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TOWER CAB DIGITAL DISPLAY OPERATIONAL EVALUATION,(U)
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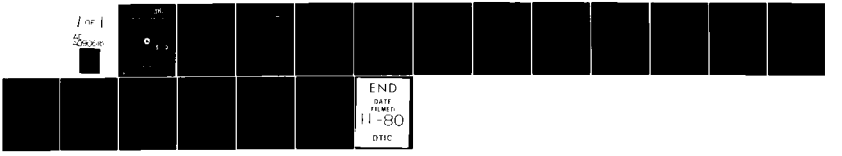

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TOWER CAB DIGITAL DISPLAY OPERATIONAL EVALUATION

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FINAL REPORT

SEPTEMBER 1980

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
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16. Abstract

This report discusses the operational evaluation of the Tower Cab Digital Display (TCDD). The TCDD is used for air traffic control operations in the St. Petersburg control tower and the MacDill Air Force Base ground control approach (GCA) and control tower facilities as part of the Automated Radar Terminal System (ARTS) IIIA Remote Tower Display System. Evaluation objectives were to determine the usefulness and suitability of TCDD operational features. Resultant findings will be input to the Systems Research and Development Service (SRDS) technical data package for future production TCDD's. For the most part, resultant findings are favorable to existing TCDD capabilities. Some modifications are recommended for future production models.

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METRIC CONVERSION FACTORS

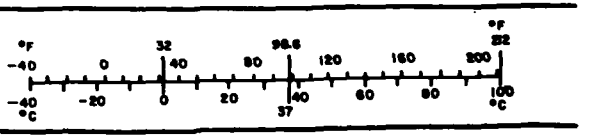
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
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

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

PURPOSE.

The Remote Tower Display System utilized in the Tampa/Sarasota air traffic control (ATC) environment is designed to present primary and secondary (beacon) radar targets on tower cab digital displays (TCDD's) at Tampa International Airport (TPA), Sarasota-Bradenton Airport (SRQ), St. Petersburg-Clearwater Airport (PIE), and MacDill Air Force Base (MCF). Evaluation objectives were to determine the usefulness and suitability of TCDD operational features for air traffic control operations. This document presents the results of the TCDD operational evaluation conducted by the Federal Aviation Administration (FAA) Technical Center from January to March 1980. The data herein will be input to a Systems Research and Development Service (SRDS) technical data package for future production models.

BACKGROUND.

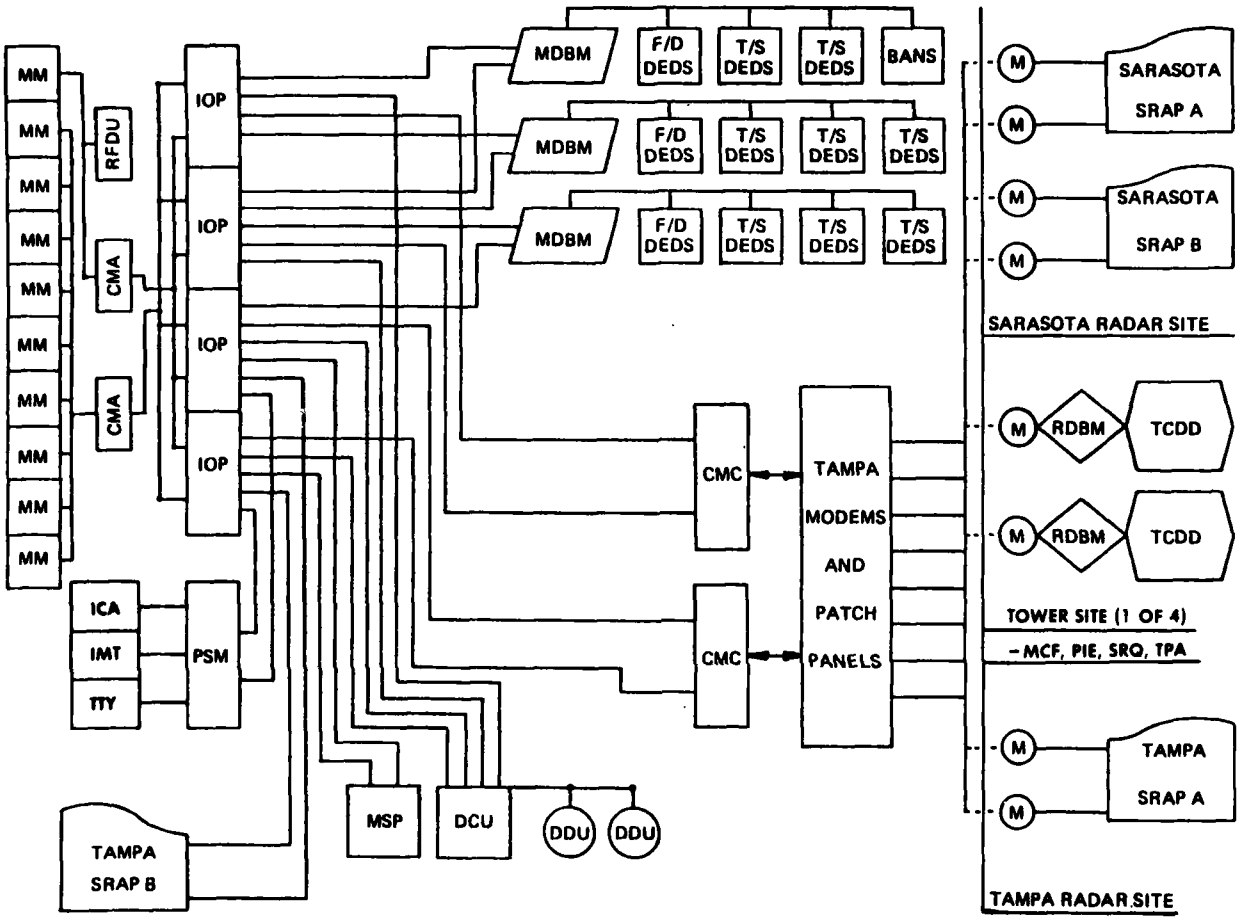
The Technical Center was the site for tests and evaluations of (1) beacon and primary radar digitizing and (2) a terminal area all-digital system which included the digital transfer of radar data from a remote radar site via land-lines, the tracking of primary radar and beacon targets, and data presentations on full-digital displays. A contract was subsequently awarded to Univac for development of the Remote Tower Display System for implementation in the Tampa Air Traffic Control Tower (ATCT), four remote satellite towers, and MacDill Air Force Base (AFB) ground control approach (GCA) facility. Univac subcontracted the TCDD development and production to Magnavox. During the system development phase, the FAA decided to relocate one TCDD subsystem, originally intended for installation in the Albert Whitted ATCT, to the Tampa ATCT. Site operational system tests and FAA system acceptance from the contractor were accomplished. Operational use of the system followed, first in the Tampa Terminal Radar Approach Control Facility (TRACON) in May 1979 and then in the tower cabs and the MacDill AFB GCA facility. Due to system problems which affected operational functions of the system, TCDD use in the Tampa and Sarasota ATCT's was curtailed. This was the situation at the start of the operational evaluation period in January 1980.

SCOPE.

The TCDD operational evaluation was originally planned for accomplishment in the Tampa, Sarasota, and St. Petersburg ATCT's and in the MacDill AFB tower cab and GCA facilities. However, due to system problems and the resulting curtailment of TCDD operational use in the Tampa and Sarasota ATCT's, this evaluation report only includes data from the St. Petersburg ATCT and MacDill AFB tower cab and GCA facilities where TCDD operations continued throughout the evaluation period.

SYSTEM DESCRIPTION

The TCDD subsystems are part of the Remote Tower Display System (figure 1) installed in the Tampa ATCT and remote control tower and GCA facilities. Primary and secondary radar data are acquired at the Tampa and Sarasota radar sites where they are digitized in sensor receiver and processor (SRAP) equipment. Within the SRAP, aircraft targets and weather data are detected. Primary and secondary radar target data for the same aircraft are correlated. These digital data are then transmitted to the Automated Radar Terminal System (ARTS) IIIA Data Processing Subsystem (DPS) in the equipment room at the Tampa ATCT.



LEGEND:

BANS - BRITE ALPHANUMERIC SUBSYSTEM
BRITE - BRIGHT RADAR INDICATOR TOWER EQUIPMENT
CMA - CENTRAL MEMORY ACCESS
CMC - COMMUNICATIONS MULTIPLEXER CONTROLLER
DCU - DISK CONTROL UNIT
DDU - DISK DRIVE UNIT
F/D DEDS - FULL DIGITAL DATA ENTRY AND DISPLAY SUBSYSTEM
ICA - INTERFACILITY COMMUNICATIONS ADAPTER
IMT - INTERGRATED MAGNETIC TAPE UNIT
IOP - INPUT/OUTPUT PROCESSOR
M - MODEM
MDBM - MULTIPLEXED DISPLAY BUFFER MEMORY
MM - MEMORY MODULE
MSP - MEDIUM SPEED PRINTER
PSM - PERIPHERAL SWITCH MODULE
RDBM - REMOTE DISPLAY BUFFER MEMORY
RFDU - RECONFIGURATION AND FAULT DETECTION UNIT
SRAP - SENSOR RECEIVER AND PROCESSOR
TCDD - TOWER CAB DIGITAL DISPLAY
T/S DEDS - TIME-SHARED DATA ENTRY AND DISPLAY SUBSYSTEM
TTY - TELETYPE

80-31-1

FIGURE 1. REMOTE TOWER DISPLAY SYSTEM

The DPS processes the incoming data from the SRAP's as well as input data from controller consoles in the Tampa TRACON, tower cabs at Tampa, Sarasota, and St. Petersburg ATCT's, and MacDill AFB tower cab and GCA facilities. The DPS also transmits data for display on time-shared and full-digital displays in the Tampa TRACON and on TCDD's in the tower cab/GCA facilities.

Each of the four ATC facilities (Tampa, Sarasota, St. Petersburg, and MacDill AFB) has two TCDD subsystems. One is used operationally in the tower cab at each facility. At Tampa, Sarasota, and St. Petersburg, the second TCDD subsystem is in the equipment room. It is used for maintenance purposes and is available as a replacement for the tower cab TCDD equipment, if needed. At MacDill AFB, the second TCDD subsystem is used operationally in the GCA facility. Each TCDD subsystem includes the following components: remote display buffer memory, electronics cabinet, power supply, display console, remote control panel, two alphanumeric (A/N) keyboards, and two trackball units. Telephone landlines and modems are used for the transmission of data between TCDD's at the remote facilities (Sarasota, St. Petersburg, and MacDill AFB) and the DPS at Tampa.

Overall, the Remote Tower Display System provides all the functions existent in the predecessor basic ARTS III system. It also adds new capabilities including those previously mentioned, fail-safe/fail-soft features, continuous data recording, digital display of video maps and weather data, and keyboard entries and brightness controls for the new digital data features.

METHOD OF APPROACH

The TCDD operational evaluation was conducted as specified in the Technical Center's "Tower Cab Digital Display Operational Evaluation Plan," dated July 1979. However, deviations did occur due to unanticipated system problems. The evaluation was conducted from January to March 1980 instead of over a 4-month period. This is of minor significance since the controllers were training with and had used the TCDD equipment prior to the start of the official evaluation period. Many controllers had much more than 4 months of exposure to TCDD operations. The lack of TCDD data from Tampa and Sarasota ATCT's is significant since comparisons to predecessor tower cab radar displays (BRITE-4 at Tampa; analog display at Sarasota) could not be evaluated. However, the evaluation start could not have been delayed any more if timely results were to be obtained.

The TCDD's were used operationally and evaluated by air traffic controllers in the St. Petersburg tower cab and in the MacDill AFB tower cab and GCA facilities. In early January 1980, initial questionnaires were completed by controllers in these facilities and also by Tampa and Sarasota controllers. These data were summarized and provided to SRDS and Tampa ATCT personnel. As intended, the questionnaires were used not to obtain evaluation findings, but to identify existing problems for possible corrective action. The questionnaires were completed a second time in late March 1980 by St. Petersburg and MacDill AFB controllers. The results were summarized and analyzed by personnel of the ATC Applications Branch (ACT-210), Systems Simulation and Analysis Division, FAA Technical Center. The ACT-210 TCDD evaluation coordinator also observed TCDD operations in the facilities and met with facility representatives for detailed discussions.

DISCUSSION OF RESULTS

Overall, air traffic controllers in the St. Petersburg ATCT and MacDill AFB

tower cab and GCA facilities responded favorably to most questions on TCDD features. The following discussion includes separate sections on the results obtained in four areas of interest: (1) display controls, (2) display data, (3) keyboard functions, and (4) automatic system/display recovery. Questionnaires were completed by 21 controllers in the MacDill (MCF) GCA facility, 16 in the MacDill Tower, and 11 in the St. Petersburg (PIE) Tower. Results were obtained from the questionnaires and from TCDD observations and meetings in the ATC facilities. Tables 1 to 4 present statistical summaries of satisfactory and unsatisfactory responses to the questions in percentage form. The questionnaires are retained by ACT-210 at the Technical Center.

DISPLAY CONTROLS.

Controller responses to questions on TCDD manual controls are summarized in table 1, TCDD Controller Questionnaire Statistical Summary, Display Controls. Questions were included on controls for field select/inhibit, leader length, leader direction, radar range, range rings, high/low gain levels, character size, center/decenter, panel illumination, trackball, A/N keyboard location, A/N keyboard legibility (day and night), A/N keyboard positive key action, and quicklook. The satisfactory response percentages for all facility responses combined ranged from 100 to 81 percent for the display controls questions. Further discussion and pertinent controller comments follow:

1. Field select/inhibit—PIE tower (one comment). Not used.

2. High/low gain levels—Five comments on this were in the questionnaires. Controllers at all facilities expressed a need for more intensity controls including separate controls for range rings, map, and weather. This is not consistent with the high percentage of satisfactory responses but was evident from the strong opinions expressed at the meetings.

3. Character size—Eight comments were in the questionnaires. These and meeting discussions indicated that character sizes were either too small or too large. It was apparent that maintenance adjustments were needed to optimize sizes for the controllers. Several comments indicated that the smaller sizes were useless in the tower cab and that larger character sizes were needed there.

4. Panel illumination—PIE tower (three comments). This control performs properly for illumination of the A/N keyboard. However, the comments and meeting discussions indicated that when the control is set for high illumination the resulting heat causes spurious A/N keyboard entries (i.e., without controller action) and erroneous readouts on the display.

5. Trackball—The trackball performs properly for the transmittal of position data to the computer. However, questionnaire and meeting comments indicated that too precise manual positioning of the trackball was required, which necessitated numerous reentries. The required preciseness of the trackball entry is based on computer program parameters.

A suggestion was made for an adjustable "gate size" to alleviate this problem. Two other comments indicated that sometimes, after a message with a SLEW ENTER was accepted and acted upon properly, a NO SLEW error readout appeared. One comment suggested that the trackball not be homed and remain where it was at the time of message entry. This would minimize trackball movement for message reentries.

6. A/N keyboard location—Numerous MCF GCA and MCF tower comments were

TABLE 1. TCDD CONTROLLER QUESTIONNAIRE STATISTICAL SUMMARY, DISPLAY CONTROLS

Question	MCF GCA			MCF Tower			PIE Tower			All Facilities		
	#	%S	%U	#	%S	%U	#	%S	%U	#	%S	%U
Field select/inhibit	20	100	0	15	93	7	10	90	10	45	96	4
Leader length	20	100	0	16	100	0	11	100	0	47	100	0
Leader direction	21	100	0	16	100	0	11	100	0	48	100	0
Radar range	19	95	5	16	100	0	11	100	0	46	98	2
Range rings	21	100	0	16	100	0	11	100	0	48	100	0
High/low gain levels	21	95	5	16	100	0	10	90	10	47	96	4
Character size	20	90	10	16	94	6	11	73	27	47	87	13
Center/decenter	21	90	10	16	94	6	11	100	0	48	94	6
Panel illumination	21	100	0	16	94	6	11	82	18	48	94	6
Trackball	21	95	5	16	94	6	11	91	9	48	94	6
A/N keyboard, location	20	85	15	16	69	31	11	91	9	47	81	19
A/N keyboard, legibility of labels, day	21	100	0	16	100	0	11	100	0	48	100	0
A/N keyboard, legibility of labels, night	21	100	0	16	100	0	11	100	0	48	100	0
A/N keyboard, positive key action	20	95	5	16	100	0	11	91	9	47	96	4
Quicklook	21	95	5	16	100	0	9	89	11	46	96	4

- Number of responses
%S - Percent satisfactory
%U - Percent unsatisfactory

concerned with the need for permanent locations for the keyboards, flush mounting, and mounting in a console. A suggestion was made for an ARTS III console in the GCA facility. Three comments suggested that keyboard characters be arranged in typewriter format since military controllers are very familiar with this.

DISPLAY DATA.

Controller responses to questions on TCDD display characters and symbology are summarized in table 2, TCDD Controller Questionnaire Statistical Summary, Display Data. Questions were included on target symbols, target history trails, controller symbols, weather presentations, terminal maps, range marks, data legibility when multiple targets are in vicinity, data legibility in normal lighting conditions, maximum data display for 30 nautical miles (nmi) from radar antenna, automatic variations of data display range, timeliness of target and weather data presentations, and timeliness of responses to keyboard entries. The satisfactory response percentages for all facility responses combined ranged from 100 to 70 percent for the display data questions. Further discussion and pertinent controller comments follow:

1. Primary radar-only tracked target.

a. Due to system problems, the operational use of digital primary radar-only tracked targets was curtailed in the early part of the evaluation. This was due to non-TCDD related causes. The TCDD displayed only what was transmitted to it from the computer. On this subject, controller comments were concerned with unreliable primary radar targets (especially in turns) and false targets.

b. Other comments indicated that the dash was too small for a target symbol and was not satisfactory for the issuance of traffic advisories. When a full data block was associated with a target (primary radar only, beacon-only, or primary radar and beacon (merged)), the dash was displayed as the target symbol. An MCF GCA comment stated that they could not tell how many aircraft were in a flight. This included fast-moving flights of military aircraft.

2. Beacon-only tracked target—See paragraph 1(b) above.

3. Merged tracked target (primary radar and beacon)—See paragraph 1(b) above.

4. Target symbol legibility (when multiple targets are in vicinity)—See paragraph 1(b) above. Many MCF GCA and MCF tower comments were concerned with poor legibility of target symbols, history trails, and controller symbols when multiple targets were in proximity. The small size of the dash target symbol and history trail dots was a contributing factor. The availability of only two data intensity controls for five categories of display data negated the use of different intensity levels to distinguish the types of display data. The automatic offset works for the overlap of full data blocks for targets controlled only at that console. When quicklook or individual data block readouts were effected, the automatic offset function did not apply (per system design) to these data blocks when overlaps occurred. This definitely contributed to the legibility problem in the MacDill ATC facilities. Small character size was also a contributing factor.

5. History trails—See paragraph 4 above. One comment stated that history trails were unusable if the target was slow moving. The history trail dots were not separated in this case. An MCF tower comment indicated that history trails were barely visible for aircraft in tight or fast turns. Too many aircraft were too close in a small area.

TABLE 2. TCDD CONTROLLER QUESTIONNAIRE STATISTICAL SUMMARY, DISPLAY DATA

Question	MCF GCA #	MCF GCA %S	MCF GCA %U	MCF Tower #	MCF Tower %S	MCF Tower %U	PIE Tower #	PIE Tower %S	PIE Tower %U	All Facilities #	All Facilities %S	All Facilities %U
Primary radar-only tracked target	20	80	20	16	94	6	11	73	27	47	83	17
Beacon-only tracked target	19	95	5	16	100	0	9	100	0	44	98	2
Merged tracked target (primary radar and beacon)	20	85	15	16	81	19	9	89	11	45	84	16
Untracked target	19	89	11	16	88	12	10	90	10	45	89	11
Target symbol legibility (multiple targets in vicinity)	20	60	40	16	63	37	10	100	0	46	70	30
History trails	20	95	5	16	88	12	9	100	0	45	93	7
Retain display of one history trail	18	83	17	14	93	7	8	88	12	40	88	12
Retain display of two history trails	17	88	12	15	93	7	8	100	0	40	93	7
Retain display of three history trails	20	100	0	15	93	7	9	100	0	44	98	2
Retain display of four history trails	18	100	0	15	100	0	8	100	0	41	100	0
Retain display of five history trails	18	100	0	15	100	0	8	100	0	41	100	0
History trail legibility (multiple targets in vicinity)	20	100	0	15	73	27	11	100	0	46	91	9
Controller symbol legibility (multiple targets in vicinity)	20	65	35	15	67	33	10	100	0	45	73	27
Light weather (dotted radial lines)	21	100	0	16	100	0	11	91	9	48	98	2
Heavy weather (solid radial lines)	21	100	0	16	100	0	11	91	9	48	98	2
TPA digital map	11	100	0	14	100	0	9	100	0	34	100	0
MCF digital map	21	100	0	16	100	0	-	-	-	37	100	0
PIE digital map	-	-	-	-	-	-	11	89	11	11	89	11
Range marks	21	100	0	16	100	0	11	100	0	48	100	0
Maximum data display (30 nmi square)	21	90	10	15	100	0	11	100	0	47	96	4
Automatic variation of data display range	19	79	21	15	100	0	10	100	0	44	91	9
Data legibility in normal lighting	21	100	0	16	94	6	10	100	0	47	98	2
Timeliness of data presentation, tracked targets	20	95	5	16	94	6	11	100	0	47	96	4
Timeliness of data presentation, untracked targets	20	90	10	15	100	0	10	100	0	45	96	4
Timeliness of data presentation, weather	21	100	0	16	100	0	11	100	0	48	100	0
Timeliness of data presentation, responses to keyboard requests	20	100	0	16	94	6	11	82	18	47	94	6

- Number of responses
%S - Percent Satisfactory
%U - Percent Unsatisfactory

Several comments indicated that one or two history trail dots served no purpose.

6. Controller symbol legibility (when multiple targets are in vicinity)—See paragraph 4 above. Controller symbol "F" looked like "E" and controller symbol "T" looked like "I." This occurred when the dash target symbol was very close to or merged with the "F" or "T." Special message entry (F7, 3, (1, 2, or 3), ENTER) was designed to advise the computer of the character size in use so that the distance between the controller symbol and the dash target symbol would be adjusted appropriately. The message entry was not effective. Character confusion still resulted after the message was entered.

7. Weather—Several comments indicated that display jitter occurred when both heavy and light weather intensities were displayed. One MCF GCA comment stated that GCA needs some way to tell when the Tampa radar is using circular polarization for weather.

8. Maximum data display (30 nmi square)—The system is designed to transmit display data to the TCDD's for a maximum of 30 nmi from the radar site. The 30 nmi is measured from the radar site to the sides of a square; 30 nmi is exceeded in the corners of the square. With MacDill AFB located approximately 10 miles south of the Tampa radar, MCF GCA can only see TCDD data for about 20 miles south of their location. MCF GCA comments indicated that, for GCA operations, the display of data for a longer range was needed. Requests were made for up to 45 miles from 120° to 270° and up to 60 miles. Tampa TRACON sometimes effected handoffs beyond the GCA's visible range. Decentering capabilities were not adequate for aircraft operations to the south. Another comment indicated that, after use of the manual control to increase range, display data were added in 2-mile increments rather than all at once. It took too long to see data for the manually requested longer range.

9. Automatic variation of data display range—When the amount of data to be transmitted to a TCDD exceeded transmission capacity, data were sent for a shorter range in 2-mile decrements. When transmission capacity increased, data was sent for a longer range in 2-mile increments until the maximum data display range (30 nmi) or the manually controlled range was reached. There had been a major problem at the MacDill ATC facilities; data display ranges automatically varied excessively. This was resolved when 4800 baud modems were replaced by 9600 baud modems. This minimized the range variations. Conditioned phone lines were also planned for MacDill TCDD subsystems. Two MCF GCA comments suggested a visual or aural alarm when the range data readout is below its maximum setting; e.g., blink the range data readout.

10. Timeliness of responses to keyboard requests—See paragraph 5 in the Display Controls section above. One comment pertained to slow response to keyboard functions involving a trackball entry. Another indicated slow response when initiating a function.

11. One comment stated that a display larger than the TCDD is needed in the MCF GCA facility for their operations.

KEYBOARD FUNCTIONS.

Controller responses to questions on TCDD keyboard functions are summarized in table 3, TCDD Controller Questionnaire Statistical Summary, Keyboard Functions. Questions were included primarily for the new keyboard functions. The satisfactory response percentages for all facility responses combined ranged from 100 to 91 percent for the keyboard functions questions. Further discussion and pertinent controller comments follow:

TABLE 3. TCDD CONTROLLER QUESTIONNAIRE STATISTICAL SUMMARY, KEYBOARD FUNCTIONS

Question	MCF GCA #	MCF GCA %S	MCF GCA %U	MCF Tower #	MCF Tower %S	MCF Tower %U	PIE Tower #	PIE Tower %S	PIE Tower %U	All Facilities #	All Facilities %S	All Facilities %U
F7, 3, P, ENTER (display trackball rho theta coordinates)	19	79	21	14	100	0	11	100	0	44	91	9
F7, 3, R, ENTER (display trackball X, Y coordinates)	19	84	16	14	100	0	11	100	0	44	93	7
F7, 3, (1, 2 or 3), ENTER (enter character size)	20	95	5	14	100	0	11	100	0	45	98	2
Other F7 entries (multifunction entries)	19	100	0	16	94	6	11	100	0	46	98	2
F8, H, ENTER (display/inhibit heavy weather)	20	100	0	16	100	0	11	100	0	47	100	0
F8, L, ENTER (display/inhibit light weather)	20	100	0	16	100	0	11	100	0	47	100	0
F8, M, ENTER (display map name)	19	100	0	16	100	0	11	100	0	46	100	0
F8, M, 0, ENTER (inhibit map display)	20	95	5	16	100	0	11	100	0	47	98	2
F8, Mb, ENTER (display selected map)	9	78	22	14	100	0	9	100	0	32	94	6
F8, T, N, ENTER (select number of history trails)	9	78	22	13	100	0	9	100	0	31	94	6
F8, W, dd, ENTER (inhibit weather display to dd nmi)	9	78	22	13	100	0	9	100	0	31	94	6
Other keyboard entries	17	100	0	15	100	0	11	100	0	43	100	0

- Number of responses
%S - Percent satisfactory
%U - Percent unsatisfactory

1. F7, 3, P, SLEW ENTER (display range and azimuth of trackball position)—Three comments suggested that the displayed coordinates should be referenced to the airport location of the requestor, rather than in relation to the Tampa radar site. Two comments stated that the function was not needed.

2. F7, 3, R, SLEW ENTER (display X,Y coordinates of trackball position)—The same comments were made as in paragraph 1 above.

3. F7, 3, (1, 2 or 3), ENTER (enter character size control setting)—See paragraph 6 in the Display Data section above for discussion of this message entry.

AUTOMATIC SYSTEM/DISPLAY RECOVERY.

Controller responses to questions on automatic system and display recoveries are summarized in table 4, TCDD Controller Questionnaire Statistical Summary, Automatic System/Display Recovery. The satisfactory response percentages for all facility responses combined was 91 percent for the automatic system recovery question and 95 percent for the automatic display recovery question. Further discussion and pertinent controller comments follow:

1. Automatic system recovery—Two comments indicated that the recovery was slow.

2. Automatic display recovery (blanking and reinitialization of display data)—One comment indicated that the action was intermittent, sometimes slow. Another comment opined that two display reinitializations per day would be the maximum permissible.

CONCLUSIONS

1. Air traffic controllers in the St. Petersburg Airport Traffic Control Tower (ATCT) and MacDill Air Force Base (AFB) tower cab and ground control approach (GCA) facilities considered the tower cab digital displays (TCDD) to be a welcome addition for their air traffic control operations.

2. Most TCDD features were satisfactory for air traffic control operations with the following exceptions:

a. The availability of only two high/low gain level controls for five categories of display data (video maps, range marks, weather, radar targets/history trails, data blocks/other alphanumeric data) did not permit the controller to vary intensity levels to distinguish sufficiently between categories of display data. This was particularly harmful when multiple targets and data blocks were in proximity or overlapping.

b. Small character sizes were not useful to some controllers at their normal operating positions (i.e., too far away to read).

c. Excessive heat, resulting from high illumination of the A/N keyboard, caused spurious keyboard entries and erroneous display readouts.

d. Controllers considered the required precision positioning of the trackball to be extreme, often causing numerous message reentries when their precision was not adequate or when the target moved prior to slew entry action.

TABLE 4. TCDD CONTROLLER QUESTIONNAIRE STATISTICAL SUMMARY, AUTOMATIC SYSTEM/DISPLAY RECOVERY

Question	MCF GCA			MCF Tower			PIE Tower			All Facilities		
	#	%S	%U	#	%S	%U	#	%S	%U	#	%S	%U
Automatic system recovery	17	100	0	15	80	20	11	91	9	43	91	9
Automatic display reinitialization	17	100	0	15	93	7	11	91	9	43	95	5

- Number of responses
%S - Percent satisfactory
%U - Percent unsatisfactory

e. The dash was unsatisfactory as a target symbol because of its small size and straight-line feature which caused it to blend with other display data.

f. One or two history trail dots were not useful.

g. Display jitter occurred when both heavy and light weather were displayed.

h. For GCA operations, the 30 nautical miles of display data provided was insufficient.

i. After setting the radar range control to a longer range, data for the requested range were slow to appear because they were added in 2-mile increments rather than all at once.

j. The 4800 baud modems did not satisfactorily handle the volume of data transmissions.

k. The controller was not always immediately aware of automatic data display range decreases and the resulting loss of display data when all data transmissions could not be handled.

l. The message used to tell the computer of the character size in use did not produce proper results in separating the controller symbol and target symbol. "F" and "T" appeared as "E" and "I," respectively. This problem was satisfactorily resolved after the evaluation was concluded.

RECOMMENDATIONS

1. Provide five individual controls to vary the intensity of the following five data categories: (1) video maps, (2) range marks, (3) weather, (4) radar targets and history trails, and (5) data blocks and other alphanumeric data.

2. Redesign the A/N keyboard to eliminate excessive heat when the illumination is high.

3. Test the use of less precise trackball positioning requirements for message entries. The objective would be to minimize the need for message reentries due to imprecise trackball positioning while simultaneously not increasing erroneous trackball position associations.

4. Test the use of symbols other than the dash for use as a target position symbol (e.g., inverted triangle).

5. Redesign so as to completely eliminate display jitter when both heavy and light weather are displayed during severe weather conditions.

6. Permit the presentation of display data for ranges over 30 nautical miles as required for operational needs.

7. After setting the radar range control to a longer range, display all data for the requested range immediately, not in increments.

8. When the data display range readout is not at its high setting, based on the system maximum and range control setting, blink the readout to alert the controller of the display data loss.