176
1-20.3.10.4.6.1	External Inputs	176
1-20.3.10.4.6.2	Functional Processing	176
1-20.3.10.4.6.3	External Outputs	177
1-20.3.10.4.6.4	Error Processing	177
1-20.3.10.4.6.5	Quality Assurance Provisions	177
1-20.3.10.4.7	Procedure 7 - WW Group Processing	177
1-20.3.10.4.7.1	External Inputs	177
1-20.3.10.4.7.2	Functional Processing	179
1-20.3.10.4.7.3	External Outputs	179
1-20.3.10.4.7.4	Error Processing	179
1-20.3.10.4.7.5	Quality Assurance Provisions	180
1-20.3.10.4.8	Procedure 8 - WH Group Processing	180
1-20.3.10.4.8.1	External Inputs	180
1-20.3.10.4.8.2	Functional Processing	181
1-20.3.10.4.8.3	External Outputs	181
1-20.3.10.4.8.4	Error Processing	181
1-20.3.10.4.8.5	Quality Assurance Provisions	181
1-20.3.10.4.9	Procedure 9 - WS, UWS, WA, and WAC Group Processing	182
1-20.3.10.4.9.1	External Inputs	182
1-20.3.10.4.9.2	Functional Processing	184
1-20.3.10.4.9.3	External Outputs	184
1-20.3.10.4.9.4	Error Processing	184
1-20.3.10.4.9.5	Quality Assurance Provisions	185
1-20.3.10.4.10	Procedure 10 - WST Group Processing	186
1-20.3.10.4.10.1	External Inputs	186
1-20.3.10.4.10.2	Functional Processing	187
1-20.3.10.4.10.3	External Outputs	187
1-20.3.10.4.10.4	Error Processing	187
1-20.3.10.4.10.5	Quality Assurance Provisions	188
1-20.3.10.4.11	Procedure 11 - FA Group Processing	188
1-20.3.10.4.11.1	External Inputs	188
1-20.3.10.4.11.2	Functional Processing	189
1-20.3.10.4.11.3	External Outputs	189
1-20.3.10.4.11.4	Error Processing	189
1-20.3.10.4.11.5	Quality Assurance Provisions	189
1-20.3.10.4.12	Procedure 12 - FT Group Processing	190
1-20.3.10.4.12.1	External Inputs	190

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.10.4.12.2	Functional Processing	191
1-20.3.10.4.12.3	External Outputs	191
1-20.3.10.4.12.4	Error Processing	191
1-20.3.10.4.12.5	Quality Assurance Provisions	191
1-20.3.10.4.13	Procedure 13 - FD Group Processing	192
1-20.3.10.4.13.1	External Inputs	192
1-20.3.10.4.13.2	Functional Processing	193
1-20.3.10.4.13.3	External Outputs	193
1-20.3.10.4.13.4	Error Processing	193
1-20.3.10.4.13.5	Quality Assurance Provisions	193
1-20.3.10.4.14	Procedure 14- SD Group Processing	194
1-20.3.10.4.14.1	External Inputs	194
1-20.3.10.4.14.2	Functional Processing	194
1-20.3.10.4.14.3	External Outputs	195
1-20.3.10.4.14.4	Error Processing	195
1-20.3.10.4.14.5	Quality Assurance Provisions	195
1-20.3.10.4.15	Procedure 15 - TWEB/SYNS Group Processing	196
1-20.3.10.4.15.1	External Inputs	196
1-20.3.10.4.15.2	Functional Processing	197
1-20.3.10.4.15.3	External Outputs	197
1-20.3.10.4.15.4	Error Processing	197
1-20.3.10.4.15.5	Quality Assurance Provisions	197
1-20.3.10.4.16	Procedure 16 - WO Group Processing	198
1-20.3.10.4.16.1	External Inputs	198
1-20.3.10.4.16.2	Functional Processing	199
1-20.3.10.4.16.3	External Outputs	199
1-20.3.10.4.16.4	Error Processing	199
1-20.3.10.4.16.5	Quality Assurance Provisions	199
1-20.3.10.4.17	Procedure 17 - FX Group Processing	200
1-20.3.10.4.17.1	External Inputs	200
1-20.3.10.4.17.2	Functional Processing	201
1-20.3.10.4.17.3	External Outputs	201
1-20.3.10.4.17.4	Error Processing	201
1-20.3.10.4.17.5	Quality Assurance Provisions	201
1-20.3.10.4.18	Procedure 18 - Message Editing and Correction	201
1-20.3.10.4.18.1	External Inputs	201
1-20.3.10.4.18.2	Functional Processing	202
1-20.3.10.4.18.3	External Outputs	203
1-20.3.10.4.18.4	Error Processing	203
1-20.3.10.4.18.5	Quality Assurance Provisions	203
1-20.3.11	Demonstrable Unit 9 - Device Control	205
1-20.3.11.1	Functional Capabilities Description	205

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20.3.11.2	System Components Required	206
1-20.3.11.3	Other Demonstrable Units Required	206
1-20.3.11.4	Function 1 Control Lights	206
1-20.3.11.4.1	Procedure 1 - Decode Tower Cab Control Buttons	208
1-20.3.11.4.1.1	External Inputs	208
1-20.3.11.4.1.2	Functional Processing	208
1-20.3.11.4.1.3	External Outputs	208
1-20.3.11.4.1.4	Error Processing	208
1-20.3.11.4.1.5	Quality Assurance Provisions	209
1-20.3.11.5	Function 7 - Device Control	209
1-20.3.11.5.1	Procedure 1 - Specify Control	209
1-20.3.11.5.1.1	External Inputs	209
1-20.3.11.5.1.2	Functional Processing	209
1-20.3.11.5.1.3	External Outputs	209
1-20.3.11.5.1.4	Error Processing	210
1-20.3.11.5.1.5	Quality Assurance Provisions	210
1-20.3.11.5.2	Procedure 2 - Control Device	210
1-20.3.11.5.2.1	External Inputs	210
1-20.3.11.5.2.2	Functional Processing	210
1-20.3.11.5.2.3	External Outputs	210
1-20.3.11.5.2.4	Error Processing	210
1-20.3.11.5.2.5	Quality Assurance provisions	211
1-20.3.12	Demonstrable Unit 10 - Event Reconstruction	211
1-20.3.12.1	Functional Capabilities Description	211
1-20.3.12.2	System Components Required	211
1-20.3.12.3	Demonstrable Units Required	211
1-20.3.12.4	Function 1 - Event Reconstruction	211
1-20.3.12.4.1	External Inputs	212
1-20.3.12.4.2	Functional Processing	213
1-20.3.12.4.3	External Outputs	215
1-20.3.12.4.4	Error Processing	215
1-20.3.12.4.5	Quality Assurance Provisions	215

LIST OF TABLES

1-20-1	Remote Instruments and Devices	59
1-20-2	List of Demonstrable Units	63
1-20-3	List of Functions by Definition Section and the DU that Performs the Function	64
1-20-4	Summary of Command Sequences	204

FAA-ER-500-007/1

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1-20-1	Function Summary	49
1-20-2	Command/Subcommand Hierarchy Rules	71
1-20-3	Critical Display Format	125
1-20-4	Backup Critical Display Page Format	126
1-20-5	Lighting Control Panel Layout	207

APPENDIX B

FAA-ER-500-007, PART 2, APPENDIX 2-1, TABLE OF CONTENTS

APPENDIX 2-1 TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
2-1	SCOPE	2
2-1.1	Scope of Part 2	2
2-1.2	Applicable Definitions	2
2-1.3	Applicable Abbreviations	2
2-2	Applicable Documents	3
2-2.1	FAA Documents	3
2-2.1.1	FAA Specification	3
2-2.2	Other Documents	3
2-3	Requirements	3
2-3.1	General Description	3
2-3.2	General Requirements	4
2-3.3	Equipment to be Furnished by the Contractor	5
2-3.3.1	Critical Display	5
2-3.3.1.1	Operational Performance Requirements	5
2-3.3.1.1.1	Continuous Display	5
2-3.3.1.1.2	Update Time	6
2-3.3.1.1.3	Display Boundary Surface Wind	6
2-3.3.1.1.4	Set RVR Alarm Limit	6
2-3.3.1.1.5	Alarm Alert/Alarm Acknowledge	6
2-3.3.1.1.6	Manual Request Logging	6
2-3.3.1.2	Hardware/Performance Requirements	6
2-3.3.1.2.1	Functions and Contents	7
2-3.3.1.2.2	Size	7
2-3.3.1.2.3	Panel Layout	7
2-3.3.1.2.3.1	Automatic Brightness Control	7
2-3.3.1.2.3.2	Manual Brightness Control	8
2-3.3.1.2.4	Test Button	8
2-3.3.1.2.5	Acknowledge Button	8
2-3.3.1.2.6	LLWSAS Buttons	8
2-3.3.1.2.7	RVR Threshold Controls	8
2-3.3.1.2.8	Alarm	8
2-3.3.1.2.9	Marking	8
2-3.3.1.2.10	Display Information Location	9
2-3.3.1.2.10.1	Line One	9
2-3.3.1.2.10.2	Lines Two, Three, and Four	9
2-3.3.1.2.10.3	Line Five	9
2-3.3.1.2.10.4	Lines Six, Seven	9
2-3.3.1.2.10.5	Lines Eight, Nine	9
2-3.3.1.2.10.6	RVR Threshold Indicators	9
2-3.3.1.2.11	Character Brightness/Indicators	9

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
2-3.3.1.2.12	Ambient Operation	10
2-3.3.1.2.13	Front Screen	10
2-3.3.1.2.13.1	Tinting	10
2-3.3.1.2.14	RVR Threshold Panel	10
2-3.3.1.2.15	Cooling/Ventilation	11
2-3.3.1.2.16	Interface/Addressing	11
2-3.3.1.2.17	Cabling	12
2-3.3.1.2.18	Power Supply	12
2-3.3.1.2.19	Test Functions	12
2-3.3.1.2.20	Alarms	12
2-3.3.1.2.21	Reliability	13
2-3.3.1.2.22	Maintainability	13
2-3.3.2	Supplementary Display	13
2-3.3.2.1	Operational/Performance Requirements	13
2-3.3.2.1.1	Data Paging	13
2-3.3.2.1.2	Log On/Log Off	14
2-3.3.2.1.3	Manual Request Logging	14
2-3.3.2.2	Hardware/Performance Requirements	14
2-3.3.2.2.1	Function and Contents	14
2-3.3.2.2.2	Display Type	14
2-3.3.2.2.2.1	Filter Requirements	14
2-3.3.2.2.2.2	Etch Requirements	15
2-3.3.2.2.2.3	Antireflective Coating	15
2-3.3.2.2.2.3.1	Surface Reflectance	15
2-3.3.2.2.2.3.2	Anti-Reflective Coating Durability	16
2-3.3.2.2.3	Raster	17
2-3.3.2.2.4	Size	17
2-3.3.2.2.5	Panel Configuration/Controls	17
2-3.3.2.2.6	Bezel	18
2-3.3.2.2.7	Ambient Operation	18
2-3.3.2.2.7.1	Contrast Ratio	18
2-3.3.2.2.8	Refresh	19
2-3.3.2.2.9	Interface/Addressing	19
2-3.3.2.2.10	Cabling	19
2-3.3.2.2.11	Cooling/Ventilation	20
2-3.3.2.2.12	Power Supplies	20
2-3.3.2.2.13	Test Functions	20
2-3.3.2.2.14	Alarm	20
2-3.3.2.2.15	Reliability	20

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
2-3.3.2.2.16	Maintainability	21
2-3.3.3	TRACON Display	21
2-3.3.3.1	Operational/Performance Requirements	21
2-3.3.3.1.1	Continuous Display	21
2-3.3.3.1.2	Update Time	21
2-3.3.3.1.3	Data Paging	21
2-3.3.3.1.4	Log On/Log Off	21
2-3.3.3.1.5	Manual Request Logging	21
2-3.3.3.2	Hardware/Performance Requirements	21
2-3.3.3.2.1	Functions and Contents	22
2-3.3.3.2.2	Type of Display	22
2-3.3.3.2.3	Size	22
2-3.3.3.2.4	Panel Configuration	22
2-3.3.3.2.5	Controls	23
2-3.3.3.2.6	RVR Threshold Panel	23
2-3.3.3.2.7	Ambient Operation/Overlay	23
2-3.3.3.2.8	Interface/Addressing	24
2-3.3.3.2.9	Cabling	24
2-3.3.3.2.10	Power Supply	24
2-3.3.3.2.11	Test Functions	25
2-3.3.3.2.12	Alarm	25
2-3.3.3.2.13	Reliability	25
2-3.3.3.2.14	Maintainability	25
2-3.3.4	Supervisory/Maintenance Display	25
2-3.3.4.1	Operational/Performance Requirements	25
2-3.3.4.1.1	Log On/Log Off	26
2-3.3.4.1.2	Data Paging	26
2-3.3.4.1.2.1	Backup Critical Display Data Page	26
2-3.3.4.1.2.2	RVR Data Page	26
2-3.3.4.1.2.3	ILS Status Data Page	26
2-3.3.4.1.2.4	ALS/MALS Data Page	26
2-3.3.4.1.2.5	Field Lighting Data Page	26
2-3.3.4.1.3	Enable/Disable Sensor Data	26
2-3.3.4.1.4	Manual Data Entry	26
2-3.3.4.1.4.1	Critical Data	27
2-3.3.4.1.4.2	Adaptation Parameters	27
2-3.3.4.1.4.3	Supplemental Data	27
2-3.3.4.1.5	Runway Assignment	27
2-3.3.4.1.6	Display Configuration	27
2-3.3.4.1.7	Text Messages	27
2-3.3.4.2	Hardware/Performance Requirements	27
2-3.3.4.2.1	Functions/Contents	27

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
2-3.3.4.2.2	Type	28
2-3.3.4.2.3	Size	28
2-3.3.4.2.4	Editing	28
2-3.3.4.2.5	Ambient Operation	28
2-3.3.4.2.6	Interface/Addressing	28
2-3.3.4.2.7	Cabling	29
2-3.3.4.2.8	Test Functions	29
2-3.3.4.2.9	Alarm	29
2-3.3.4.2.10	Reliability	29
2-3.3.4.2.11	Maintainability	29
2-3.3.5	Lighting Control Panel	30
2-3.3.5.1	Operational/Performance Requirements	30
2-3.3.5.1.1	Select Intensity Level	30
2-3.3.5.1.2	Acknowledge Lighting Intensity	30
2-3.3.5.1.3	Manual Request Logging	30
2-3.3.5.2	Hardware/Performance Requirements	30
2-3.3.5.2.1	Functions and Contents	30
2-3.3.5.2.2	Hardware Description	30
2-3.3.5.2.2.1	Type A	31
2-3.3.5.2.2.2	Type B	31
2-3.3.5.2.2.3	Type C	31
2-3.3.5.2.2.4	Type D	31
2-3.3.5.2.3	Power	31
2-3.3.5.2.4	Test	31
2-3.3.5.2.5	Panel Layout	31
2-3.3.5.2.6	Ambient Operation	31
2-3.3.5.2.7	Test	32
2-3.3.5.2.8	Interface/Addressing	32
2-3.3.5.2.9	Cabling	32
2-3.3.5.2.10	Reliability	32
2-3.3.5.2.11	Maintainability	32
2-3.4	Software	32
2-3.5	Documentation	32
2-3.5.1	Hardware Documentation	33
2-3.5.2	Software Documentation	33
2-3.6	Design and Construction	33
2-3.6.1	General Requirements	33
2-3.6.2	Ventilation and Cooling	34
2-3.6.3	Fuses	34
2-3.6.4	Subsystem Grounding	34

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
2-3.6.5	Conducted and Radiated Interference	34
2-3.6.6	Cables	34
2-3.6.7	Service Conditions	34
2-3.6.8	Electrical Service Conditions	35
2-3.6.8.1	Transient State	35
2-3.6.8.2	Startup Surges	35
2-3.6.9	Electrical Design	35
2-3.6.10	Reliability and Maintainability	35
2-3.6.10.1	Maintenance Approach	36
2-4	Quality Assurance Provisions	36
2-4.1	General	36
2-5	Preparation for Delivery	36

LMED
-8