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SATELLITE COMMUNICATIONS MODE SIMULATION TESTS FOR OCEANIC AIR --ETC(U)  
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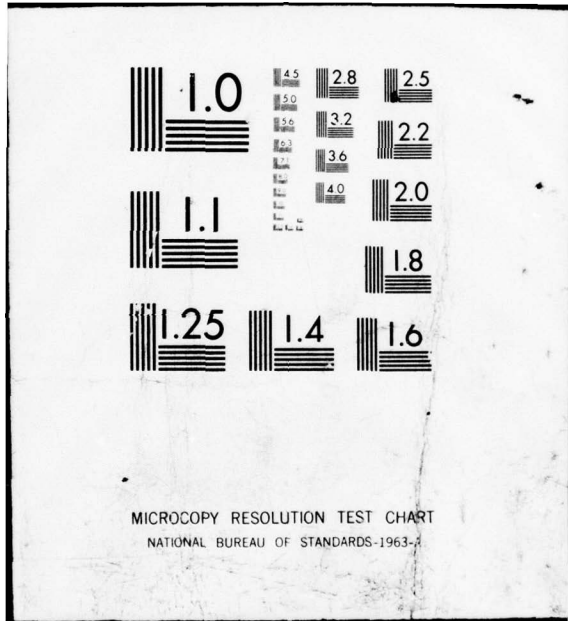
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# SATELLITE COMMUNICATIONS MODE SIMULATION TESTS FOR OCEANIC AIR TRAFFIC CONTROL

Francis W. Jefferson

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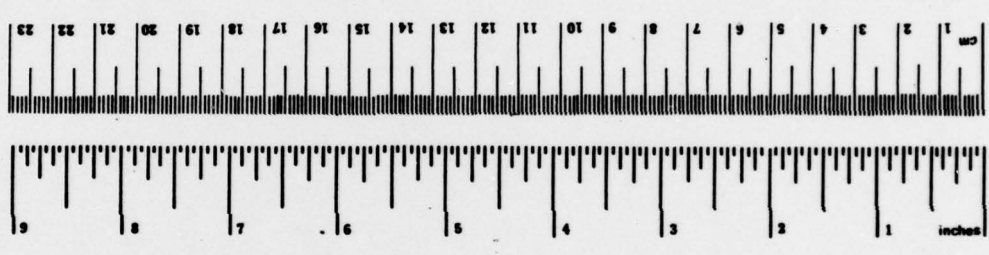
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## METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures		Approximate Conversions from Metric Measures	
Symbol	When You Know	Multiply by	To Find
<b>LENGTH</b>			
in	inches	2.5	centimeters
ft	feet	30	centimeters
yd	yards	0.9	meters
mi	miles	1.6	kilometers
<b>AREA</b>			
in <sup>2</sup>	square inches	6.5	square centimeters
ft <sup>2</sup>	square feet	0.09	square meters
yd <sup>2</sup>	square yards	0.8	square meters
mi <sup>2</sup>	square miles	2.5	square kilometers
acres	acres	0.4	hectares
<b>MASS (weight)</b>			
oz	ounces	28	grams
lb	pounds (2000 lb)	0.45	kilograms
	short tons	0.9	tonnes
<b>VOLUME</b>			
tsp	teaspoons	5	milliliters
Tbsp	tablespoons	15	milliliters
fl oz	fluid ounces	30	milliliters
c	cups	0.24	liters
pt	pints	0.47	liters
qt	quarts	0.96	liters
gal	gallons	3.8	liters
ft <sup>3</sup>	cubic feet	0.03	cubic meters
yd <sup>3</sup>	cubic yards	0.76	cubic meters
<b>TEMPERATURE (exact)</b>			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature



Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
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
<b>AREA</b>				
cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
km <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
ha	hectares (10,000 m <sup>2</sup> )	2.5	acres	acres
<b>MASS (weight)</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	short tons
<b>VOLUME</b>				
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 <sup>3</sup>	cubic meters	35	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.3	cubic yards	yd <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

\*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.

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<p>16. Abstract                  Tests of simulated satellite system configurations and channel access control were conducted with air traffic control (ATC) test subjects to determine controller reaction to the satellite mode of communications and their interaction with associated input/output interfaces.</p> <p>The tests were designed to simulate an oceanic ATC environment supported by satellite communications and surveillance. Traffic scenarios were simulated through use of prepared flight plans and communications scripts and use of a simulated aircraft terminal. Communications delays were introduced into the tests to approximate those delays that may be encountered during actual satellite-supported ATC operations. Data were acquired for the controller test subjects reaction to different voice and data communications delay/restriction situations, voice channel queuing, data communications message length and format constraints, acceptance of required communications disciplines, and the mix of voice and data communications when there was a choice between the two methods of communication.</p> <p>Results were: (1) Controller test subjects favored using data communications to accomplish routine controller-to-pilot communications transactions and voice communication to resolve difficult traffic control situations, (2) actual data from the test logs corroborated test subjects' stated preference, and (3) controller test subjects tended to adapt their communications procedure options to be compatible with the communications system disciplines.</p>		
<p>17. Key Words                  Air Traffic Control      Simulation                  Data Communications      Satellite                  Communications Systems      Voice                  Communications Channel      Access Control</p>	<p>18. Distribution Statement                  Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161</p>	
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PREFACE

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## INTRODUCTION

### PURPOSE.

The purpose of this effort was to conduct satellite system configuration/channel access control (SSC/CAC) simulation tests with air traffic control (ATC) test subjects to determine controller reactions to the satellite modes of communication and their interaction with associated input/output interfaces. This effort was in support of the Federal Aviation Administration (FAA) Aeronautical Satellite (AEROSAT) program.

### BACKGROUND.

The AEROSAT program is designed to develop the operational and technical concepts of oceanic ATC systems utilizing satellite communications and surveillance capability. Since the cost of the satellite is proportional to its transmitter power, the AEROSAT satellites will be limited in the number of communications channels available. The need to maintain a minimum signal level on each channel favors the use of satellite antenna spot beams rather than earth-coverage antenna patterns. Because of this design and proposed operation of the system, channel management and access control will have a vital role in AEROSAT.

The satellite configurations and access techniques to provide services to the airborne and ground users have been studied under FAA and Department of Transportation (DOT) contracts by Bell Aerospace Company and Computer Sciences Corporation. These studies outlined several configurations using frequency division multiplexing that are technically feasible and show good promise toward operational suitability. However, operational suitability and controller/computer interfaces were not addressed in the studies.

In the present-day ATC domestic environment, all communication is by voice, with no data communication capability. The controller manages the voice communication channels, and initiates all pilot responses. By monitoring the voice channels, pilots determine an opportune time to call the controller, who may create queues by using phrases like "standby."

In the satellite environment, there will be a limited number of available voice channels. This will result in controllers sharing voice channels. Therefore, the controller-managed system will be difficult to implement. In addition, aircraft will not be able to monitor other aircraft-to-ground communications to determine an opportune time to call the controller. As an alternate communications management system, a computer-controlled access to voice channels will be implemented. Both controllers and pilots will request use of the channels. The computer will grant the request when the channel is free.

Additionally, data communication will be available in the satellite environment. Although limited experimentation has been done with the controller/computer interface in domestic air/ground data communication, important

differences occur in satellite data communication. For example, the delays are greater due to the lower bit rate, longer communication path, a more lengthy synchronization prekey, and increased number of aircraft accommodated on a single polling channel. In the satellite environment, data communication will probably be used for less rigidly constructed message types than those expected to be employed in the domestic system when it is implemented.

## DISCUSSION

### METHOD OF APPROACH.

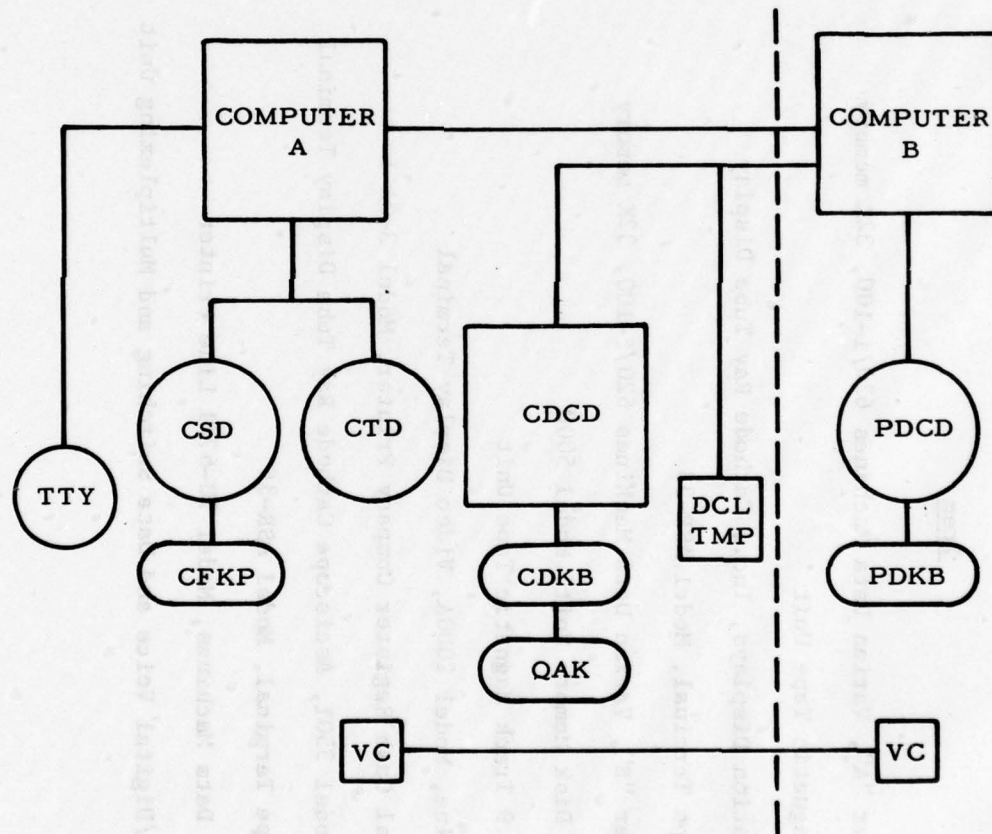
It was not expected nor an objective of this effort that numerical, quantitative data be derived from the SSC/CAC simulation tests. For example, quantities such as numbers of aircraft to be served and average queuing times for communications channel access are best derived from fast-time computer models which can simulate several hundred airborne and ground users. However, the simulation tests were designed to provide preliminary data on air traffic controller reactions to conducting ground-air-ground communications via data link and voice channels in an oceanic control environment supported by satellite communications and surveillance. Communications delays were introduced into the tests to approximate those delays that may be encountered during actual satellite-supported ATC operations. The tests were designed to expose each controller test subject to various delay times and message length and format restrictions. Data were acquired which indicated test subject preferences and reactions to different simulation test configurations. Additionally, data were obtained for (1) controller reactions to data communication message delay and voice channel queuing, and acceptance of satellite communications operating disciplines, (2) an estimate of the mix of voice and data messages in controlling oceanic traffic via satellite-supported communications and surveillance, and (3) a determination of whether any unique operating procedures will be needed in any of the proposed AEROSAT system satellite configurations/channel access control techniques.

### DESCRIPTION OF THE SIMULATION TESTBED.

The simulation testbed was configured as shown in figure 1 to provide an ATC position representing an oceanic sector and a pilot's position simulating an airborne user. Minicomputer equipments, displays, and input/output devices previously used in support of the Applications Technology Satellite (ATS-6) ATC demonstrations (reference 1), with additional hardware and software, were utilized to develop and construct the simulation testbed. Table 1 lists these equipments and their nomenclatures, and figures 2 through 4 are photographs of the controller's and simulated pilot's positions and the computer complex.

CONTROLLER'S POSITION. As indicated in figure 1, the controller's position consisted of an air traffic cathode ray tube (CRT) situation display with associated function key panel, a tabular CRT display on which aircraft flight

- CSD - CONTROLLER SITUATION DISPLAY
- CTD - CONTROLLER TABULAR DISPLAY
- CFKP - CONTROLLER FUNCTION KEY PANEL
- TTY - TELETYPE TERMINAL
- CDCD - CONTROLLER DATA COMMUNICATIONS DISPLAY
- CDKB - CONTROLLER DATA KEYBOARD
- QAK - QUICK ACTION KEYS
- DCLTMP - DATA COMMUNICATIONS LONG TEXT MESSAGE PRINTER
- PDCD - PILOTS DATA COMMUNICATIONS DISPLAY
- PDKB - PILOTS DATA KEYBOARD
- VC - VOICE COMMUNICATIONS TERMINAL



77-37-1

FIGURE 1. BLOCK DIAGRAM OF SATELLITE SYSTEMS CONFIGURATION/CHANNEL ACCESS CONTROL SIMULATION TESTBED

TABLE 1. SSC/CAC SIMULATION TESTS EQUIPMENT COMPLEMENT

<u>Item</u>	<u>Number</u>
Computer "A", Varian Data Machines 620/i-100, 32K memory	1 each
Link Magnetic Tape Unit	1 each
Information Displays, Inc., Cathode Ray Tube Display	2 each
Teletype Terminal, Model ASR-33	1 each
Computer "B", Varian Data Machines 620/f-100, 32K memory	1 each
Pertec Disk Memory Unit, Model 5000	2 each
Pertec 9 Track Magnetic Tape Unit	2 each
Hazeltine, Model 2000A, Video Display Terminal	1 each
National Cash Register Company Printer, Model 3-CA-1	1 each
ITT, Model 3501, Asciscope Cathode Ray Tube Display Terminal	1 each
Teletype Terminal, Model ASR-35	1 each
Varian Data Machines, Model 70-6721 Line Printer	1 each
Analog/Digital Voice and Data Switching and Multiplexing Unit	1 each

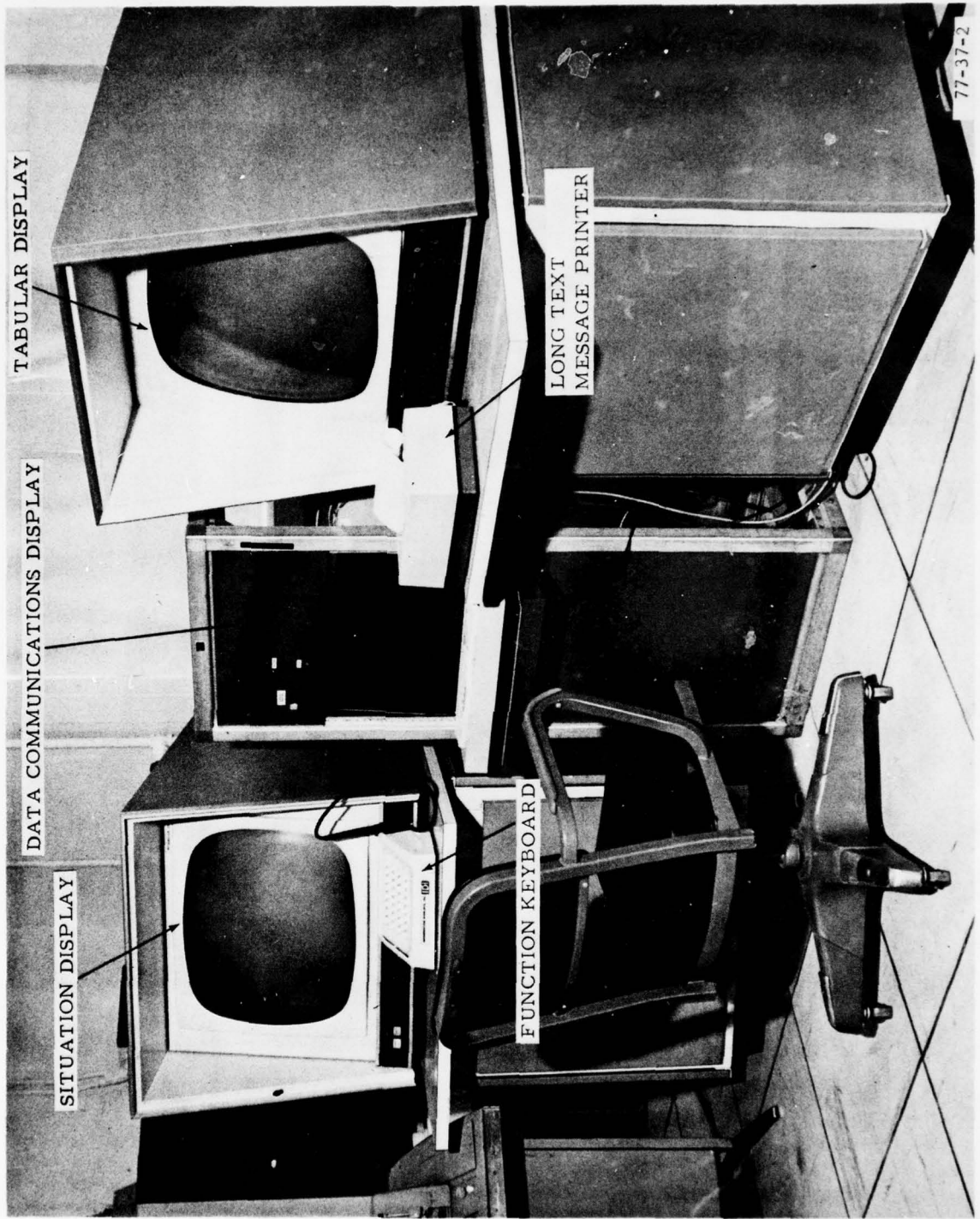


FIGURE 2. SIMULATION TESTBED, ATC TEST SUBJECT'S POSITION

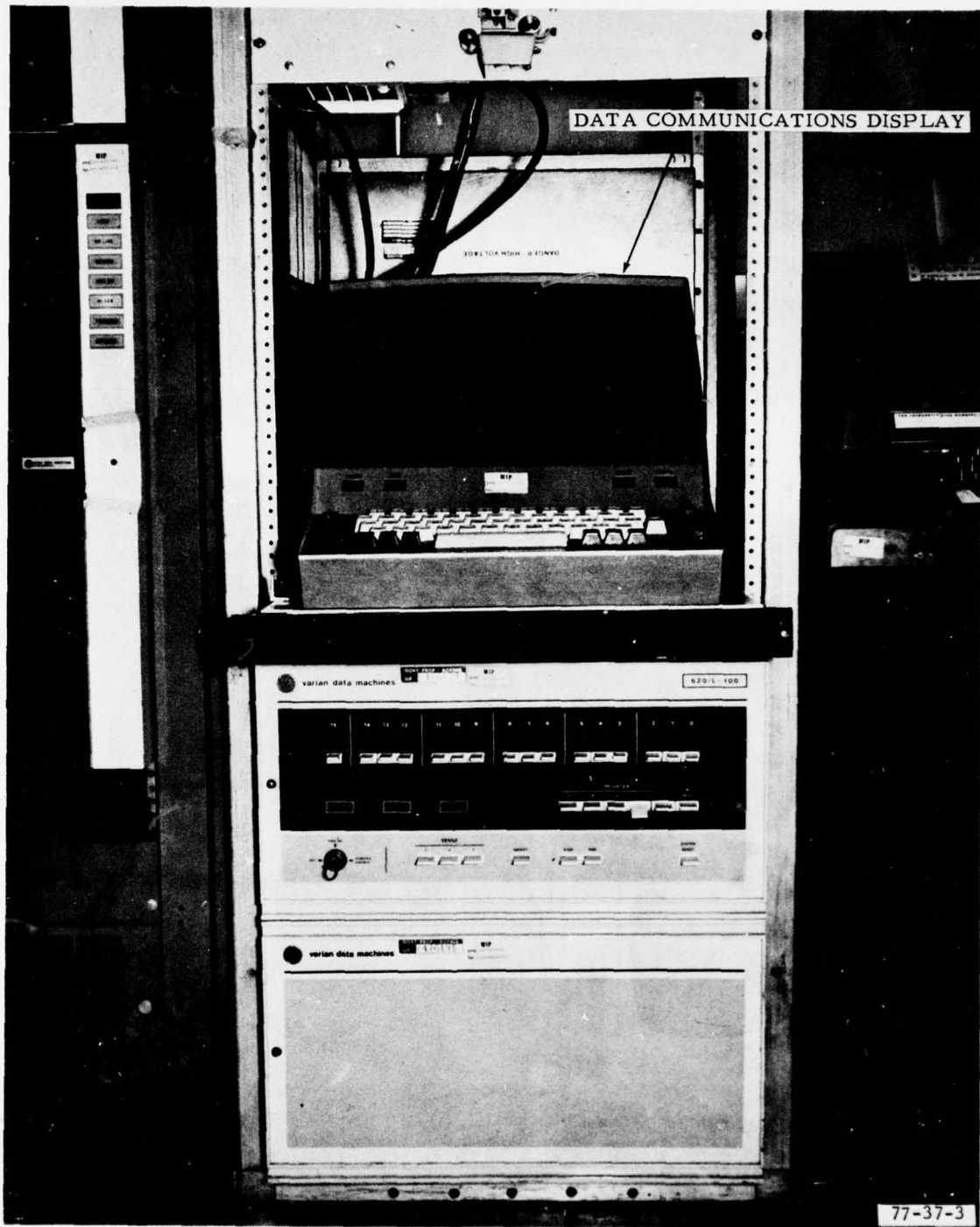


FIGURE 3. SIMULATION TESTBED, SIMULATED PILOT'S POSITION



FIGURE 4. SIMULATION TESTBED, COMPUTER COMPLEX



plan information was shown (figure 5), and a data communication CRT display with data keyboard and quick action keys. A teletype terminal, used for print-out of message format errors, a data communication long-text message printer, and a headset with microphone were also located at this position. The situation and tabular displays were controlled by computer "A", while the data communication display and long text message printer were controlled by computer "B".

Computer A. The software in computer "A" generated an oceanic area map (figure 6) with latitude and longitude grid, permanent route structures, aircraft targets with projected routes, data blocks, leaders, velocity vectors, problem time, the menu selected (a choice of two), conflict and late alerts, and verified signals for display on the situation display. The software also provided capability for the controller to manipulate the presentation on the display. This capability was accomplished through use of a special keyboard, depicted in figure 7, and a light pen. The latter item functioned similar to the track ball associated with the National Airspace System's (NAS) radar controller position.

A description of the situation and tabular display control provisions with their associated functions is contained in appendix A.

Computer B. The software in computer "B" controlled the data and voice communications transactions of the simulation tests, provided the time delays, which simulated satellite channel access delays, and generated the format and message presentation for the data communication display. Figure 8 shows a typical display presentation for a simulation test that featured a choice by the controller test subject of voice or data communications.

Communications between computer "A" and "B" were accomplished through a computer-to-computer interface and special software. These software provisions enabled the controller to use the data keyboard and associated communication display to enter changes in flight plans and introduce air files into the system for both data and voice communications transactions.

The data communication display/control provisions and associated functions are described in appendix A.

SIMULATED PILOT'S POSITION. The simulated pilot's position, shown in figure 3 consisted of a computer terminal display/keyboard and a headset with microphone. The display/keyboard unit was used to simulate a cockpit display unit (CDU) I/O that would normally be utilized by a pilot for satellite data communication in an oceanic environment. The actual CDU, located in the aircraft's cockpit, would have a design more compact in size and feature a small CRT display and a keyboard that emphasizes dedicated function keys.

The simulated pilot's display/control provisions and associated functions are described in appendix A.

Voice communication transactions between the ATC test subject and simulated pilots positions were logged for posttest analysis by a four-channel magnetic tape recorder. The recorder was remotely operated by the computer. It was turned ON when the computer activated a voice channel and turned OFF when the channel was deactivated.

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LAST REPORTED FIX DATA

IDENT	FIX	ATA	FL	HEIT	FIX	CETA	PEVA	SPEED	POSITION
AAG77	3413/07045	0050	410	3400	07040	0100	0100	485	3018/06935
PA292	3500/06616	0100	390	2500	05530	0100	0112	485	3044/06715
AC485	3559/05735	0100	370	3500	05620	0116	0117	480	3341/06533
HAL	2533/07455	0100	370	DAR	0114	0115	485	485	2937/07121
PA262	2309/05543	0059	350	CAN	0102	0102	430	480	2630/06642
PA759	2316/05740	0059	350	RFT	0100	0100	480	480	2708/06942
PA191	4117/05420	0127	330	PXE	0127	0127	480	480	4103/06421
AA215	3501/07400	0100	330	3420	07340	0105	0105	480	3127/07219
AC957	2103/05511	0127	310	CJA	0128	0127	480	480	2113/05514
EA444	2856/07621	0058	310	2900	07600	0102	0101	435	2940/07216
EA983	3628/07125	0102	290	3400	07040	0121	0122	485	3304/07023
W42	3059/07209	0126	290	TUN	0127	0127	480	480	3845/07205
DL302	3026/08135	0127	270	JAY	0128	0127	480	480	3035/08129
PA260	3202/05644	0059	250	3200	05700	0102	0102	320	3132/06945

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FIGURE 5. SIMULATION TESTBED, TABULAR DISPLAY SHOWING ENROUTE FLIGHT PLAN DATA

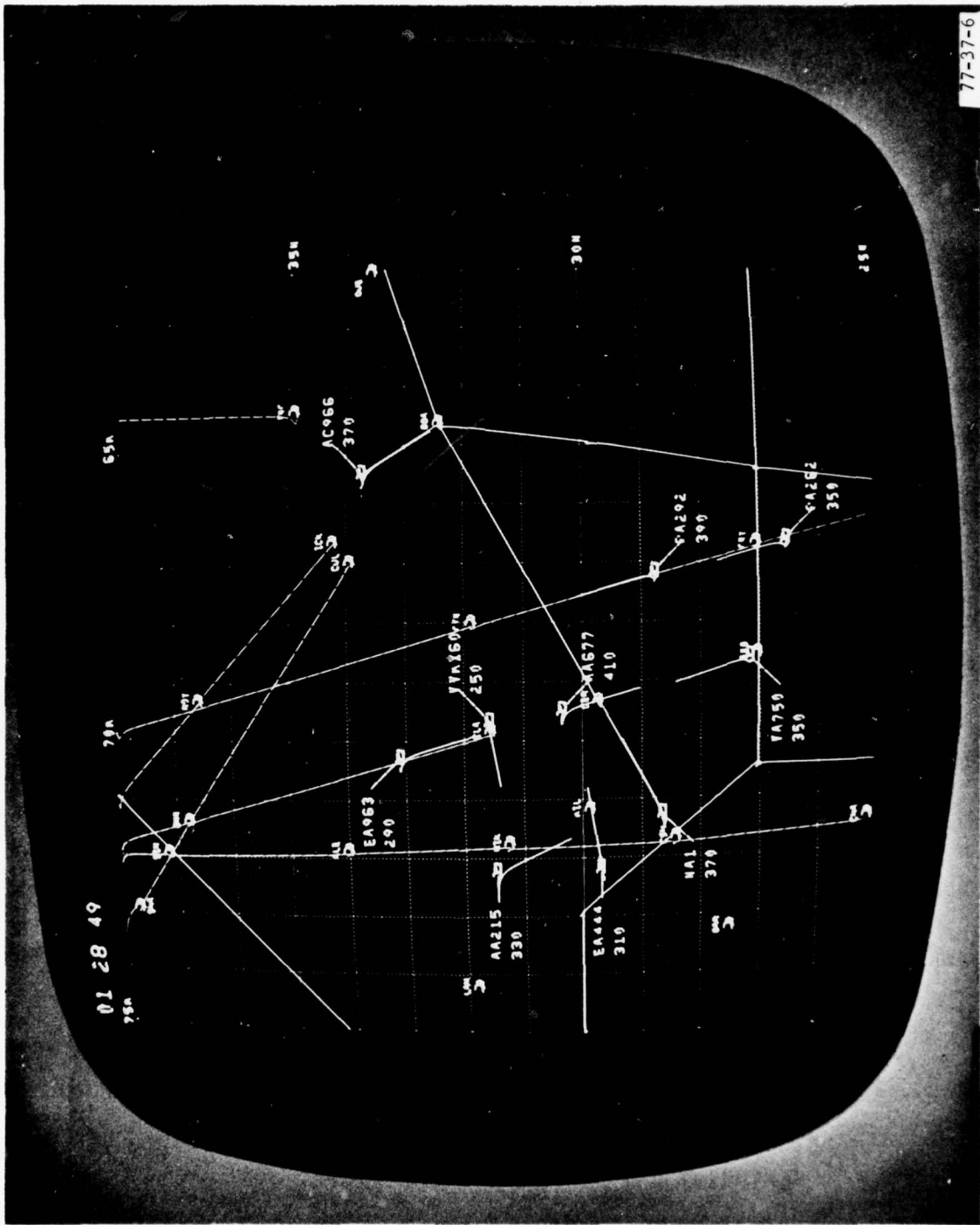
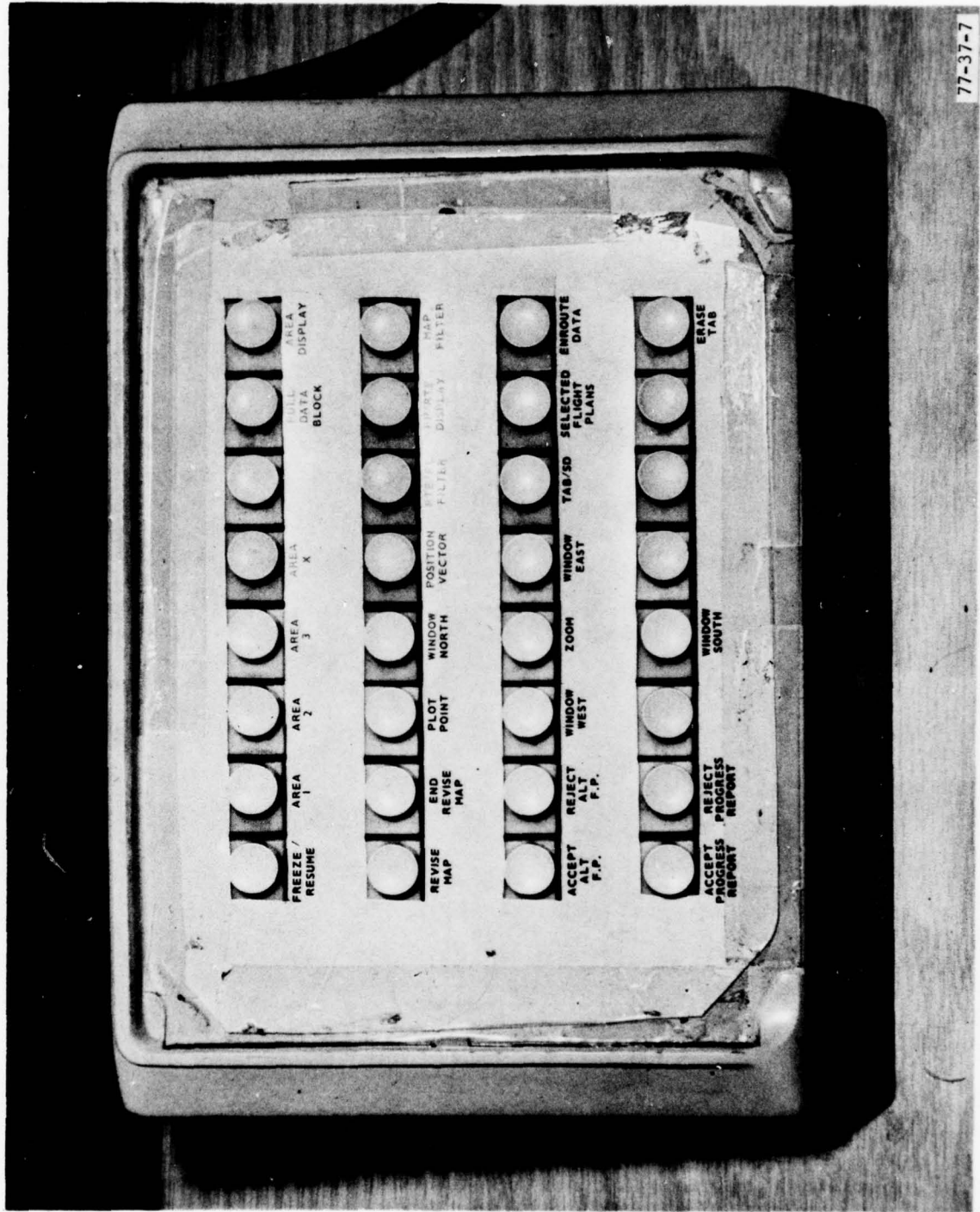
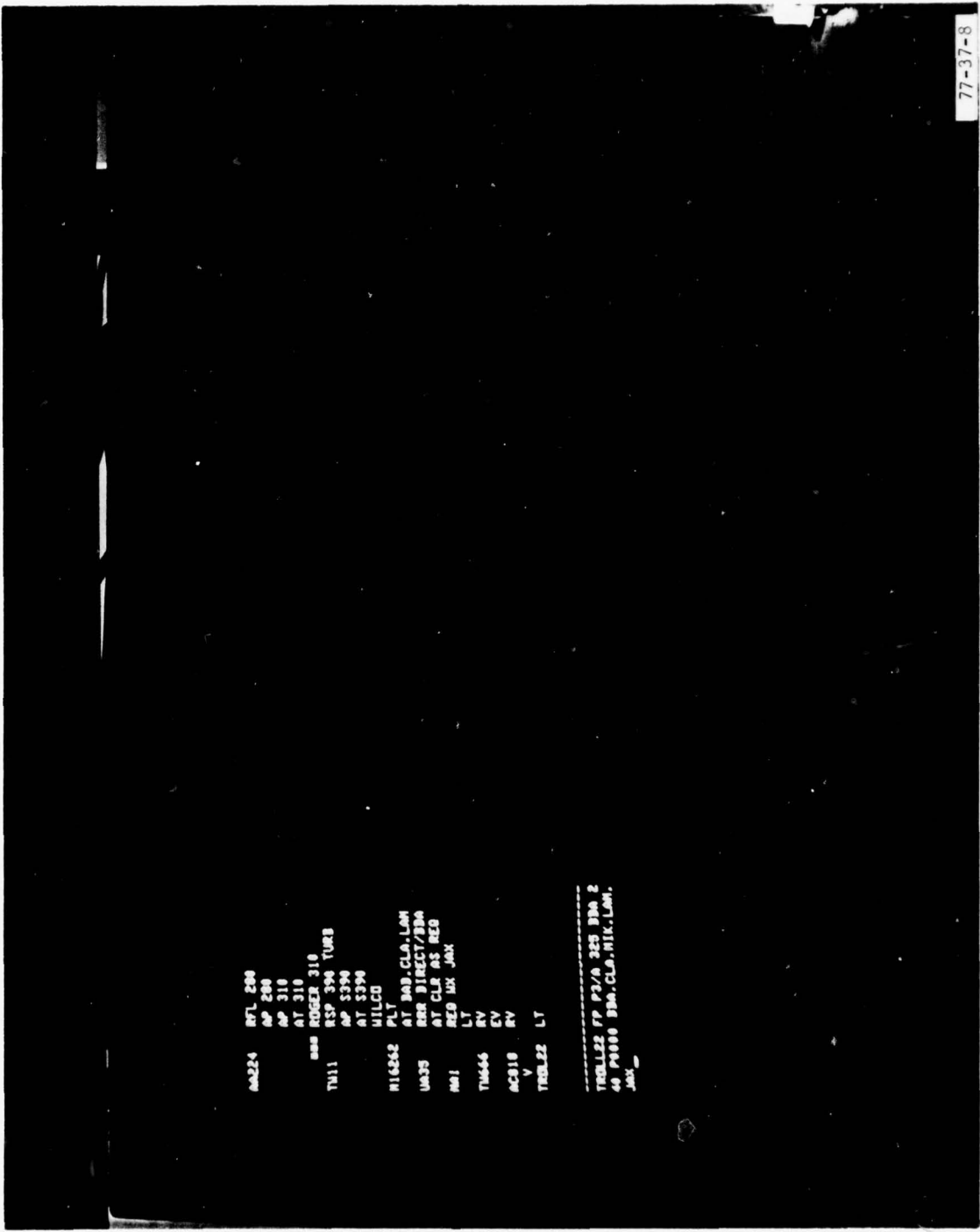


FIGURE 6. SIMULATION TESTBED, SITUATION DISPLAY SHOWING OCEANIC AREA MAP



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FIGURE 7. SIMULATION TESTBED, SITUATION AND TABULAR DISPLAYS FUNCTION KEYBOARD



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AM224 RTL 200  
 AP 200  
 AP 310  
 AT 310  
 \*\*\* ROGER 310  
 TH11 SSP 300 TURE  
 AP 3300  
 AT 3390  
 MILCO  
 N16542 PLT  
 AT 300.CLA.LAM  
 UAS25 ROR DIRECT/300  
 AT CLR AS RED  
 M01 RED MX JAX  
 LT  
 TM666 BV  
 ACS10 BV  
 Y  
 T06L22 LT

T06L22 P2 P3/O 325 300.2  
 40 P0000 300.CLA.NIK.LAM.  
 JAX\_

FIGURE 8. SIMULATION TESTBED, DATA COMMUNICATIONS DISPLAY SHOWING A TYPICAL PRESENTATION FOR A VOICE AND DATA TEST

### SIMULATION TEST DESIGN.

The initial step in the simulation design for the SSC/CAC tests was to define the characteristics embodied in the proposed AEROSAT system's configurations and channel access control techniques which affect the system user. The nature of the major impact on the system user was resolved to be delays in channel access. The basic contributors to channel access delay were determined to be the number of channels available, the number of aircraft involved, and the method of access and control being used in the satellite communications system. The delays could be very short, which would be representative of a system that has many channels available, and the usage is primarily dedicated to data communication. Delays could also be very long, as in a system with few channels and where these channels are essentially used for voice communication which requires substantially more on-channel time than data communication. Systems management and the techniques employed for determining who will use a particular channel at any one time will also have a significant affect on delays. There are many different configurations of a satellite communications system that can produce the same type and duration of delay. In the subject simulation design, no attempt was made to relate different time delays to particular system configurations. In most cases, the delays will vary over certain ranges which can be represented through delay curves. These curves graphically show the minimum and maximum time delays and the probability of occurrence of a particular delay.

There were two types of delay curves used in the simulation tests, flat distribution and Gaussian distribution. The flat delay curve provided an equal probability of getting any delay between the minimum and the maximum values within the delay range defined. For example, when using the flat delay curve with a range of 5 to 25 seconds delay, there was an equal probability of having a 7-second delay as a 13- or 20-second delay. The range of the curve was 20 seconds ( $5-25=20$ ) with a mean delay value of 15 seconds ( $\frac{5+20}{2}=15$ ).

Therefore, this particular delay curve was referred to as a 15-second flat delay curve. Conversely, the Gaussian delay curve resulted in a delay distribution that provided a high probability for having a delay which approached the mean value within the delay range defined. Using the same delay range of 5 to 25 seconds for the Gaussian curve, the predicted probability of having a delay between 12 to 18 seconds, for example, was 71 percent, while the probability of having a delay of 5 or 25 seconds, the extremes of the delay range, was less than 10 percent. The delay value with the highest probability of occurring was the mean value or as in this example, 15 seconds.

In the SSC/CAC simulation testbed, the methods used to obtain the flat and Gaussian delay periods applied in the individual tests was a pseudorandom selection of a delay value from a table of discrete delay periods. The table consisted of 64 slots, each containing a delay period value derived from predetermined flat or Gaussian delay curves. Through utilization of the high-speed, real-time clock in computer "B" incrementing a 1 to 64 counter and by employing a nonperiodic slow sampling of the counter output, a pseudorandom number generator was implemented. When a delay period was required during a test, a random number from 1 to 64 was generated, and that number was used to

indicate which slot of the 64 slots in the delay table was to be used. This method of choosing the delay period ensured that each slot in the delay table had an equal probability of being selected; therefore, it was directly applicable for providing the flat delay curve delays. Gaussian delay curve delays were provided by placing the higher probability delay values in multiple slots in the delay table and the lower probability values in fewer slots in the table. The delay curves with their respective range of delay values used for the SSC/CAC simulation tests are listed in table 2.

TABLE 2. SSC/CAC SIMULATION TESTS DELAY CURVES

<u>Delay Curve/Type</u>	<u>Range of Delay Values</u>
30 Seconds Flat	15 to 46 seconds
45 Seconds Flat	13 to 76 seconds
60 Seconds Flat	25 to 88 seconds
30 Seconds Gaussian	5 to 68 seconds
45 Seconds Gaussian	7 to 90 seconds

A third type of delay used in the subject simulation tests was a fixed 5-second delay used for all short-text data communications messages. The 5-second delay was selected to represent the minimum time period required for acquisition of a channel and synchronization, or lock-up, of the satellite system's ground and airborne terminals digital communications equipments.

The next step in the simulation design was to develop an air traffic scenario for use in the individual test runs. Three traffic samples consisting of 15 aircraft and associated flight plans (appendix B) were prepared. The aircraft's flightpaths were arranged to reflect current oceanic separation standards. (In brief, these standards require 120 nautical miles (nmi) lateral spacing of aircraft, 20 minutes flying time separation in longitude, 1,000 feet vertical separation up to and including 29,000 feet altitude, and 2,000 feet vertical separation above an altitude of 29,000 feet.) Six scripts (appendix B) associated with the aircraft in the three flight plans were prepared. These scripts contained communications cues for the controller test subject and simulated pilot. At appropriate points in the aircraft's flight, communication transactions were identified for initiation by either the controller test subject or the simulated pilot. Some of the communication transactions, depending upon the actual traffic situation in the simulation run at that time, could necessitate several exchanges between the controller and simulated pilot.

There were 10 test runs designed into the simulation tests: two voice-only, two data-only, and six choices of data or voice; the latter, the choice of data or voice, was at the discretion of the controller test subject. The three traffic samples and associated scripts described above were used interchangeably for the three types of test runs. Data communication test runs were divided into three levels of message constraints for the purpose of simulating three

different kinds of I/O capability in the AEROSAT user aircraft cockpit. These constraints were: Level 1 - unconstrained in length of message and type of format used (assumption: user aircraft has a computer-type display/keyboard I/O device), Level 2 - constrained in length of message used to 16 characters, excluding the aircraft identification and quick action function identifier symbol (assumption: user aircraft has a limited window display capability of 16 characters and alphanumeric keyboard I/O device), and Level 3 - constrained to the use of fixed format messages that were acceptable in format for computer processing (assumption: user aircraft has a limited window display capability of 16 characters and dedicated function button I/O device).

Figure 9 presents a listing of the test parameters associated with the 10 simulation test runs. The SSC/CAC test schedule was arranged to accommodate 10 ATC test subjects; however, due to a conflict in availability, only 9 test subjects actually participated in the data collection runs. Each test subject was assigned to a 2-week effort, 1-week for briefing/training and 1 week for the actual tests. During the first week, the test subject was briefed on the test details, operation of the equipment at the testbed controller's position, and familiarization with the traffic samples and test area geography.

Conduct of the individual test runs required four participants: testbed operator, simulated pilot, test observer, and test subject. The duties of these participants were as follows:

Testbed Operator - Turn ON testbed equipment, checkout system, bring up proper traffic sample, set in delay factor, monitor run for system malfunctions, and set up voice recording equipment.

Simulated Pilot - Checkout simulated pilot's position equipment, confirm use of proper flight plan and associated script, confirm test run parameters, checkout communications' channel if test run is a voice-only or choice of voice or data, and operate the simulated pilot's position in accordance with the test scenarios.

Test Observer - Confirm that all testbed equipment is ON and functioning properly, confirm that the proper traffic sample and associated script is being used for the test run and that the appropriate delay parameter has been set into the computer, distribute the test run script and flight plan, brief controller test subjects on the type of test run and the test parameters, make entries of all applicable data on observer's log, start test run, record time, monitor test run and cue test subject on ATC-initiated actions as required, log all occurrences that may have a bearing on the data, end test run when all items on the script are completed, log type number on voice recording for applicable test runs, gather together and label all hard copy data logs from the high-speed printer and long text printer, debrief test subject, log comments, brief test subject on next test run, administer prepared questionnaires to test subjects as required, and maintain the integrity of the data package for posttest analysis.



SSC/CAC SIMULATION TEST PARAMETERS

<u>Run Number</u>	<u>Sample Number</u>	<u>Run Type</u>	<u>Delay Shape</u>	<u>Test Constraints</u>
1	2	VOICE	45 SEC FLAT	NOT APPLICABLE
2	2A	DATA	30 SEC FLAT (LONG) 5 SEC FLAT (SHORT)	UNCONSTRAINED IN MESSAGE LENGTH & FORMAT
3	3	CHOICE V or D	30 SEC G (VOICE) 5 SEC FLAT (DATA)	FIXED FORMAT
4	3A	CHOICE V or D	45 SEC G (VOICE) 5 SEC FLAT (DATA)	ONE LINE LIMIT (16 CHARACTERS)
5	1	CHOICE V or D	45 SEC FLAT (VOICE) 5 SEC FLAT (DATA)	UNCONSTRAINED IN MESSAGE LENGTH & FORMAT
6	1A	VOICE	45 SEC G	NOT APPLICABLE
7	2	DATA	30 SEC FLAT (LONG) 5 SEC FLAT (SHORT)	UNCONSTRAINED
8	2A	CHOICE V or D	30 SEC FLAT (VOICE) 5 SEC FLAT (DATA)	FIXED FORMAT
9	3	CHOICE V or D	45 SEC FLAT (VOICE) 5 SEC FLAT (DATA)	ONE LINE LIMIT (16 CHARACTERS)
10	3A	CHOICE V or D	60 SEC FLAT (VOICE) 5 SEC FLAT (DATA)	UNCONSTRAINED IN MESSAGE LENGTH & FORMAT

Notes: V = VOICE  
D = DATA  
G = GAUSSIAN DELAY CURVE

FIGURE 9. TEST PARAMETERS USED IN THE 10 SSC/CAC SIMULATION TEST RUNS

Test Subject - Learn test area geography, become familiar with operation of equipment in the testbed controller's position and the traffic samples, know what the test subject duties are, respond to return channel communications and initiate forward channel communications on cue, observe test parameter restraints during test runs, and provide test run comments to test observer.

A typical simulation test run progressed as follows: the test observer determined that the testbed was in a ready status for conduct of the test. The controller test subject, using the displayed video map (figure 6) and the assigned traffic sample, would initiate action through the "freeze/resume" key on the function key panel (FKP). Normally, the controller would first choose the area to be displayed by the FKP "area" key and then activate the "zoom" key once to enlarge the central portion of his operation area. At this point, the script was implemented in the test run. The script contained 14 separate action cues, 10 of which were initiated by the simulated pilot and the remaining 4 initiated by the controller test subject. The script was faithfully followed until all items were completed. No action item was commenced until the previous one was concluded. Over and above the script items, ATC conflicts could occur during a test run. When conflicts did occur, they were signaled to the controller who was expected to resolve them before proceeding to the next script item. The test run required 30 to 45 minutes to complete, depending upon the imposed test constraints. Upon completion of the test run the controller test subject was debriefed by the test observer, and the data logs from the high-speed printer, long text message printer, voice channel magnetic tape recordings, and observer notes were collected and stored as a discrete data package for posttest data analysis.

A general questionnaire on the SSC/CAC tests was administered to each controller test subject upon completion of the 5th test run and again upon completion of the 10th test run. Additionally, a questionnaire on the CRD was administered to each test subject after completion of the 10th test run. Copies of these questionnaires are contained in appendix B.

## TEST RESULTS

The SSC/CAC tests results were derived from several sources: test subject opinions and comments via the questionnaires, test observer notes, and the data and voice communications logs.

### GENERAL QUESTIONNAIRE.

The results of the general questionnaire are addressed in the following discussions:

a. In voice-only communication tests, the majority of the test subjects indicated that the waiting times for the channel were acceptable, no matter which delay factor was used in the test runs.

b. In "choice" tests, where either voice or data communication was available, all but one of the nine test subjects favored use of the data channel over the voice channel.

c. The voice channel was preferred by six of nine test subjects as the most expedient means for resolving difficult control situations.

d. All test subjects indicated that they believed, from their experiences in the tests, that the voice channel would be used less than 25 percent of the time in a similar design real life system for oceanic ATC.

e. The test subjects were in agreement that the types of messages provided through the computer message identifier quick action keys and the restricted format messages used in the data communication tests were sufficient in scope and acceptable to them as a satisfactory means for all of the ATC functions they would require in an oceanic environment. In their answers to the questions relating to message types and formats for data communication, the test subjects had the following comments: two of the message formats that were especially useful for the data communication mode were altitude/speed changes; however, they suggested that there should be a more positive differentiation of the two than simply an "S" in the speed change format of the message. In the tests, speed change messages were inadvertently sent without the "S," with the result of having altitudes changed to the requested speed. Although an in-air reroute was easily entered by means of the "AT" message, most test subjects felt that an "RR" message identifier would enhance operations, but was not an essential item. The flight plan format was acceptable to the test subjects, but believed by some to be cumbersome and difficult to remember as evidenced in the fact that they were not totally familiar with it until late in the data communication test runs. Some test subjects had difficulty remembering to accomplish the mechanical function of activating the "accept" or "reject" control provision function key after entry of a position report. The position report and hold messages were considered to be straightforward and easily entered. In the reception of pilot-initiated messages, the test subjects suggested that a standard format for a "Pilot's Report" (PIREP) would be a useful feature.

f. Test subjects were about equally divided in their response to the question of whether they were forced to use the voice channel more than they actually wanted to when test restraints were placed on the length of data communication messages.

g. When asked to compare data to voice communication in the first administered questionnaire, seven of the nine test subjects indicated that they would rather use data than voice; the remaining two indicated that data communication could be used to supplement voice. On the second administered questionnaire, all test subjects indicated that they would rather use data than voice communication, but three of them also indicated that in some ATC situations data-supplemented voice communication would be their choice.

h. The question of what the test subjects considered to be prominent features of the simulated oceanic ATC satellite communications' system elicited the following responses: The situation display met with unanimous approval, but the displays of tabular information were criticized for containing too much information. The positive communication feature of the data channel and availability of a direct voice channel were considered to be a quantum improvement over current oceanic communications capabilities. In connection with the availability of a voice channel, it was thought that there should be a means of immediate contact of a particular aircraft or the preempting of a channel in use to deliver an imperative message and also provisions for simultaneously transmitting an advisory to all aircraft in a particular sector. The automatic conflict alert provision was considered to be a good feature; however, some test subjects thought that at times alerts were activated (flashed on the display) too much in advance of conflicts. It was suggested that the system should provide the controller with alternate courses of action to resolve the conflicts, such as available free altitudes or route changes. The provision of dependent or independent surveillance was recognized as an immediate means for reducing oceanic separation standards and thus ensuring more efficient use of oceanic airspace and accommodation of large traffic volumes. In addition to the CRD being used as the data communications I/O, it was suggested that this device would serve as an excellent replacement for flight strips. To accommodate this application, computer storage of ground/air and air/ground messages, at least for the period of time the aircraft was in the sector, would need to be provided. It was noted that during the transition of an aircraft through his sector, a controller may need to refer to a message previously sent to or received from an aircraft. The controller could have this option through the utilization of a message storage bank. Message storage would also eliminate loss of data due to an overloaded CRD. Additionally, if message storage could be retained for periods up to 24 hours, this feature could also be used for traffic counts much like the use of flight strips for this purpose in current domestic operations.

#### TEST SUBJECT COMMENTS ON SITUATION DISPLAY AND CONTROL FUNCTIONS.

The test subjects were quite impressed with the situation display and considered it one of the key features of the simulation testbed. Their use of the display and associated control function keys, as noted by the test observer and recounted from their comments obtained during the debriefings, are presented in the following discussions under headings related to certain control provisions.

FULL DATA BLOCK. This control provision and associated menu list was selected most often by the test subjects to remain displayed during the test run. It provided the means for the controller to offset data blocks around the target symbol and to control the size of the alphanumeric characters. In its use for character size adjustment, the next-to-the-smallest size setting was the one most universally used by the test subjects. The offset feature of this menu was the one most frequently used, whereas the delete data block feature was never used by the test subjects during the test runs. In the use of this menu list, the requirement to terminate the manipulation of the list items was alerted to the controller by the appearance of "end select" at the bottom of

the data block. This alert was very easily overlooked by the test subjects and was considered to add another unneeded step to what should be a simple feature. It was suggested by some test subjects that a provision for offsetting the data blocks through a keyboard entry, as well as the light pen and associated menu list, would be an enhancement option for the simulation testbed.

AREA DISPLAY, REVISE MAP, END REVISE MAP. These control provisions actually were not utilized by the test subjects during the test runs; apparently, because they found no real need to employ them. In simulation scenarios wherein separate voice and data communications controllers are used to man the position, the requirement to use these control features would be more evident to the controller handling surveillance (similar to the NAS radar controller position).

WINDOW-NORTH/SOUTH/EAST/WEST. These control provisions were used primarily during rerouting operations to select routes. The utilization of these controls increased with the test subjects experience with the system. Once the window concept was assimilated these control features became more useful. This was a concept that was more easily understood through demonstration than briefing.

POSITION VECTOR. This control provision was not manipulated to any extent by the test subjects. Normally, it was set to 20 minutes of future track at the beginning of a test run and allowed to remain at that setting throughout the run.

ROUTE/FLIGHT LEVEL FILTER. This control provision, which was available to the controller for deleting selected aircraft targets by flight level, was not used by the test subjects during the test runs, since only one ATC sector was involved in the simulation scenario.

FLIGHT PLAN ROUTE DISPLAY. This control provision, which was available to the controller for displaying aircraft flight tracks to destination and was particularly useful in conflict situations, was seldom used in the test runs by the test subjects. The conflict alerts were provided well in advance of the actual conflict; in some instances, as much as 1 hour of flight time. After initial test runs demonstrated to the controllers that invariably the projected flight-paths did indeed cross at the altitude being flown by each aircraft in the conflict situation, the controllers accepted with a high level of confidence that the computer program for conflict alerts was very dependable. Once so convinced, the controllers thereafter would simply resolve the potential conflict at the time it was alerted to them. This procedure on the part of the test subjects is considered to be unrealistic for an actual live situation, since each controller will exercise his own technique in dealing with a potential conflict situation. Although alerts for an oceanic environment would be programmed to occur 30 minutes in advance of a conflict, false alerts could occur earlier than that. Some controllers will take immediate action, while others will defeat the early alert and wait for the alert that is within the prescribed minimum time period.

MAP FILTER. This control provision which enabled the controller to manipulate the map presentation was not used by the test subjects during the test runs

because the size of the traffic sample used in the simulation scenario was not large enough to clutter up the map presentation; therefore, there was no urgent requirement for filtering the map symbology.

ACCEPT/REJECT ALTITUDE/FLIGHT PLAN. These control provisions were the means for the controller to accept or reject outputs of computer-derived probes of altitudes, airspeeds, and conflict alerts concerning flights within his sector air space. It was noted this testbed feature showed the resourcefulness of controllers for finding a way to reduce their workload. During "choice" (voice or data communication) runs and data-only runs, the test subjects automatically rejected all probes (clearances and conflicts) through the "Reject Altitude" control provision, and in lieu of this method for updating, the computer sent the cleared altitude or airspeed change by a data communication "AT" message which appeared at the simulated pilot position display and updated the computer at the same time. When voice-only runs were in progress, the simplest way to update the computer in response to a requested change in a flight plan was to utilize the "Accept Altitude" control provision. To use the data communication "AT" message technique as described above for updating the computer would be an unneeded operation, since the controller would have to advise the simulated pilot of the clearance through the voice channel anyway. It was noted that often test subjects would forget to accept or reject probes and this tied up the function keyboard so that no other control provision could be used. Activation of either the "Accept" or "Reject Altitude/Flight Plan" function key was necessary to terminate each probe and allow activation of another desired control provision. It was the general opinion of the test subjects and observer that this control provision would not be realistic for use in a real environment. The controller, before granting an altitude change request, would need to determine if the altitudes above or below the altitude being maintained by the aircraft requesting the change were occupied by other flights, since the subject aircraft would have to climb or descend through these altitudes. If the probe would provide data on free altitudes, rather than just the altitude probed with added data on restrictions where intermediate altitudes were occupied, the control provision would be more realistic.

TAB/SITUATION DISPLAY. This control provision enabled the controller to move either the "situation" or "tabular" presentation being displayed from one display unit to the other. Although its function seemed to be straightforward, it caused problems for some test subjects. Apparently the problem was related to the fact that the tabular data presentation displayed could be either the selected flight plan or enroute flight plan data; the selection of which was controlled by another control provision, the "Selected Flight Plan" function key. Often a test subject would forget which tabular presentation had been selected; therefore, when he moved the tabular display presentation onto the display unit he was viewing, he sometimes became confused when it was not the presentation he was expecting. This problem was attributed to unfamiliarity with the control provisions on the part of some test subjects, and it is expected that it would be readily resolved with sufficient experience.

SELECTED FLIGHT PLANS. This control provision was available to the controller to call up onto the tabular display the menu of all ACID's in his controlled airspace for which the selected (filed) flight plan data of each aircraft could be displayed through activation of the light pen. This particular tabular presentation was not extensively used by the test subjects during the test runs.

ENROUTE DATA FLIGHT PLANS. This control provision, similar in function to the above "Selected Flight Plans" provision, provided the controller with the dynamic flight plan data on each aircraft under his control. This tabular display presentation was the one most frequently used by the test subjects. Test subjects indicated that it was difficult at times to pick out individual bits of information for an aircraft halfway down the 10 or so columns of data displayed. It was suggested that the use of this display could be enhanced by inserted computer-generated lines between each two lines of data, or pulsating brightness of the particular data of interest. The latter-suggested modification would require the entering of some kind of computer message, probably an ACID and associated special character, through the I/O keyboard in order to designate which flight plan data were the data of interest.

ACCEPT/REJECT PROGRESS REPORT. These two control provisions were available to the controller in connection with his manual entering of an aircraft flight progress report. If the entered data did not agree with the computer-generated data, an alert indicating a disagreement in data and the need for a verification was given the controller. This alert took the form of a flashing "V" next to the aircraft track symbol on the situation display and also by the flashing of the erroneous data in the enroute data tabular display. By the activation of either of these two control function keys, the controller either accepted or rejected the computer alert and took the appropriate follow-on action. During the test runs, if the test subject was viewing the situation display and not paying attention to the enroute data tabular display or busying himself with operations at the data communication position, he often overlooked the alert on the situation display. This problem was attributed to inexperience on the part of the test subject in the proper use of the different displays and an artificial simulated oceanic ATC environment; the latter because the test subject was manning both the "S" (surveillance) and "D" (data) positions. In real life, there would be a separate controller for each position.

COMPUTER READOUT DEVICE QUESTIONNAIRE.

The following discussion summarizes the results of the questionnaire on the CRD.

All test subjects were of the opinion that the information capable of being displayed on the CRD, the size of the preview and the computer areas, the functions provided by the quick-action keys, and the methods for deleting data were of good design. They also indicated that the overall use of the CRD for ground-air-ground data communication was acceptable to them. A number of test subjects had suggestions for improvements which they thought would be beneficial to the "D" position of the simulation testbed; these were:

- a. The ability to identify the receiving aircraft for dispatch of a message by other means than typing in an ACID, such as a track-ball.
- b. Provision to alert the controller of a potential data overflow in the computer area of the CRD and the capability for storage of the overflow data for future recall.

c. Provision for the controller to have an option for using or defeating the automatic ACID feature to prevent its confusing him. Some test subjects found this feature helpful to them, others indicated it was causing them added workload.

d. An increase in the display time for the special alert symbols associated with aircraft reply messages displayed in the computer area of the CRD. The display time designed into this feature was 15 seconds, which seemed to be adequate; however, it is not a critical item and can be adjusted to whatever period is determined to be optimum.

#### TEST OBSERVER COMMENTS.

The test observer notes concerning general comments on the simulation tests and the testbed are summarized in the following discussions:

a. Data communication was preferred over voice communication by the test subjects primarily for two reasons, delays in obtaining a voice channel and because the computer flight plan information was updated automatically by the data message. Another advantage noted was that data communication would provide a positive transfer of control instructions to pilots of foreign flag carriers whose national language is not English, viz., printed data are more intelligible than spoken word.

b. The fixed reroute message format used in the tests did not provide for inclusion of an altitude. It was the opinion of all test subjects that an altitude should be specified in the message to preclude the necessity of having to accomplish the added operation of updating the computer-stored altitude in the event the controller had to change the aircraft assigned altitude.

c. It was observed that most test subjects could cope with the limited length message (16 characters) constraint by judicious use of abbreviations. This would suggest that a standardized list of abbreviations and control symbols would be a beneficial feature for a real-time oceanic system.

d. Another observation concerned controller techniques when replying to an altitude change request via data communication. Some test subjects simply replied with a message containing a different-than-requested altitude without any advice to the pilot that his requested altitude was unavailable. Other controllers would return a message that indicated they were unable to provide the requested altitude and were offering an alternate altitude for the pilot's concurrence; for example, "Unable 290 OK 310." If there were no alternate altitudes available, the message would be, "Unable 290 remain at 270." This procedure avoided uncertainty on the pilot's part; otherwise he might conclude that the controller gave him the wrong requested altitude due to a garble in his air-to-ground message.

#### DATA RECORDS/LOGS ANALYSIS.

One of the objectives of the SSC/CAC tests was to determine from analysis of the data and voice communications logs answers to such questions as:



a. What was the mix of voice and data communication messages in the simulated satellite-communications-supported oceanic ATC environment?

b. What was the merit of the design of the data communication "Quick Action Keys" configuration?

c. Did the controller test subjects resort to use of abbreviations to expedite data communication exchanges during test runs which were restricted to the free format mode?

d. Was there a need to redesign the fixed format messages used in the data communication tests?

e. Was there a need for lengthening the selected short text message length used in the data communication tests?

The answers to the above questions are addressed in the following discussions.

The simulation test runs that featured a choice for the controller test subjects between voice and data communication were used in the analysis to determine the mix of voice and data communication that might be expected in an ATC oceanic environment supported by satellites. The results of the analysis showed that there were 74-percent data and 26-percent voice messages or a ratio of 3 to 1 in the use of data communication.

The analysis of the merits of the design of the "Quick Action Key" configuration revealed that most of the message provisions selected for the single-key entry were a good decision. Utilization of the different quick action message provisions were governed to a certain degree by the design of the test scenarios. The most-used "Quick Action Keys" were the "Probe" and "Transmit" message functions followed by "Flight Plan", "Activate Flight Plan", "Progress Report", "Delete Data", "Hold/Delay", and "Cancel." By design, "Request Voice" and "End Voice" keys were required to be used for all voice communication transactions; therefore their utilization rate was high as expected.

A review of the data logs for the test runs devoted to free format messages did not reveal any action on the part of the controller test subject to resort to abbreviations to expedite data communication transactions. It should be noted that when the test subjects were briefed on the simulation tests, they were given a suggested list of 12 abbreviations (appendix B) for use in composing data messages. These abbreviations were used extensively in the fixed format as well as the unconstrained format tests. Therefore, it is believed that there will be a requirement for deriving a lexicon of standard abbreviations for the application of data communication in satellite-supported oceanic and Continental United States (CONUS) ATC systems.

To determine an answer to the question of whether there was a need to redesign the fixed format used for data communication in some of the simulation tests, the event logs from those "choice" tests in which the fixed format was a test constraint were analyzed. There was no evidence from the examination of these logs that the controller test subjects were dissatisfied with the use of the

fixed format data message and therefore resorted to using voice communication. Actually, the event logs show that 59 percent of the communication transactions were accomplished through data messages, while the remaining 41 percent were accomplished by voice.

To determine whether the short text message (16 characters) selected for the simulation tests was sufficient in length for utilization in oceanic ATC communications, it was postulated that if there was a significant difference in the amount of data messages for tests with the short-text constraint versus those for the fixed format constraint, this might indicate the need for a longer short text message length. Analysis of the event logs of tests for both test constraints did not confirm this premise, since the data indicated that there was only a small difference in message count, 5 percent more, for tests with the short-text constraint. Some explanation for this can be drawn from the test observer's log of comments, in which he noted that most controller test subjects were able to cope with limited character messages by judicious use of abbreviations. Conversely, a close examination of messages sent in response to pilots' requests for changes in their flight plan indicated that in many instances the short text message could not accommodate all of the information that could have been sent to the pilot to ensure full information clarification. Naturally, for those situations where the pilot will need further clarification of a message, he will initiate another communication transaction; however, this action will impact on channel availability. From the results and experience of the simulation tests, it is recognized that certain data communication transactions could not be handled expeditiously if limited to short text message of 16 character length. For these situations under this limitation either long text data messages or voice communication would be required. An alternative to the utilization of cockpit display unit designs that feature limited display capability (most designs considered to date have only 2 rows of 8 windows, a total capability for displaying 16 characters) would be the use of a small CRT display with capability for the display of 3 lines of 16 characters each or a total of 48 characters. The latter concept has been investigated, and mockups have been constructed and checked out for potential future application in the National Aviation Facilities Experimental Center (NAFEC) proposed ATC Automated Oceanic Control Center (AOCC) Satellite Communications Simulation Testbed.

## CONCLUSIONS

Based on an evaluation of subjective information and test data, it is concluded that:

1. In an oceanic ATC communications system supported by satellites, 75 percent of the controller-to-pilot communications transactions will be accomplished through data messages. Voice communication will be used by controllers primarily to resolve difficult traffic control situations or in response to an air-to-ground voice transaction initiated by the aircraft pilot.
2. Controllers, once exposed to a data communication system for use in oceanic ATC, will recognize its efficiency and advantage, especially as a positive means for transfer of control instructions to pilots, and especially those whose national language is not English.
3. Standardization of abbreviations and control symbols is considered an essential system design goal for the data communication operations mode.
4. Controller test subjects exposed to the SSC/CAC simulation tests tended to adapt their communication procedure options to be compatible with the communication system discipline. This behavioral pattern should be anticipated for whatever satellite oceanic communications/surveillance system design is implemented for AEROSAT.
5. The experience gained from design of the SSC/CAC simulation testbed and tests, and the results from these tests, has provided valuable expertise, information, and data for application in future simulation efforts relevant to satellite communications systems and oceanic ATC automation.

## RECOMMENDATIONS

To assure continuing effort in the acquisition of supportive system design data and operational concepts/procedures for the development of an oceanic ATC satellite communications system, it is recommended that:

1. The proposed NAFEC ATC AOCC Satellite Communications Simulation Testbed be utilized for further and more comprehensive tests of air traffic controllers' reactions to the disciplines of the satellite mode of communications and their interaction with related input/output interfaces.
2. These tests incorporate communication delays based on projected user populations to ensure realism.
3. These tests feature candidate avionics input/output devices in at least one of the simulated pilot's positions.
4. The experience, information, and test results obtained from the SSC/CAC simulation tests delineated in this report be utilized in the proposed NAFEC ATC AOCC Satellite Communications Simulation Testbed.

#### REFERENCES

1. Air Traffic Control Experimentation and Evaluation with the NASA ATS-6 Satellite, Volume II: Demonstration of Satellite-Supported Communications and Surveillance for Oceanic Air Traffic Control, FAA Final Report No. FAA-RD-75-173-II, April 1976.

APPENDIX A

DESCRIPTION OF THE SSC/CAC CONTROLLERS' AND SIMULATED  
PILOTS' DISPLAYS, CONTROLS, AND FUNCTIONS

## LIST OF ILLUSTRATIONS

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A-3	Simulation Testbed, Simulated Pilot's Position Data Communication Display/Keyboard Showing a Typical Presentation	A-12

## SITUATION AND TABULAR DISPLAYS FUNCTION KEYBOARD CONTROLS.

The situation and tabular display control provisions activated by means of the special keyboard were as follows:

1. Freeze/Resume - Stopped and started action on the display.

2. Area Keys (1, 2, 3, X) - Allowed the controller to select geographical area appropriate to the sector of his responsibility. The numbered areas displayed oceanic coverage as follows:

Area 1 Lat 18°N to 45°N (27°)  
Lon 55°W to 82°W (27°)

Area 2 Lat 13°N to 74°N (61°)  
Lon 8°W to 70°W (62°)

Area 3 Lat 19°N to 65°N (36°)  
Lon 27°W to 63°W (36°)

Area X No function programmed

The latitude and longitude grid was displayed in 1° increments.

3. Zoom Key - Expanded the center of map in four steps. Each activation of the key produced an increased expansion. Each expansion reduced the area of coverage by approximately half; e.g., area 1 covers 27° of latitude by 27° of longitude. Zoom 1 reduced the area to 13° of latitude by 13° of longitude, zoom 2 to 7° of latitude by 7° of longitude, zoom 3 to 3° of latitude by 3° of longitude, and zoom 4 to 1° of latitude by 1° of longitude. The normal area coverage was restored by activation of the associated area key.

4. Area Display Key - Called up a menu which permitted map refinement by means of the situation display light pen. The menu provided a choice of three predetermined areas in addition to a discrete zoom and window function. The zoom provision functioned as described above. The window feature caused any point on the display to be shifted to any other point on the display without affecting the total number of degrees displayed. The menu for the "Area Display Key" is described below:

### AREA/DISPLAY

\*ERASE

\*AREA 1

\*AREA 2

\*AREA 3

\*ZOOM

\*WINDOW

Note: The asterisked items in the above and following described menus are computer command words. To execute the computer command the light pen was pointed at any part of the selected command word and the switch on the side of the light pen was depressed.

5. Plot Point Key - No function programmed.

6. Revise Map Key - Called up a menu which enabled the controller to add or delete mapped fixes, routes, or boundaries by the light pen. The menu for this provision is described below:

REVISE MAP

\*ERASE

\*FIX       \*ADD  
\*RTE       \*DEL  
\*BDRT

7. End Revise Map Key - No function programmed.

8. Map Filter Key - Called up a menu which allowed the controller to delete or recall and dim or brighten the map features. The menu for this provision is described below:

MAP FILTER

\*ERASE

\*LAT/LONG       \*ON  
\*SECT BDRT       \*OFF  
\*OCB EXTN        \*BRT  
\*FIXES           \*DIM  
\*FIX IDS  
\*RTES  
\*SEL RTE

9. Route Flight Level Filter Key - Called up a menu which enabled the controller to select targets by flight level, and delete traffic which was not in his area of responsibility. The menu for this provision is described below:

RTL/FL  
FILTER

\*ERASE

\*ALL FL  
\*HIGH  
\*LOW  
\*SEL FL

1 2 3  
4 5 6  
7 8 9  
0

\*RESTORE ALL



10. Flight Plan Route Display Key - Called up a menu that allowed the controller to depict by vectors the point at which an alerted conflict would take place. If more than one conflict situation existed, the menu allowed display or inhibition of the flightpaths of all or selected flights and would display the estimated time that the flightpaths would cross associated with the aircraft identification (ACID) of the aircraft involved. The menu for this provision, with sample aircraft conflicts and times of occurrence, is described below:

FP/RTE/ALERT

\*ERASE  
\*DPLAY  
\*INHIBIT  
\*SEL  
\*ALL  
\*INTERSECT

AC966  
0139  
NA1  
0130

11. Window Keys (window, N, S, E, and W) - The activation of any of these keys moved the map in 5° increments in the direction opposite that described on the window key. The window keys had no limit on the number of activations.

12. Full Data Block Key - Called up a menu which enabled the controller to offset data blocks to eight points equally spaced around the target symbol, made the data blocks larger or smaller, and turned the data blocks ON or OFF. These functions could be applied to selected data blocks or to all data blocks shown on the display. The menu for this provision is described below:

FULL DATA BLOCK

\*ERASE

\*ALL        \*LGR  
\*SEL        \*SMLR  
             \*ON  
             \*OFF

13. Position Vector Key - Called up a menu which enabled the controller to vary the vector length emanating from target blocks to reflect aircraft future position. Choices available were (in minutes): 0, 10, 20, 30, and 40. The menu for this function is described below:

POS VECT

\*ERASE

\*0    \*10    \*20  
\*30    \*40

14. Accept Altitude/Flight Plan Key - This key became active when a probe had been entered into the computer. Depression of this key would then update the computer data bank and change the aircraft data block to reflect the aircraft altitude, speed, or route at the probed output value.

15. Reject Altitude/Flight Plan Key - This key became active when a probe had been entered into the computer. If the probe showed a conflict, this key was depressed by the controller to nullify probe action. This key was also utilized if the probe indicated clear, and it was desired to update the computer by means of a ground-to-air data communication message. The last action of the controller as a result of a probe had to be the use of either the "accept" or "reject" flight plan key. This completed the probe and freed the computer to make it available for the next function or controller action.

16. Accept Progress Report Key - This key became active whenever the information in a manually entered aircraft position report was not in agreement with the computer data. Depressing this key overrode the computer disagreement and repositioned the aircraft track symbol to the position indicated by the progress report entry. A flashing "V" symbol near the aircraft symbol indicated the progress report did not agree with the computer data and requested a verification be made.

17. Reject Progress Report Key - This key functioned in a manner similar to the "Accept Progress Report Key" except that it was used to reject the manually entered aircraft progress report whenever there was disagreement with the computer data. Upon rejection of the manually entered progress report, the controller had to re-enter the message correcting the information that was in error.

18. Tab/Situation Display Key - This key was used by the controller whenever he desired to replace the situation map displayed on the situation display with either of two tabular displays, the selected flight plan data, or the enroute flight plan data.

19. Selected Flight Plans Key - Called up a tabular list of all ACID's that were active in the simulation. By use of the light pen, the complete filed flight plan of one or more aircraft selected would be displayed on the tabular display.

20. Enroute Data Key - Called up the tabular display showing "last reported fix data." This included the ACID, actual time of arrival (ATA) over last fix, flight level (FL), next fix, computer estimated time of arrival (CETA), pilot-estimated time of arrival (PETA), speed, and position coordinates.

21. When the computer detected that a conflict had occurred, the word "conflict" appeared flashing on the lower left side of the situation display, with the ACID of the two or more aircraft in conflict appearing to the right of the word "conflict". The position vectors of the aircraft involved also flashed. The flashing message: "Turn off alert," appeared on the lower right side of the display. These indications continued until the alert was resolved.

22. When an aircraft position update was not received by the system within 10 minutes of passing a reporting point or reporting time, an alert would flash on the situation display in the form of the word "late" near the aircraft track symbol and the words "turn off alert" would appear at the bottom right of the display. The alerts could be extinguished by updating the computer or be overridden by means of the light pen.

All menu lists that were called up required light pen action; however, only two menus could be displayed at any one time. Menus displayed had to be erased by light pen action prior to replacement with another menu.

The tabular menu lists described above were normally displayed on the designated "tabular display" (figure 2). In addition to the menu lists, flight plans of aircraft in conflict were displayed on the tabular display. When a progress report entered into the computer did not agree with the computer data, the progress report was displayed in alphanumeric with the headings of the disputed elements flashing. Late alerts were displayed next to the ACID and flight plan on the tabular list. In conjunction with these alert displays, the phrase "turn off alert" appeared flashing on the tabular display.

#### DATA COMMUNICATION DISPLAY CONTROLS AND FUNCTIONS.

The data communication computer terminal display/keyboard, which was the controller's principal input/output (I/O) device for addressing the computers and simulated pilot position, was configured through special software residing in computer "B" to provide certain features available in the NAS "D" position Computer Readout Device (CRD). The display presentation was sized to the same dimensions as the CRD and formatted to contain a computer area of 20 lines and a preview area of 3 lines, with each line providing a maximum of 25 characters. These two areas of the presentation were separated by a dashed line. The computer area was reserved for display of all information being either received or sent by the controller. The preview area was reserved for composing and editing of all message contents by the controller prior to entering that information into the computer for processing. The computer software was designed to recognize format and ACID errors and cause appropriate error indicators to be displayed in the preview area in order to alert the controller of an improper input. The software also provided the display of the ACID in the preview area automatically upon receipt of a message from an aircraft if that area were blank at the time. This feature was incorporated for controller convenience so that he would not have to enter the ACID when he composed an answer to the message.

Information that appeared in the computer area was grouped according to the aircraft associated with the communications' transaction, with the ACID appearing to the left of the first line in each message group. The last line in each message group was the last communication to or from the particular aircraft. When a new ACID with associated message appeared in the computer area, it occupied the top line of the presentation and caused all other lines to scroll downward one line. In order to prevent the computer area from becoming filled to capacity, the controller had the provision for selectively deleting any group of messages associated with an ACID or consecutive bottom lines of the existing presentation. Manipulation of the presentation in the computer and

preview areas was accomplished through the alphanumeric and quick action keys of the communication display keyboard. Figure A-1 shows the layout of the controller data communication keyboard, while the discussion that follows below provides a summary description of the keyboard functions.

The data communication keyboard, as shown in figure A-1, contained a set of alphanumeric typing keys similar to a standard typewriter keyboard with three exceptions. There was a key for the numeral "1", a "clear key" located to the left of the letter "Q" key, and to the left of the normal apostrophe key was an "enter" key. Adjacent to the alphanumeric keys was a set of 10 "quick action" keys laid out similar to a standard telephone pushbutton matrix. To the right of the "quick action" keys were the cursor controls and editing keys, and along the far right edge of the keyboard were the mode control buttons and indicators. The majority of the controller's inputs required use of the typing keys and "quick action" keys. When a message had been composed and edited in the preview area, it was transferred to the computer for processing by means of the "enter" key. If the message text, including 9 characters for ACID as a header, was 25 characters total or less, it would appear as entered in the computer area. If there was more than 25 characters in the message, it would be printed out on the long text printer (figure A-2) associated with the data communication control position. However, the ACID and the letters "LT" were displayed in the computer area to alert the controller to the nature of the message and the related readout device.

The clear key was used to remove all information from the preview area. The transfer of an aircraft or a computer update message would also clear the preview area.

Incoming messages to be displayed on the CRD were signaled to the controller by an audio/visual aid in the form of a message-waiting light indicator/pushbutton mounted above the data communication display. Upon arrival of a message, the indicator portion of the "message waiting" light illuminated, and an audio tone sounded. The waiting message was not displayed until the controller activated the pushbutton. If the message was an initial message from an aircraft, it would appear at the top of the computer area; if it was a reply to a message from the controller it would appear under the previous entries for that particular ACID. Such messages, since they could appear in the midst of a number of message groups, were identified by three asterisk symbols placed to the left of the message. These symbols remained displayed for 15 seconds to alert the controller to the most recent message.

As noted above, messages exceeding 25 characters in length were routed to the long text (LT) printer, and the associated ACID with the letters "LT" was displayed in the computer area.

Messages identified to the computer as "AT messages" and controlled through the "AT" quick action key could be sent in two forms, formatted and unformatted. Formatted messages updated the computer and were displayed at the simulated pilot's position; unformatted messages were displayed at the simulated pilot's position only. Unformatted "AT" messages were limited to 72 characters in length, including the ACID and the "AT" symbol, but could be composed in plain language and in any form.

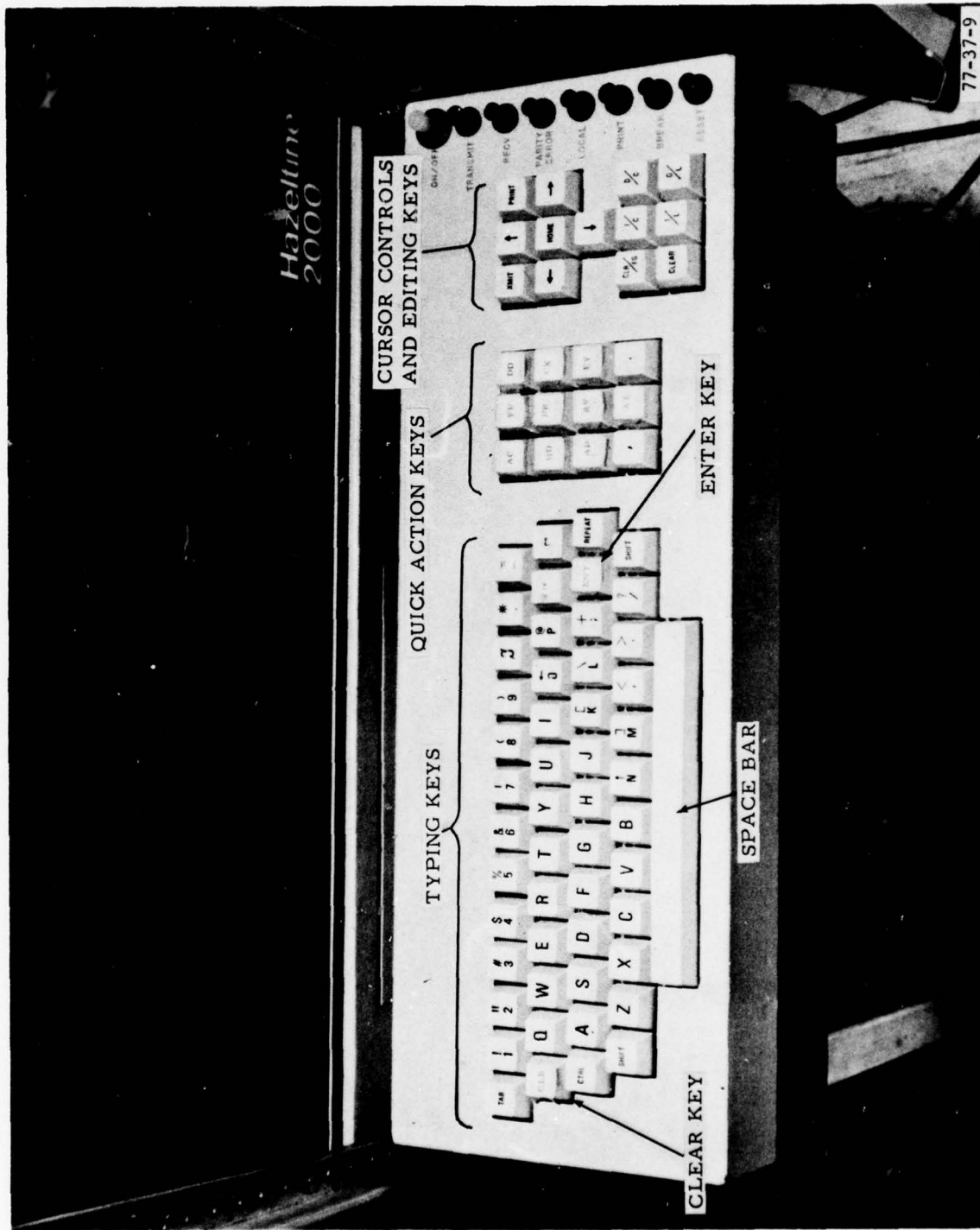
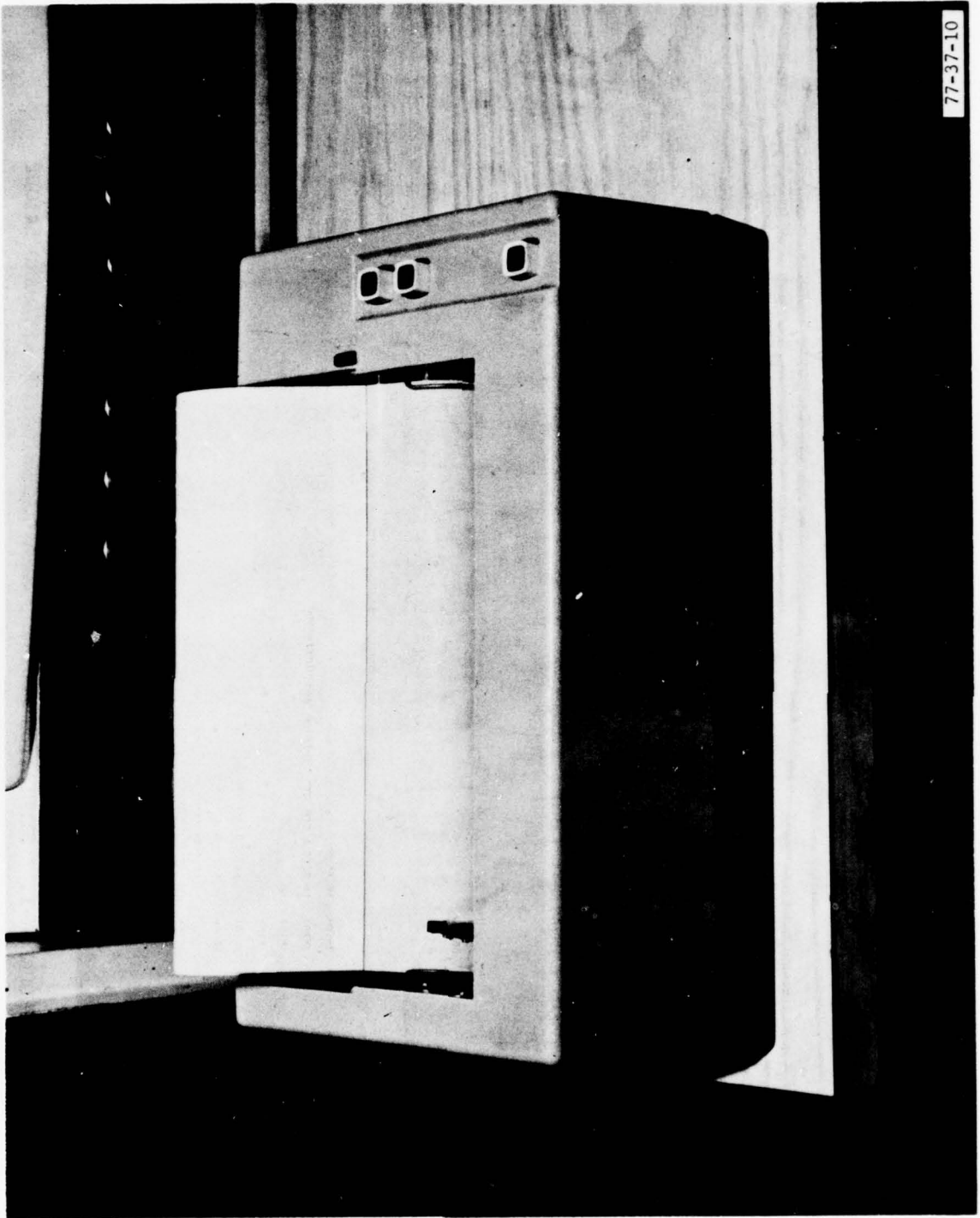


FIGURE A-1. SIMULATION TESTBED, DATA COMMUNICATION KEYBOARD LAYOUT



77-37-10

FIGURE A-2. SIMULATION TESTBED, DATA COMMUNICATION LONG TEXT MESSAGE PRINTER

"Probe," message identifier symbol "AP," was normally addressed to the computer prior to complying with a pilot request for an altitude or airspeed change. If the requested change would not cause a conflict, the word "clear" would flash on the lower right portion of the situation display. If the change would bring the flight into any conflict, the word "conflict" would appear on the lower right portion of the situation display, and the position vectors of the aircraft involved would flash. When the probe of an altitude was made, the associated data block would show the aircraft at the probed altitude. In the case of a probe showing "clear," the "accept altitude/FP" key on the situation display function key panel could be depressed, and the probed altitude or airspeed would be incorporated into the computer data. This action would normally be done if the change request was made through a voice channel transaction. The controller could clear the flight for the change by voice and update the computer by accepting the probe on the function key panel. If the requested change was made through data communication, then the "reject altitude/FP" key on the function key panel could be utilized to reject the probe, since the requested altitude/airspeed clearance would be sent to the pilot via data communication, updating the computer and data block at the same time. In the case where the probe showed a conflict, then the probed altitude/airspeed would be rejected, and an alternate altitude/airspeed probed.

"Request voice," message identifier symbol "RV," was the provision used by the controller to request the computer to assign a voice channel to any individual aircraft identified. As indicated previously in the report, voice communication provisions in the simulation tests were under computer control just as they would be in an actual ATC satellite communications system. If the controller or pilot needed to communicate by voice, they had to request a voice channel. Once a voice channel was requested, the computer would delay activation of the channel for the period of channel access time delay designed into the test. Activation of a voice channel by the computer caused a "voice channel active" indicator light at the controller's position to be illuminated and an identifying symbol "-V-" was displayed under the ACID in the computer area of the CRD.

"End voice," message identifier symbol "EV," was the provision used by the controller to request the computer to deactivate the voice channel between himself and the simulated pilot. The voice channel request provisions in the simulation testbed were designed so that either the controller or pilot could request a voice channel, but only the controller's position could request termination of the voice channel. When the "EV" message was entered into the computer by the controller, the "voice channel active" indicator was extinguished, and the letter "-V-" was removed from the CRD.

"Delete data," message identifier symbol "DD," enabled the controller to delete information in the computer area of the CRD. It was the only "quick action key" function that could be activated before the ACID was entered. The "DD" key could be used in two ways. First, the key could be depressed as many times as there were lines of data displayed, and upon activation of the "enter" key, one line of data would be deleted for each time the "DD" key was depressed. Deletion of the data was accomplished from the bottom to the top of the CRD presentation. If the "DD" key was depressed more times than there were lines of data in the computer area, no action occurred when the "enter" key was

activated. The second use of the "DD" key was to delete all information on any particular aircraft shown in the computer area. This was accomplished by depressing the "DD" key, typing in the aircraft ID, and activating the "enter" key. All information associated with that ACID was deleted, and any other aircraft message groups displayed below the deleted information would move up to fill in the vacated space.

"Progress report," message identifier symbol "PR," enabled the controller to manually enter aircraft position report data into the computer. Progress reports which were not received automatically by the computer through data communication, such as those received by the controller during voice channel simulation tests, were manually entered into the computer data bank by the controller. If the position data did not agree with the computer-interpolated position data, a "verify alert" was flashed on the situation display. This alert action required the controller to either accept or reject the computer-derived position report data through an input on the situation display function keyboard.

"Flight plan," message identifier symbol "FP," was a provision used by the controller to enter a new flight plan into the computer data bank. This requirement would occur whenever an aircraft initiated an "air file" flight plan. Following the controllers' entering of the flight plan information and an "activate flight plan" message to the computer, the target symbol and related flight information would appear on the situation display, and the flight was listed on the tabular display.

"Activate flight plan," message identifier "AC," was the provision used by the controller to activate a flight plan after it was manually entered into the computer. No flight plan information would appear on the situation display until the flight plan was activated; however, if the controller had a need for its display, the flight plan could be called up on the tabular display prior to activation. The time of activation entered into the computer had to be at a future time of the problem time.

"Hold/delay," message identifier "HD," enabled the controller to stop the progress of a flight in response to a pilot request or ATC requirement. The message contained the ACID, "HD" identifier, and a time. The time entered was the "end time" at which the aircraft would hold its present position. The situation display presentation would show a nonmoving target symbol. The aircraft target would remain fixed on the display until the controller caused it to resume on course by initiating an "AT" message. When the "AT" message is used to clear an aircraft on course, a "PR" message must be entered into the computer to cause it to resume the extrapolation of the target again.

"Cancel," message identifier "CX," was the provision used by the controller to delete all information on file in the computer in connection with the aircraft identified and to cause deletion of all situation and tabular display information.



### SIMULATED PILOT'S DISPLAY CONTROLS AND FUNCTIONS.

The display used for the simulated pilot's position provided the capability of 12 lines of 72 characters each for display of data communication messages entered and received by the simulated pilot. The keyboard was employed essentially as a normal computer terminal keyboard with the following exceptions: messages entered into the computer data bank were activated by means of the "return" key and a provision was made for a single back-space error correction for use when composing messages. The latter was accomplished by depressing the "control" key together with the "H" character key. Figure A-3 shows a view of the display and keyboard with typical data communication messages displayed.

There were only two computer message identification symbols available to the simulator pilot; "AT" for an ATC message and "RV" for requesting a voice channel. When the simulated pilot requested a voice channel, the computer caused an alert message "VOICE CHANNEL READY\*\*\*\* GO AHEAD" to appear on the display upon its activation of the voice channel. If the simulated pilot, upon entering a message into the computer, used an incorrect format or ACID not in the computer data bank, the computer caused an error alert message to be displayed. This action negated the entire message and required that the complete message be recomposed and re-entered correctly.

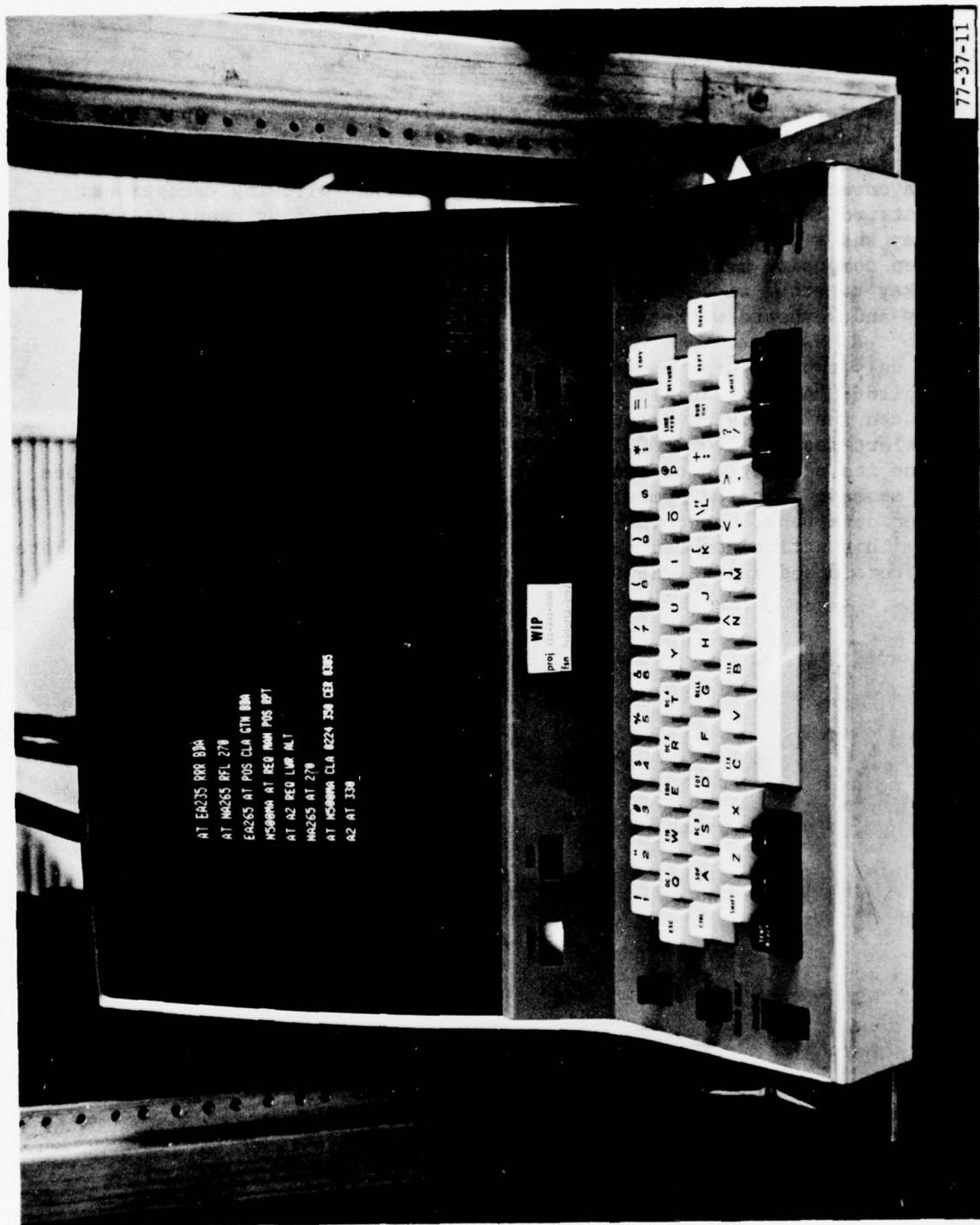


FIGURE A-3. SIMULATION TESTBED, SIMULATED PILOT'S POSITION DATA COMMUNICATION DISPLAY/KEYBOARD SHOWING A TYPICAL PRESENTATION

**APPENDIX B**

**MATERIAL ON SSC/CAC SIMULATION TESTS**

SSC/CAC SIMULATION TEST TRAFFIC SAMPLES

TRAFFIC SAMPLE NO. 1

FLIGHT PLANS

<u>ACID</u>	<u>TYPE</u>	<u>A/S</u>	<u>DPT</u>	<u>ALT</u>	<u>ETD</u>	<u>ROUTE OF FLIGHT</u>
VA 750	DC8/A	480	SJU	350	P0100	SJU, RFT, END, TUNA, JFK
AA677	H747/A	485	BOS	410	P0100	BOS, 3400/07040, CLA, END, RFT, SJU
EA 444	B727/A	435	ZQA	310	P0101	ZQA, 2900/07600, LAM, TUNA, JFK
PA 262	B727/A	430	SJU	350	P0102	SJU, GAN, GNY, GLD, JFK
VVWX60	P3/A	320	BDA	250	P0102	BDA, 3200/06700, GTN, CLA, 3045/ 07445, JAX
AA 215	H707/A	480	CHS	330	P0105	CHS, 3420/07340, 2700/07010, SJU
PA 292	H747/A	485	SJU	390	P0112	SJU, 2600/06630, GNY, GTN, GLD, BOS
NA 1	H747/A	485	PBI	370	P0125	PBI, DAR, CSH, CER, BDA, SNN
AC 966	DC8/A	480	YYR	370	P0117	YYR, 3500/06620, BDA, 2950/06500, 2700/06525, SJU
EA 963	L101/A	485	BOS	290	P0122	BOS, 3400/07040, CLA, END, RFT, SJU
VV53615	P3/A	325	GTN	240	P0100	GTN, CLA, 3045/07445, JAX <u>(AIRFILE)</u>
N 42	B707/A	480	ACY	290	00100	ACY, TUNA, BMN, CLE, END, SJU
TW 101	B707/A	480	BOS	330	P0100	BOS, PKE, TNG, DAR, JAX
AC 967	DC8/A	480	SJU	310	P0100	SJU, GUA, GAN, GNY, LAM, CLA, BDA
DL 202	B727/A	480	PBI	270	P0100	PBI, JAX, CHS, LAM, CLA, BDA

TRAFFIC SAMPLE NO. 2

FLIGHT PLANS

<u>ACID</u>	<u>TYPE</u>	<u>A/S</u>	<u>DPT</u>	<u>ALT</u>	<u>ETD</u>	<u>ROUTE OF FLIGHT</u>
DO 920	DC8/A	480	SJU	350	P1000	SJU, RFT, END, TUNA, JFK
DL 555	H747/A	485	BOS	330	P0100	BOS, 3400/07040, CLA, END, RFT, SJU
AA 224	B727/A	435	ZQA	310	P0101	ZQA, 2900/07600, WIL, LAM, TUNA, JFK
PA 112	B727/A	430	SJU	350	P0102	SJU, GAN, GNY, GLD, JFK
M16262	C131/A	320	BDA	250	P0102	BDA, 3200/06700, GTN, CLA, 3045/ 07445, JAX
SO 117	B727/A	480	CHS	330	P0105	CHS, 3420/07340, 2700/07010, SJU
TW 666	H747/A	485	SJU	390	P0112	SJU, 2600/06630, GNY, GTN, GLD, BOS
TW 11	H747/A	485	PBI	370	P0125	PBI, DAR, CSH, CER, BDA, SNN
AC 818	DC8/A	480	YJR	370	P0117	YJR, 3500/06620, BDA, 2950/06500, 2700/06525, SJU
AA 633	L101/A	485	BOS	290	P0122	BOS, 3400/07040, CLA, END, RFT, SJU
N 1AP	B707/A	480	ACY	370	P0100	ACY, TUNA, BMN, CLA, END, SJU
UA 35	B707/A	480	BOS	330	P0100	BOS, PKE, TNG, DAR, JAX
MPDXC	DC8/A	480	SJU	310	P0100	SJU, GUA, GAN, GNY, GTN, ROY, YJR
N 600F	B727/A	480	PBI	270	P0100	PBI, JAX, CHS, LAM, CLA, BBDA
TROL 22	P3/A	325	GTN	240	P0100	GTN, CLA, 3045/07445, JAX <u>(AIRFILE)</u>

TRAFFIC SAMPLE NO. 3

FLIGHT PLANS

<u>ACID</u>	<u>TYPE</u>	<u>A/S</u>	<u>DPT</u>	<u>ALT</u>	<u>ETD</u>	<u>ROUTE OF FLIGHT</u>
AF 110	DC8/A	480	SJU	350	P0100	SJU, RFT, END, TUNA, JFK
EA 997	L101/A	185	BOS	330	P0100	BOS, 3400/07040, CLA, END, RFT, SJU
EA 626	B727/A	435	ZQA	310	P0101	ZQA, 2900/07600, WIL, LAM, TUNA, JFK
AA 600	B727/A	430	SJU	350	P0102	SJU, GAN, GNY, GLD, JFK
DORK10	P3/A	250	BDA	250	P0102	BDA, 3200/06700, GTN, CLA, 3045/ 07445, JAX
DL 377	B727/A	480	CHS	330	P0105	CHS, 3420/07340, 2700/07010, SJU
PA 866	H747/A	485	SJU	390	P0112	SJU, 2600/06630, GNY, GLD, BOS
BA 100	H747/A	485	PBI	370	P0125	PBI, DAR, CHS, CER, BDA, SNN
AF 260	DC8/A	480	YYR	370	P0117	YYR, 3500/06620, BDA, 2950/06500, 2700/06525, SJU
TW 431	L101/A	485	BOS	290	P0122	BOS, 3400/07040, CLA, END, RFT, SJU
N500MA	FFJ/A	480	ACY	370	P0100	ACY, TUNA, BMN, CLA, END, SJU
EA 265	B707/A	480	BOS	330	P0100	BOS, PKE, TNG, DAR, JAX
A2	B707/A	480	SJU	310	P0100	SJU, GUA, GAN, GNY, GTN, ROY, YYR
BN 102	B727/A	480	PBI	270	P0100	PBI, JAX, CHS, LAM, CLA, BDA
STUD69	P3/A	325	GTN	240	P0100	0/GTN, CLA, 3045/07445, JAX <u>(AIRFILE)</u>

SSC/CAC SIMULATION TEST SCRIPTS

SCRIPT NO. 1

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	NA 1	RFL 410
2	(P)	EA 444	REQ SPEED 425 KTS, TURBULENCE
3	(C)	EA 963	SAY YOUR FLIGHT CONDITIONS
4	(P)	VVWX60	REQ RETURN TO BDA, NO. 1 ENGINE OUT
5	(P)	AA 215	RFL 290, CAT
6	(C)	AA 677	SAY YOUR AIRSPEED
7	(P)	VV53615	<u>AIRFILE:</u> O/BDA GTN CLA MIK JAX, RFL 240, P3/A, 325 KTS
8	(C)	AC 966	<u>ATC REROUTE:</u> TO SJU VIA 3000/06400 2700/06300 SJU 370
9	(P)	TW.101	REQ HOLD PRES. POS. 10 MINUTES
10	(C)	AC 966	DESCEND TO FL 200
11	(P)	N42	REQ SATELLITE DERIVED POSITION
12	(P)	AC 967	RFL 350
13	(P)	DL 202	RFL 370
14	(P)	NA 1	REQ COMPUTER ETA FOR NEXT FIX

USE TRAFFIC SAMPLE NO. 1

CANCEL VV53615 PRIOR TO NEXT RUN

SCRIPT NO. 2

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	AA 677	RFL 430
2	(P)	PA 262	REQ SPD 400 KTS
3	(C)	TW 101	SAY AIRSPEED
4	(P)	VVWX60	REQ REROUTE TO JAX
5	(P)	EA 963	RFL 200
6	(C)	AC 967	SAY AIRSPEED
7	(P)	VV53615	<u>AIRFILE:</u> O/BDA GTN CLA MIK JAX, RFL 240, P3/A, 325 KTS
8	(P)	TW 101	REQ REROUTE TO JFK
9	(P)	NA 1	REQ HOLD FOR 10 MINUTES PRES. POS.
10	(C)	AC 967	CLIMB TO FL 330
11	(P)	TW 101	REQ SATELLITE DERIVED POSITION
12	(P)	VVWX60	RFL 200
13	(P)	PA 262	RFL 370
14	(P)	N 42	REQ COMPUTER ETA FOR NEXT FIX

USE TRAFFIC SAMPLE NO. 1

CANCEL VV53615 PRIOR TO RUN



SCRIPT NO. 3

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	AA 224	RFL 280
2	(P)	TW 11	REQ SPEED 425 KTS, TURBULENCE
3	(C)	PA 112	<u>ATC REQ:</u> VERIFY AT FL 350
4	(P)	M16262	REQ REROUTE TO CHS VIA PRES POS CLA LAM CHS
5	(P)	SO 117	RFL 370
6	(C)	AA 633	<u>ATC ADVISORY:</u> SATELLITE SHOWS YOU 20 NM WEST OF CRS
7	(P)	TROL22	<u>AIRFILE:</u> O/BDA CLA MIK JAX, RFL 240, P3/A, 325 KTS
8	(P)	UA 35	REQ REROUTE TO BDA
9	(P)	UA 35	REQ LOWER ALTITUDE
10	(C)	AC 818	DESCEND TO FL 200
11	(C)	N 1AP	<u>ATC REQ:</u> MAKE MANUAL POSITION REPORT
12	(P)	MPDXC	RFL 350
13	(P)	N 600F	RFL 370
14	(P)	TW 666	REQ SATELLITE DERIVED POSITION

USE TRAFFIC SAMPLE NO. 2

CANCEL TROL22 PRIOR TO NEXT RUN

SCRIPT NO. 4

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	AA 224	RFL 310
2	(P)	TW 11	REQ SPEED 480 KTS
3	(C)	PA 112	<u>ATC REQ:</u> VERIFY AT FL 350
4	(P)	M16262	REQ REROUTE TO SJU VIA PRES POS CLA END SJU
5	(P)	SO 117	RFL 330
6	(C)	AA 633	<u>ATC ADVISORY:</u> SATELLITE SHOWS YOU 20 NM WEST OF CRS
7	(P)	TROL 22	<u>AIRFILE:</u> 0/BDA CLA MIK JAX, RFL 240,P3/A, 325 KTS
8	(P)	UA 35	REQ REROUTE TO SJU
9	(P)	UA 35	REQ HIGHER ALTITUDE
10	(C)	TW 666	DESCEND TO FL 200
11	(C)	N 1AP	<u>ATC REQ:</u> MAKE MANUAL POSITION REPORT
12	(P)	MPDXC	RFL 270
13	(P)	TW 666	REQ SATELLITE DERIVED POSITION
14	(P)	AC 818	REQ COMPUTER ETA NEXT FIX

USE TRAFFIC SAMPLE NO. 2

CANCEL TROL 22 PRIOR TO RUN

SCRIPT NO. 5

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	BA 100	RFL 410
2	(P)	EA 626	REQ SPEED 415 KTS
3	(C)	DORK10	REQ REROUTE TO SJU
4	(P)	DL 377	RFL 190
5	(C)	EA 997	<u>ATC ADVISORY</u> : SATELLITE SHOWS YOU 20 NM EAST OF CRS
6	(P)	STUD69	<u>AIRFILE</u> : O/BDA GTN CLA 3045/07445 JAX, P3/A, RFL 240 325 KTS
7	(C)	AF 260	<u>ATC REROUTE</u> : TO SJU VIA PRES. POS. GNY GNT SJU
8	(P)	EA 265	REQ HOLD, PRES POS, 5 MINUTES
9	(C)	AF 260	DESCEND TO FL 280
10	(P)	EA 265	REQ REROUTE TO BOS
11	(C)	N500MA	<u>ATC REQ</u> : MAKE MANUAL POSITION REPORT
12	(P)	A2	RFL 350
13	(P)	BN 102	RFL 370
14	(P)	PA 866	REQ SATELLITE DERIVED POSITION

USE TRAFFIC SAMPLE NO. 3

CANCEL STUD69 PRIOR TO NEXT RUN

SCRIPT NO. 6

<u>ITEM NO.</u>	<u>INIT</u>	<u>ACID</u>	<u>ACTION</u>
1	(P)	BA 100	RFL 370
2	(P)	EA 626	REQ SPEED 480 KTS
3	(C)	EA 997	<u>ATC ADVISORY</u> : SATELLITE SHOWS YOU 20 NM EAST OF CRS
4	(P)	DORK10	REQ REROUTE TO JAX
5	(P)	DL 377	RFL 330
6	(C)	EA 997	<u>ATC ADVISORY</u> : SATELLITE SHOWS YOU BACK ON COURSE
7	(P)	STUD69	<u>AIRFILE</u> : O/BDA GTN CLA 3045/07445 JAX, P3/A, RFL 240, 325 KTS
8	(C)	AF 260	<u>ATC REROUTE</u> : TO BDA VIA PP 2700/06300 3000/ 06400 BDA
9	(P)	EA 265	REQ HOLD PRES POS FOR 10 MINUTES
10	(C)	AF 260	DESCEND TO FL 210
11	(P)	EA 265	REQ REROUTE TO JAX
12	(C)	N500MA	<u>ATC REQ</u> : MAKE MANUAL POSITION REPORTS
13	(P)	A2	RFL 310
14	(P)	PA 866	REQ SATELLITE DERIVED POSITION

USE TRAFFIC SAMPLE NO. 3

CANCEL STUD69 PRIOR TO RUN

SSC/CAC SIMULATION TEST GENERAL QUESTIONNAIRE

Question:

1. Waiting times on the voice channel were: (V/C)

- a. Acceptable
- b. Unacceptable

2. Circle the channel you found best in this test. (C)

- a. Voice
- b. Data

Why:

3. The \_\_\_\_\_ channel provided in this test was better for resolving difficult control situations. (C)

- a. Data
- b. Voice

4. I estimate that a controller will use the voice channel approximately: (End)

- a. 25 percent or less
- b. 50 percent
- c. 75 percent
- d. 90 percent or more of the time

5. I found the message types that could be sent on the data channel which was provided in this test: (D/C)

- a. Sufficient
- b. Insufficient

Explain:

6. Did you use the voice more than you wanted to when restrictions were placed on the length of a data message? (C)

- a. Yes
- b. No

Explain:

7. The pre-defined message types were: (C/D)

- a. Acceptable
- b. Unacceptable

SSC/CAC SIMULATION TEST GENERAL QUESTIONNAIRE (CONT'D)

8. The following describes my feeling about data link (more than one answer is acceptable): (D/C)
- a. I would rather use it than the satellite voice channel
  - b. It has limited use
  - c. It can supplement the voice channel

Explain:

9. List the message types that lend themselves readily to the use of data link. (D/C)
10. List your key features of satellite system for oceanic air control. (End)

Legend: V/C - Voice Only and Choice Voice or Data Tests  
C - Choice Voice or Data Tests  
D/C - Data Only and Choice Voice or Data Tests  
End - To be answered after completion of all ten test runs.

SSC/CAC SIMULATION TEST DATA COMMUNICATION READOUT DEVICE QUESTIONNAIRE

1. The information displayed on the CRD was:
  - a. Acceptable
  - b. Unacceptable
2. The size of the preview area was:
  - a. Good
  - b. Bad

Explain:
3. The size of the computer area was:
  - a. Good
  - b. Bad

Explain:
4. The automatic ACID feature in the preview area was:
  - a. Helpful and easy to use
  - b. Confusing and difficult to use
5. Methods of deleting information were:
  - a. Satisfactory
  - b. Unsatisfactory
6. The overall use of the CRD for air-to-ground communication was:
  - a. Acceptable
  - b. Unacceptable
7. The Quick Action Keys provided were:
  - a. Too many
  - b. Not enough
  - c. About right
8. List any improvements you would like to see implemented.

SSC/CAC ABBREVIATIONS FOR COMPOSING DATA COMMUNICATION MESSAGES

PP - PRESENT POSITION  
HD - HOLD  
PR - PROGRESS REPORT  
CRS - COURSE  
RFL - REQUEST FLIGHT LEVEL  
RSP - REQUEST SPEED  
RRR - REQUEST REROUTING  
RR - REROUTE  
RDV - REQUEST DEVIATION  
UN - UNABLE  
TURB - TURBULENCE  
WILCO - WILL COMPLY