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BUIC III SYSTEM ANALYSIS

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CHAPTER 1

INTRODUCTION

The present system of air defense for the North American continent is the result of an evolutionary development which began shortly after the end of World War II. Until that time, the continental United States had never been seriously threatened with an air attack and no elaborate system of air defense was considered necessary. There was still no immediate threat at the end of the war, although it was clear that our geographical isolation could no longer be relied on to protect us from attack. We had proven the effectiveness of long-range bombing during the war and were ourselves vulnerable to air attack if an enemy dared to risk his own destruction from our retaliatory bombing.

As long as we were the only nation possessing the atomic bomb we might have felt secure against air attack in this weighing of attack and counterattack capabilities. But it was recognized that other nations might discover the secret of the atomic bomb and that an enemy might employ it against us in a surprise attack. Possibly an enemy could destroy our retaliatory forces before they got off the ground and defeat us in a brief, terrible atomic attack. Since this possibility might tempt an aggressor it was necessary for us to develop an active air defense system. In addition to the obvious need to be prepared for attack, we had to reduce the temptation to attack by limiting the likelihood of its success.

Stirred by the fear of an atomic attack, the nation did not sink into a state of military apathy as it did after previous wars. Extensive planning for air defense was begun in 1946 when an Air Defense Command was established in a reorganization of the Army Air Corps. In 1947 the United States Air Force became a separate service and a year later was given complete responsibility for continental air defense. It was fortunate that these organizational changes took place without delay because the theoretical threat of an air attack became a serious actual threat with the Russian atomic explosion in 1949 and the outbreak of the Korean War in 1950.

When the newly formed USAF assumed responsibility for air defense in 1948, the existing air defense system consisted of a few radar stations and Interceptor airbases loosely tied together in a network that only remotely resembled a modern command and control system. Steps were taken to convert this crude system into an effective air defense system. The immediate result was an expanded and improved system called the Manual Air Defense System.

At the heart of the Manual Air Defense System were the Air Defense Direction Centers at the surveillance radar stations where aircraft were detected. A radar operator watched a display of radar echoes for signs of movement indicating an aircraft. Having detected an aircraft, he would call out its range and azimuth to a plotter who would mark the position of the aircraft on a large vertical plotting board. The radar operator kept the plotter up-to-date on changes in the position of the aircraft so that its track could be plotted. Following detection, tracks had to be identified. This was attempted by comparing the track with flight plans which were on file. Information on the track was also told by voice to adjacent Direction Centers and to higher headquarters (Control Centers) responsible for several sites.

If it were necessary to scramble an Interceptor to aid in identifying a track or to intercept it, the Control Center would issue the scramble order to an airbase and inform the Direction Center of this action. An Interceptor controller at the Direction Center would be assigned the target and an Interceptor. With the aid of his own radar scope and height information from a height finder radar operator he would give verbal instructions to the pilot via radio for the conduct of the mission.

By 1950, it was apparent that the currently operating Manual Air Defense System was inadequate. An attempt was made to compensate for insufficient radar coverage by reactivating the wartime Ground Observer Corps in 1951. Reports of aircraft sightings were made to centrally located filter centers where they were manually plotted and relayed to Air Defense Direction Centers. There was also great concern over the amount of information the system would have to handle in the event of a large-scale attack. Tests indicated that the voice-telling and manual plotting procedures would not be adequate to maintain the accurate and up-to-date air picture required for the effective assignment and control of Interceptors. It was evident that major changes would be needed to provide an adequate air defense system. As a result, USAF asked the Massachusetts Institute of Technology (MIT) for assistance, and in 1951 MIT organized a special study group known as Project Charles.

Project Charles reviewed the problems of air defense and made recommendations for the immediate improvement of the Manual Air Defense System. It also proposed the development of a new air defense system making use of automatic data processing and automatic data transmission. A special laboratory, the MIT Lincoln Laboratory, was established for this purpose and a prototype system was quickly devised to test the feasibility of using a computer for the processing of surveillance data from several radars. The results of tests conducted with a 32-track air defense model known as the Cape Cod System were so impressive that USAF decided to implement the total system recommended by the Lincoln Laboratory. After approximately five more years of development, the first elements of the resulting system, the Semi-Automatic Ground Environment (SAGE) system, became operational in mid-1958.

With the implementation of SAGE, the focus of responsibility for the conduct of air defense shifted from the long-range radar sites, where the Manual Air Defense Direction Centers were located, to the SAGE Direction Centers. The Manual Control Centers were phased-out and SAGE became the primary air defense system.

The SAGE system was designed to provide air defense against air breathing vehicles. Its facilities were vulnerable to destruction in a successful penetration by manned bombers, although the successful completion of its operational mission would ensure its own survival. That is, in defending the North American continent against a manned bomber attack, the SAGE system would also be defending itself. However, with the perfection of ICBMs the survivability of SAGE was seriously questioned. Because of their critical functions, SAGE Direction Centers might be prime targets in an initial ICBM attack. Also, since many DCs were located near Strategic Air Command (SAC) airbases, it was likely that they would be destroyed by missiles directed at the SAC bases.

As a result of the missile threat to SAGE, it was proposed to construct hardened control centers which would be able to survive nuclear detonations. If the Direction Centers were destroyed, control of air defense would be assumed by these hardened Super Combat Centers. After partial development this project was discontinued and a less expensive, alternative back-up system, BUIC, was proposed and adopted in 1961.

The Back-Up Interceptor Control (BUIC) system was established to provide a capability for the conduct of air defense in the event that SAGE control capability is lost. BUIC control centers, called NORAD Control Centers (NCCs), have a higher probability of surviving a missile attack than SAGE DCs because they are collocated with selected long-range radar sites which are not near expected ICBM targets.

The BUIC system is being implemented in three phases. BUIC I was an interim system consisting of 27 manual NORAD Control Centers each located at a long-range radar site. The BUIC I system provided an immediate manual back-up control capability similar to that provided by the earlier Manual Air Defense system. Some BUIC I NCCs will remain in the air defense system in less critical areas but most will either be phased-out or converted into semiautomatic NCCs. The BUIC II system consists of 13 NCCs, each of which is computerized and capable of taking over the air defense responsibilities of a SAGE DC. As backup system elements, BUIC NCCs do not have the same capacities as SAGE DCs but they are capable of performing similar functions in a similar, computer-assisted manner. The BUIC II system is being replaced by the BUIC III system which provides improved and expanded capabilities.

THE BUIC III SYSTEM

BUIC III is a command and control system composed of semiautomatic NCCs located at selected long range radar sites. One, two, or three NCCs are installed in an Air Defense Division to serve as a backup to the SAGE DC. When the DC in an Air Defense Division is operating, the NCCs in that Division monitor the air defense situation to be able to assume air defense responsibility quickly in case the DC becomes inoperative. This operational mode, called the MONITOR mode, is the normal operating state of NCCs. If a SAGE DC becomes inoperative, the NCCs in that Division change to an ACTIVE mode of operation and assume responsibility for air defense operations within the Division. At the NCC, BUIC III operators receive displays of filtered and processed data and enter instructions at display consoles connected to the BUIC computer.

A digital, teletype, and voice communications network interconnects NCCs and other air defense system elements. Most of the data entering the NCC are in digital form and are entered directly into the computer. Other data, received by voice or teletype may be entered into the computer manually by card inputs. The NCC, in either a Monitor or an Active mode, receives a continuous flow of data which must be processed and displayed to support its air defense role. There is also a continuous flow of data out of the NCC, but the volume of outputs is much less in the Monitor mode than in the Active mode when the NCC has active control of air defense elements in its area of responsibility. The major elements that a typical NCC interfaces with are depicted in Figure 1-1.

In the Monitor mode, an NCC maintains a current air picture by means of radar data received directly from radar sites and track data received from its parent DC (the DC in its Division) or from associate NCCs (other NCCs in the same Division). Radar data comes from the same network of radars used by the SAGE system. This network includes long-range radars (LRRs), gap-filler radars (GFRs) and airborne long-range radars (ALRRs). These data are processed and displayed at the NCC in the same manner in either the Monitor or the Active mode. An NCC in the Monitor mode, however, has no control over the operations at the radar sites. In the Monitor mode, the track data from the DC are automatically updated by the BUIC computer program by means of radar. This helps to ensure the continuity of tracks in the system in the event the NCC has to take over the air defense function. While in the Monitor mode, an NCC does not initiate tracks, request height, or identify live tracks, nor does it commit weapons.

When the parent DC becomes inoperative, the NCCs in the Division take over the functions of the DC. The Active mode NCCs expand their interfaces and each assumes control of a predesignated portion of the Division. External defense elements are informed by voice that the NCC is assuming control and circuits are established for the flow of information. An NCC replaces its parent DC in the lateraltell network of DC communications. One NCC in the Division becomes interconnected with the SAGE Combat Center (CC) which is responsible for the direction and coordination of air defense functions in the Region. The NCC transmits

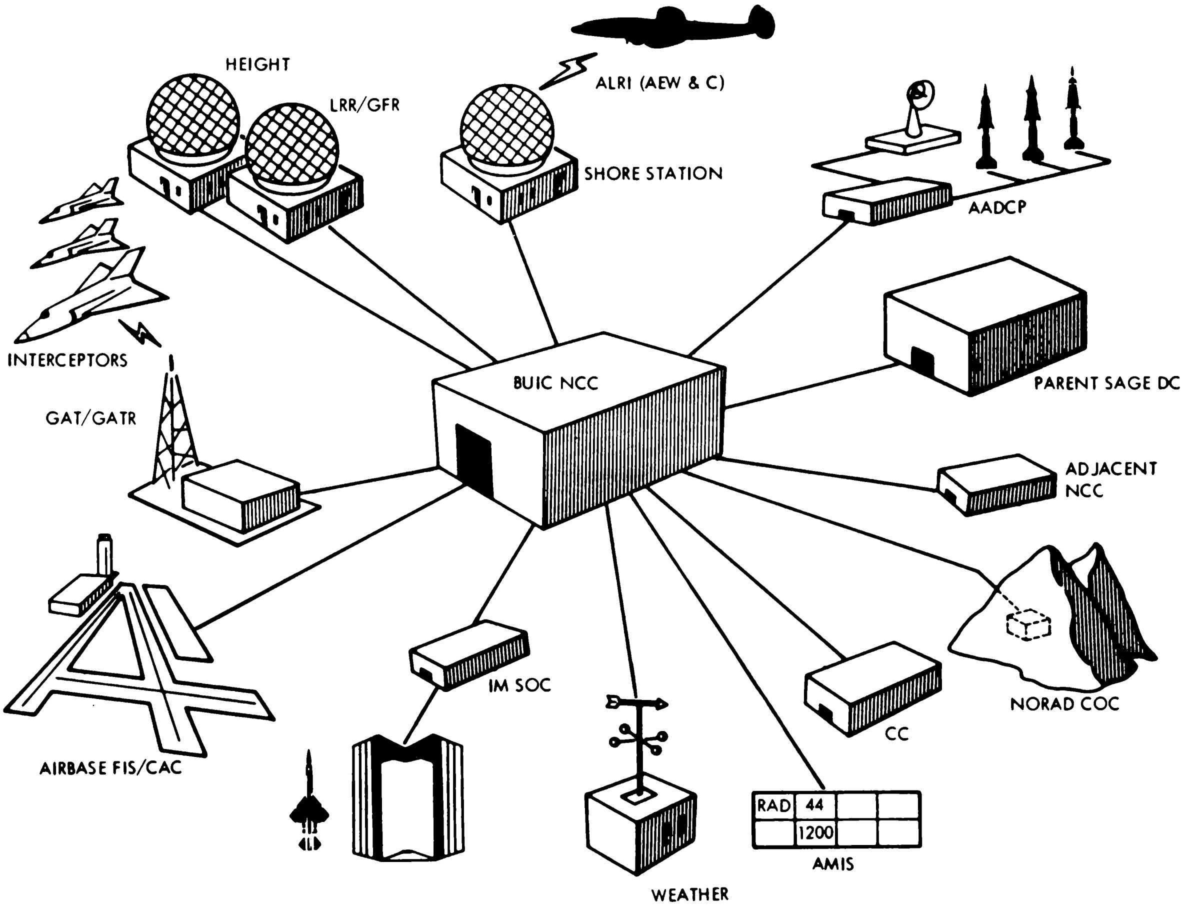


Figure 1-1. Typical BUIC NCC Interfaces

track data and weapons status information to the CC via data link. By voice, the CC provides the Active NCC with early warning information, nuclear detonation reports, and information on adjacent Region activity. If the CC becomes inoperative, and no DC in the Region remains in operation, the Battle Commander in a designated NCC establishes voice communications with the NORAD Combat Operations Center (COC) in order to transmit Region status data, battle damage, and track information to the COC and to receive threat information, nuclear hazard data, intelligence data, and battle direction.

An active NCC is responsible for all air surveillance and weapons control functions in its area of responsibility. Close coordination with radar site personnel is needed to maintain the best possible surveillance radar data. Height finding radars at these sites are also controlled. Tracks are initiated and monitored by air surveillance personnel at the NCC. Identification responsibilities are assumed. Flight plan information received from the Air Movements Information Section (AMIS) via teletype is inserted into the computer by card input for manual and automatic identification processing. Weapons personnel commit manned Interceptors or BOMARC missiles against tracks identified as Hostile or the tracks are passed to Army Air Defense Command Posts (AADCPs) for engagement by ADA fire units. Manned Interceptors are scrambled by means of voice communications between NCC weapons personnel and personnel at the Combat Alert Center (CAC) at an airbase. Control of the aircraft is ordinarily by means of data link transmitted via TDDL sites but two-way voice communications are provided by ground-to-air voice radio sites. BOMARC control is always via TDDL.

EQUIPMENT

Data processing and display equipment are installed at each BUIC III NCC to support the NCC air defense role. As an integrated group this equipment, the AN/GSA-51A Radar Course Directing Group, is capable of performing the calculations and data manipulations required by computer programs; accepting and transmitting information via digital data circuits; displaying information to operators; accepting and processing manually inserted information, operator requests and commands; and storing information for subsequent processing.

DATA PROCESSING EQUIPMENT

The BUIC III data processor consists of solid state computers, core memories, and input/output modules. Their functions and the functions of related peripheral equipment are described in the following paragraphs:

DIGITAL DATA COMPUTERS. Two digital data computers interpret and execute program instructions. They operate independently and each is capable of controlling the operation of a stored program.

CORE MEMORIES. Eight core memory modules provide a high-speed random access storage of a total of 32,768 words.

CONTROLLER-COMPARATORS. Four controller-comparators or input/output control modules control the transfer of data between the core memories and peripheral devices.

MAGNETIC DRUMS. Three magnetic drums are used for the storage of computer programs, large blocks of data, and information to be displayed. Each drum provides 65,536 words of storage. Three magnetic drum controller-converters enable the transfer of data from a display drum to a data display console.

MESSAGE PROCESSORS. Two message processors receive digital data from external sources, store the data, and send it to a controller-comparator. They also store output messages from the controller-comparators prior to transmission over the output circuits.

MAGNETIC TAPE UNITS. Four magnetic tape units or recorder-reproducers are used to record data and store computer programs and simulated data. They are made compatible with the controller-comparator modules by means of a recorder-reproducer controller.

TELEPRINTER SET. An on-line teleprinter produces permanent records of selected data. This high-speed device can print 120 characters per line in quadruplicate at a rate of 600 lines per minute.

KEY PUNCH. A key punch machine is used to punch and verify data on 80-column cards.

PUNCH CARD READER. An on-line punch card reader is used for the manual insertion of information to be used by the computer program.

TELETYPEWRITERS. Teletypewriters (teletypes) are used to receive flight plan data, winds aloft data, and weather information. They output information in both punched paper tape and printed form.

047 TAPE-TO-CARD PUNCH. This device converts the punched tape output by the teletype to punched cards which are ready for entry into the card reader.

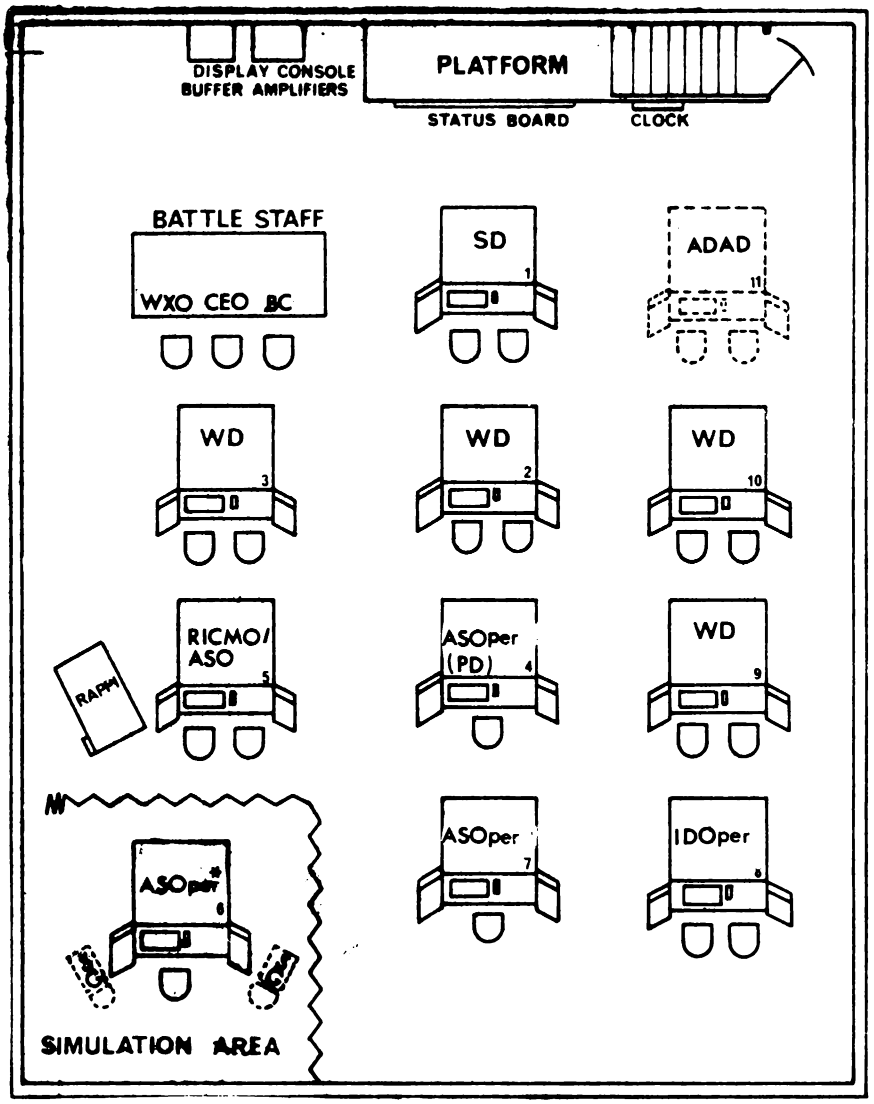
TYPEWRITER-PUNCH READER. An on-line typewriter-punch reader provides a means of communication between the data processor and maintenance personnel.

STATUS DISPLAY CONSOLE. A status display console is provided in the data processing area for use by maintenance personnel in controlling and monitoring all central and peripheral data processing equipment.

SIMULATOR GROUP. The simulator group consists of two manual input keyboards located in the data display area and one compatability unit in the data processing area. This equipment can be used to generate and control simulated Interceptors and to simulate pilot responses during a training exercise.

DATA DISPLAY EQUIPMENT

Data display consoles provide operators with the computer-generated displays they need to perform their assigned tasks, a means of selecting the information to be presented, and a means of inserting requests and command into the computer. Eleven data display consoles are provided in those NCCs having an Air Defense Artillery responsibility. All other NCCs have ten. All consoles are logically and electrically identical, but they may be assigned to different functions by means of manual input card messages. A typical configuration of display equipment and assignments is shown in Figure 1-2. The minimum and maximum number of consoles that may be assigned to various functions is as follows:



*During simulation exercises, console 6 is manned by a Simulation Supervisor (SIM SUP), and two Interceptor Pilot Simulators (IPSs) who operate the simulator group (SG) manual input keyboards.

Figure 1-2. Typical BUIC III Display Area

CONSOLE FUNCTION	MIN.	MAX.
Senior Director	1	1
Weapons Director	0	6
Air Defense Artillery Director	0	2
Radar Inputs and Countermeasures Officer/Air Surveillance Officer	1	1
Air Surveillance Operator	1	7
Identification Operator	0	2
Simulation Supervisor	0	1
Flight Path Simulator	0	3
Target Monitor	0	1

Individual overlays containing switch labels are used to adapt the consoles for various assigned functions. Each console contains a situation and a tabular display tube, display selection switches, manual intervention switches, a light sensor, and warning lights. Characteristics of the major console features are described below.

SITUATION DISPLAY. The data display console contains a cathode ray tube for the display of information concerning the air defense situation. It has a viewing area of 12 5/8 x 12 5/8 inches. Symbols and vectors are used to display such information as radar data, track information, alarms, intercept points, the location of air defense facilities, and geographic boundaries. By pushbutton action an operator may select display expansion levels of two, four, or eight in addition to the basic display which covers a square geographical area 1500 nautical miles on a side.

The classes or categories of data displayed on a situation display may be selected to be appropriate to the function being performed at each individual console. Forty 3-position category selection switches are provided on the left side of the situation display viewing surface for this purpose.

TABULAR DISPLAY. A separate cathode ray tube is provided on the data display console for the display of data in a tabular format. It has a viewing area of 3 3/16 by 3 3/16 inches. Within this area a maximum of 17 columns and 16 rows of symbols may be displayed.

COMPUTER ALARMS. One visual and one audible computer alarm are provided at each console. Activation and resetting of the alarms is under the control of the computer program but the audible alarm may also be reset manually by the console operator.

MANUAL INTERVENTION. By means of pushbuttons or switches, an operator may enter and transmit information from the display console to the data processor. The switch panel on the console contains a twelve column pushbutton keyboard, a rotary heading switch for the insertion of heading information, and an activate pushbutton/indicator to transmit information to the data processor.

LIGHT SENSOR. Operators are provided with light sensor devices similar to the SAGE light guns to initiate requests or commands to the data processor. This device is activated by positioning it over a displayed symbol or vector by means of a projected aiming circle of light.

COORDINATE DATA MONITOR. A coordinate data monitor console is provided for the monitoring of radar inputs. This equipment is also called a Random Access Plan Position Indicator (RAPPI).

Operations and maintenance personnel are stationed at each NCC for the performance of air defense operations. They are divided into functionally oriented groups consisting of a Supervisory Team, an Air Surveillance Team, a Weapons Direction Team, a Manual Data Team, a Maintenance Team, and several other support teams. The authorized positions which constitute these teams are outlined in the following paragraphs, but the number of operational positions which will be manned at any given time will depend on the NCC status and the Division air defense conditions. More than one subfunction may be assigned to a given position, and more than one crew member may perform a given subfunction. Subfunctional titles have been created for clarity of description by adding the subfunction to the authorized position title.

SUPERVISORY TEAM

The Supervisory Team is composed of the Battle Commander (BC), a Senior Director (SD), and a Senior Director Technician (SDT). The BC is responsible for the NCC operation and coordinates with higher echelons of command. The Battle Commander's position is at a table in the display area adjacent to the SD. He does not have a display console, but he may share the SD's console. The SD is responsible for air defense functions being performed within the NCC and coordinates defense operations with other NCCs. The Battle Commander is supported by the Weather Officer (WXO) and the Communications-Electronic Staff Officer (CEO), who are located at the BC position.

AIR SURVEILLANCE TEAM

The Air Surveillance Team is responsible for radar input data control, tracking, height finding, track identification and coordination with other control centers. The team's supervisor is responsible for dual functions. As the Radar Inputs and Countermeasures Officer/Air Surveillance Officer (RICMO/ASO), he supervises the action of the air surveillance function, monitors radar input data, and coordinates ECCM activities in an ECM environment. He also supervises the manual inputs function. The Air Surveillance Technician (AST) assists him in these duties. Other team positions include Air Surveillance Operators (ASOpers) who initiate and drop non-Interceptor tracks, monitor active tracking, initiate height requests, and monitor the passive tracking; and Identification Operators (IDOpers) who identify tracks and coordinate flight plan information with input agencies.

WEAPONS TEAM

The Weapons Team is responsible for directing and controlling air defense weapons and coordinating activities with other control centers and AADCPs. The team consists of Weapons Directors (WDs) and their technicians, and an Air Defense Artillery Director (ADAD) and his technician. Army personnel are stationed at the NCC to perform ADA functions.

MANUAL DATA TEAM

The Manual Data Team is responsible for handling data received by voice or teletype from external sources and entering it into the NCC data processor. Normally the team is composed of three Manual Inputs Operators (MIOs) and a Manual Status Clerk (MSC). The duties of the MSC include the maintenance of current status data on a vertical plotting board in the display area. Other than this task, the functions of the manual data team are performed in the Manual Data/Weather area, which is a 9' by 12' by 12' space partitioned within the data processing area. This team has no data display console.

WEATHER TEAM

The Weather Team provides weather information to operations personnel in the NCC. Weather staff support is given to the Battle Commander. Nuclear fallout patterns are developed and weather forecasts and winds aloft data are prepared for the Manual Data Team to enter in the data processor. The Weather Team consists of a Weather Officer (WXO) whose normal position is at the BC's table in the front of the display area and a Weather Observer (WXOB) who is located in the Manual Weather room in the data processing area.

MAINTENANCE TEAM

The Maintenance Team is under the direction of the Electronic Computer Maintenance Officer (ECMO) who normally supports the BC in the display area. The Computer Maintenance Supervisor (CMS) and the Facility Maintenance Monitor (FMM) have over-all responsibility for the maintenance and operation of the data processing and display equipment. They are assisted by Computer Maintenance Technicians (CMTs) and Display/Input-Output Technicians (D/IOTs). A Computer Program Maintenance Team (CPMT) is responsible for monitoring the operation of the NCC computer program and making on-site modifications and corrections as necessary.

TARGET MONITORING TEAM

The Target Monitoring Team consists of an Exercise Director, a Target Monitor, and their technicians. They are responsible for controlling exercise target aircraft and for ensuring the safety of all aircraft during live air defense exercises. These are not full-time positions but will be filled by qualified operations personnel as a supplement to their normal duties.

SIMULATION TEAM

The Simulation Team is responsible for the generation of the simulation environment and performance evaluation during a training mission. The only full-time position is the Training Technician (TT). Other positions are manned as required by available NCC personnel.

COMPUTER PROGRAMS

A computer program is a series of sequential instructions required for a computer to perform operations. Several programs may be grouped together to form a system which has been defined to perform a function. Within BUIC III, four program systems are provided: 1) an operational air defense system, 2) an exercise system, 3) a utility system and 4) a computer maintenance system.

AIR DEFENSE COMPUTER PROGRAM (ADP)

The ADP performs the calculations and data manipulations required for air defense operations. It provides the capability for tracking and identifying aircraft, for the scrambling and control of Interceptors, and for the transfer of information to adjacent facilities or higher echelons. In addition, a capability is provided for periodically recording operations data for later analysis. For training operations crews, a means of simulating certain inputs to an NCC is included in the program.

SYSTEM EXERCISE COMPUTER PROGRAM (SEP)

The SEP provided the capability to generate simulated data on magnetic tapes to be used as inputs to ADP during air defense exercises and during the testing of ADP. It also provides a means for analysis of data recorded during exercise and training missions. Summary information may be provided on individual operator performance as well as the performance of groups of operators or of the system as a whole.

UTILITY COMPUTER PROGRAM (UCP)

The UCP is the system used for the production and maintenance of ADP and SEP. It is also capable of maintaining itself. In producing a coded system, information is accepted by the program, assembled into a machine language and placed on a magnetic tape for later use. These tapes may be changed via the UCP to correct errors or to incorporate required changes to the system.

BACKUP CONFIDENCE-DIAGNOSTIC PROGRAM (BCDP)

The BCDP provides a means for minimizing the effects of equipment malfunction within the data processing equipment. BCDP operates in parallel with ADP in the computer module not being used by ADP. Periodically, ADP and BCDP switch computer modules so that BCDP can perform tests with alternating computer modules. When a malfunction is detected by either of the programs, BCDP attempts to isolate and correct the malfunction. The Facility Maintenance Monitor is kept informed of problems through alarms and the typewriter-punch reader or the teleprinter.

THE BUIC III AIR DEFENSE COMPUTER PROGRAM (ADP)

The Air Defense Computer Program (ADP) is the program which performs the air defense functions of BUIC III. During a system training mission, it reads-in simulated data from the Exercise tape and processes it in much the same way that it processes data originating from external data sources when it is operating for air defense purposes. Because of the high operational similarity which exists between live and simulated ADP processing the computer operator should have a basic understanding of the various programs which make up the ADP. In addition, a need to be familiar with the contents of the ADP is created by the frequent verbal comments which refer only to program "tags"*. Knowledge of tags becomes particularly important to the computer operator in cases where he is required to interpret tags as listed on ADP error printouts.

A further need for a basic understanding of the ADP is generated through the use of the ADP in checking for tell information on an Exercise tape. The BEPS portion of SEP does not have the capability to check for tell during the Exercise tape display processing period; the tape must be cycled with the ADP to ascertain the presence of proper tell information.

ADP CYCLIC OPERATION

The cyclic operation of the ADP is divided into cycles and semi-cycles. The cycle is the usual processing interval and most programs will operate at least once each cycle. Some programs, such as switch interpretation and displays will operate each semi-cycle. Some of the programs operate only when new or revised information is available (these programs are called "conditional") whereas other programs cycle regardless of the presence of new or revised information (these are called "unconditional").

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*A program tag is a label used to identify a particular program.

The ADP programs are:

Program Tag	Definition	Description
COP	Control Program of ADP	COP is the executive program of ADP; it accomplishes all necessary transfers before and after program operation; it also monitors the program sequencing and permits each program to operate as required.
SET	Startover Program of ADP	SET is the program which initiates or restarts the ADP operation.
PER	Recording Program of ADP	PER controls what is to be recorded based on recording specification tables.
KAS	Keyboard Assignment-Surveillance	One of the two keyboard interpretation programs (the other is KAW); KAS will determine if KAW is to be operated and communicate this to COP. Kas processes inputs from the simulator group as well as any of the data display consoles. Both KAS and KAW are conditional programs.
KAW	Keyboard Assignment-Weapons & Telling	The other keyboard interpretation program of ADP; Operates only if a weapons or tell action has been taken; if not, KAW is by-passed and the next program (BOP) is operated.
BOP	BOMARC Prelaunch	The first unconditional program read in by COP; BOP performs sort functions and separates the radar inputs, strobes, height, lateral-tell, and other messages into their proper tables. BOP also interrogates the BOMARC dynamic status messages, monitors missiles for launch, makes up pre-launch messages and monitors startover to determine the statuses of missiles in fire-up.
RAP	Radar Inputs Processing	RAP determines the current site load, the number of LRRs (plus the equipment at each) and uses this information to calculate the acceptable number of returns from the various sources. RAP performs the range-azimuth to xy coordinate conversion and then tries to match each return with a track. RAP sets up a table which contains correlation information which will be used by the next program (TRK) in the track smoothing process.

Program Tag	Definition	Description
TRK	Tracking-Active and Passive	The Active Tracking portion of the tracking program uses information set up by RAP to perform the smoothing and prediction of all tracks in the system. The passive tracking portion attempts to correlate TCU strobe data on all tracks which are eligible for passive correlation; and performs smoothing and prediction of passive tracks.
BID	Identification	BID maintains flight plan information, makes flight plan correlations, and performs other identification tasks required by ADP.
AAD	Army Air Defense	AAD processes reply-back messages and sends messages to BIRDIES and Missile Mentor AADCPs each cycle. Tracks are selected for passing to automatic-option AADCPs and a priority method is used for track selection when the number of tracks to be passed exceeds the slots available. Further checks are made to insure that selected tracks are being output properly.
TOP	Time Division Data Link (TDDL) Output Program	TOP makes up TDDL output messages for manned interceptors and BOMARCs (with some specific limitations). The major functions are to make up properly formatted messages, select the primary/secondary GAT sites to be used, process told-in TDDL message for transmission, order and place these messages into the output tables, and set told-out TDDL messages into proper output tables.
BIT	BUIC Information Transfer	BIT performs the lateraltell and forwardtell functions; this includes storing incoming information and responding to NCC internal switch actions.
MIN	Manual Inputs	MIN is operated conditionally once per cycle if manual inputs have been made. If input format errors are found, MIN makes up an error message for the teleprinter (or typewriter-punch reader) output. Information which is accepted is stored in appropriate tables.
SIG	Simulator Information Generator	SIG is conditional upon Real Time Simulation being conducted. SIG supplies inputs in proper formats to the ADP to which the ADP responds in the same way it would if the inputs were "live".

Program Tag	Definition	Description
MID	Manned Interceptor Direction	MID provides Guidance information for manned Interceptors on intercept missions, STOPR, or CAP/RTB Manual Vectoring. MID also provides weapons information in response to the Commitment Assistance Display (CAD) request.
BOB	BOMARC Guidance	BOB computes guidance instructions for BOMARC missiles on intercept mission, provides information in response to the CAD request and makes calculations regarding the possibility of recommitments. In the case of startover, the missile track position is extrapolated by BOB.
SID	Situation Information Display Generator	SID generates all situation displays except for radar displays.
TID	Tabular Information Display Generator	TID generates all tabular displays with the exception of Switch Action Feedback Displays. (The Switch Action Feedback Displays are generated by KAS and KAW.)
TAR	Tape Read (Exercise Tape)	TAR operates such that buffer time is used to minimize dead time; TAR inputs provide for processing one record of tape data while transferring in another record.
BOK	Bookkeeping	BOK performs miscellaneous jobs which lend themselves to centralization for use by other programs. This function also maintains/updates system tables which may be used by conditional programs since the conditional programs may not operate every cycle.
HIO	Track Altitude via Height Finder	HIO processes tracks for the purpose of requesting height via height finders or exchange tell until all available tracks are covered. Also, HIO processes those height replies which have been received and determines if any expected replies were not received.
TLO	OPS Tape Load	TLO is the program which is used to generate or revise an ADP master tape.

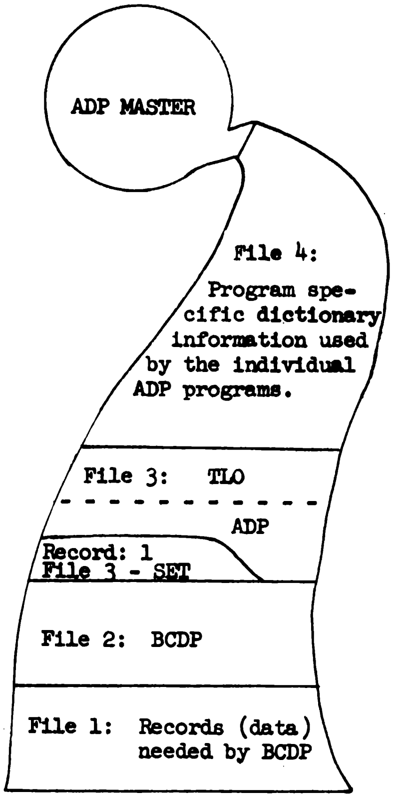


Figure 1-3. ADP Master Tape

STARTOVER IN ADP

The startover function is associated with three modes of operation; two of these modes are related to startup, the other is related to startover. The two modes of startup are the Initiate and Test Modes, and the mode of startover is the Reestablish Mode.

The Initiate mode operates the ADP with the assumption that no data concerning the air picture are available and cycling is started from information stored on the ADP Master Tape. In this mode of startup the system is cycled in the Monitor mode and continues in monitor until the Active mode switch action is taken by the Senior Director. In the Initiate mode, the entire air picture must be constructed from the beginning using all available (both internal and external) sources.

The Test mode of startup results in the same operation of the air defense function as the Initiate mode but in addition, the facility function is made available for use. This function is used to accomplish the control of the facility system which is used in testing the ADP. Programs such as the Symbolic Relative Corrector (SRC) which provides the capability to accomplish correction of programs; Pre-Recording (PRC) which accomplishes the generation or modification of the recording specification table, and Dynamite (DNA) which is used in testing programs in the ADP system are included in the facility function.

The Reestablish mode of startover results in the operation of the ADP based on the assumption that information concerning the air picture is contained within stored areas of the computer system which are set aside for such storage. (These areas are called "safe data" areas and are located on magnetic drums.) The information contained in the safe data includes information vital to the air defense function and is necessary to restore the air picture to the level that existed prior to the occurrence of the startover.

Regardless of which of the modes is involved, the computer operator is provided with printouts which describe the various conditions and whether or not any difficulties are being encountered by the system in accomplishing the startover or startup.

The startover function can be operated by various methods including the status display console switch action, flexowriter inputs, card reader inputs, and the error recovery routine operation.

ADP has various equipment configurations around which it can operate. When the maximum number of modules and units are available ADP cycles in parallel with the Backup Confidence Diagnostic Program (BCDP); if the total number of modules available reaches a lower limit, ADP will continue to cycle but will do so without the BDCP. The required minimum equipment configuration to cycle only ADP is:

A. Six core memory modules

B. One computer module

C. Two controller-comparators

D. Two magnetic drums

CONTROL IN THE ADP

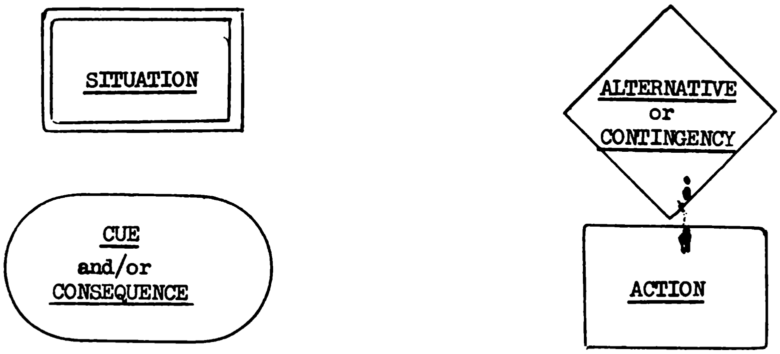
The executive program for the ADP is the control program (COP). COP monitors the sequencing of the ADP cyclic programs, recognizes program and equipment generated interrupts, and provides for transfers occurring between core memory and peripheral devices of the cyclic portions of ADP. COP also maintains a monitor on the elapsed program and cycle operating time to insure that cycling periods remain within limits.

The control function accomplishes such tasks as outputting messages transmitted to the controller-comparator, accepting controller-comparator inputs, servicing the data display consoles (and simulator group), insuring that controller-comparator and memory modules are properly alternated for BCDP analysis purposes, and servicing the card reader or flexowriter.

The interface between the ADP and the SEP is accomplished by the reading of Exercise tapes which have been developed through the SEP system. (The Exercise tapes are read by the program TAR.) The timing of the tape read function is designed so that a minimum of processing time is lost in the read function. The tape records are read by TAR at the end of each cycle and are placed into two separate storage areas; this permits the system to process the contents of one area while new data are being transferred in the other.

SYSTEM FLOW CHARTS

The logic of the ensuing flow charts is based upon the classification of events occurring during system operation into certain descriptive categories. Symbols representing these categories and the general rules for their interpretation are presented below.



SITUATION - This is a statement which describes an existing condition or set of circumstances which precedes a major activity in BUIC. The condition can be external such as the appearance of a Hostile track, or it can be an internal decision; for example, to commit a Bomarc against a Hostile. In either case the SITUATION commits the BUIC system to a specific mode of activity.

CUE and/or CONSEQUENCE are given the same symbol because in many cases the same event can be either one depending upon the particular point in time. That is: an event which is the CONSEQUENCE of a preceding action can, a moment later, become the CUE for a subsequent action. However, considered independently, they may be defined as follows:

CUE - The air situation will never be directly observable to the BUIC operators, who must instead derive what information they need from a rather highly abstracted version presented by their display consoles and other data communications media. The abstracted picture must conserve enough of the critical elements of the real situation to enable the BUIC system operators to carry out their functions.

The CUE, therefore, is the indication observed directly by the BUIC operator, and corresponds to the SITUATION or some aspect of it. This may take the form of a visual display, written message or auditory communication. However, most of the CUES which occur in BUIC are computer-generated outputs which appear on the display units of the operator's console. These are direct indications to the operator that some kind of response is required of him.

CONSEQUENCE - There are two types of consequences which occur as the result of BUIC operator or computer activity. The IMMEDIATE CONSEQUENCE, such as feedback to the operator, activation of certain program routines, etc., occurs locally at the BUIC site. The ULTIMATE CONSEQUENCE is reflected in a corresponding change of the air situation. In the present analysis, only the immediate consequences can be identified with any certainty. Therefore the CONSEQUENCES shown in the diagrams are, with few exceptions, immediate and internal to the system.

ALTERNATIVE/CONTINGENCY is the category which shows the various possible outcomes of a given situation. Whatever the outcome happens to be will determine the manner in which the BUIC system must respond.

ALTERNATIVE implies that there is a degree of choice by the BUIC operator in determining what the outcome will be. For example: he may exercise his judgment in deciding between using a Bomarc or a manned interceptor for a given air defense mission. In this case the subsequent operational events are influenced by this choice.

CONTINGENCY implies that the BUIC operator has no power of choice. The emergence of one set of events out of several possibilities is determined by circumstances over which the system has no control. Examples are: whether or not hostile tracks split, whether or not ECM is employed by the enemy, and so forth. Insofar as various contingencies can be predicted, appropriate responses can be prescribed and put into effect either by the computer program or by SOPs to be followed by the operator.

ACTION is defined as the initiation by the operator of some event or train of events to implement the BUIC function. It usually takes the form of an overt intervention into the system's operation and can be described specifically as a sequence of switch actions, verbal commands, etc.

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CHAPTER 2

MANUAL INPUTS

The Manual Inputs function processes data entered by the Manual Data Team through keyboard, card-reading, or paper-tape-reading devices. Manual Input data is received by telephone and/or teletype circuits or from requests by other BUIC III personnel. The Manual Data Team also maintains a plotting board for the presentation of data to other personnel at the NCC. The team consists of two Manual Input Operators (MIOs), and a Manual Status Clerk (MSC).

Manual Input data is converted at the NCC into a format acceptable by the computer. The card reader is the primary source of input equipment; the flexowriter may also be used, but it is much slower. Because of the human element involved here, errors are likely to be introduced in the transcribing of data. The Manual Inputs function checks the format and content of all Manual Input messages for legality. If the message is accepted, the appropriate program items are set by the Manual Inputs function. If the message is rejected because it failed a legality check, an error notification is generated for printout on the teleprinter or flexowriter. Legality is determined by a column-by-column check of the message. All valid information recorded by the program from a card that is eventually found to contain an error will be disregarded.

The message types shown in Table 1 are interpreted by the Manual Inputs function.

Table 2-1. Manual Inputs Function Message Types

TYPE	SOURCE	USE
BOMARC Channel Change	Interceptor Missile Squadron Operations Center (IMSOC)	Used by Weapons commitment function for BOMARC selection.
BOMARC Line Test	Internal	Used for NCC/IMSOC Prelaunch Line testing.
BOMARC Prelaunch Status Test	Internal	Used for NCC/IMSOC interface testing.
BOMARC Status	IMSOC	Used to determine missile availability.
Call Sign Association Data	ARTCC	Identification and monitoring of SAC aircraft on peaceful missions.
Console Function	Internal	Used to assign a particular function to a data display console.
Date and Time	Internal	Used to initialize date and time in the computer.
Exercise SIF Code	Internal	Used for Positive Target Control.

Table 2-1. (Cont'd)

TYPE	SOURCE	USE
Exercise Track Correlation Box	Internal	Used in the correlation of Exercise tracks and their flight plans.
Flight Plan Data	ARTCC via AMIS ARTCC via AMIS NAS ARTCC	Identification of Friendly-class aircraft. Assign height, flight size and SIF Code to Exercise target aircraft.
GAT Site Status	GAT Site	By Weapons Guidance function for routing data link transmission.
Group Category Assignment	Internal	Used to determine the routing of forced situation displays.
Input Channel Assignment	Internal	Assigns message processor channels to various non-radar sources.
Lateraltell Strobe Selection	Internal	Used to indicate the adjacent BUIC III facility that is to receive strobes that fall within a specified azimuth wedge of a particular LRR.
Operational Conditions for Simulation	Internal	Used in the control of simulated inputs, simulation options and weapons mission evaluation parameters.
Output Channel Assignment	Internal	Assigns message processor channels to various recipients.
Radar Channel Assignment and Height Request Availability	Internal	Assigns message processor channels to radar sources. Legalizes height and establishes their simulation mode.
Registration and Collimation Error	Parent DC	Used by radar inputs function to correct range and azimuth errors.
Track Data	Manual DCs, ADA, Early Warning	Used to extend the area of surveillance.
Voice Frequency Assignment	Internal	Used to assign voice frequency channels to the SD and WDs.
Weapons Status	Fighter Interceptor Squadron/Combat Alert Center (FIS/CAC)	Used to determine manned interceptor availability.
Winds Aloft Data	National Meteorological Center	Used for weapons guidance.

BOMARC CHANNEL CHANGE: This message is used to update the seeker frequency channel number of the designated BOMARC missile.

BOMARC LINE TEST: This message is used to control the transmission of ground-to-ground line test messages from the BUIC III NCC to the IMSOC.

BOMARC Prelaunch Status Test: This message will allow simulated prelaunch messages to be transmitted from the NCC to the IMSOC when simulated BOMARC symbology is generated as a result of the BOMARC commitment action at the NCC.

BOMARC Status: This message contains the status of particular BOMARC missile launchers at the designated squadron. It is used in the event that dynamic status reporting from the squadron fails.

CALL SIGN ASSOCIATED DATA (CAT TRACK): This message provides the necessary data for the association of an aircraft call sign with a track number for display as a CAT track.

CONSOLE FUNCTION: This message designates a data display console to one of the following functions:

FUNCTION	MINIMUM NUMBER OF CONSOLES	MAXIMUM NUMBER OF CONSOLES
Senior Director (SD)	1	1
Weapons Director (WD)	Ø	6
Identification Operator (IDOper)	Ø	2
Air Defense Artillery Director (ADAD)	Ø	2
Target Monitor (TM)	Ø	1
Simulation Supervisor (SIMSUP)	Ø	1
Flight Path Simulators (FPS)	Ø	3
Radar Inputs and Countermeasures Officer/Air Surveillance Officer (RICMO/ASO)	1	1
Air Surveillance Operator (ASOpers)	1	7

In addition to the above breakdown, the RICMO/ASO and each ASOper may be designated as having one of the following assignments: Radar Inputs, Height, Active Tracking, Telling, or Passive Detection. Should this further assignment be designated, the program will route forced displays pertinent to the particular function to only those operators assigned that specific task.

DATE AND TIME: This message contains date (Month, Day and Year) and Zulu time (Greenwich Mean Time).

EXERCISE SIF CODE: This message designates the SIF codes which will be exercise SIF codes during live exercises utilizing Positive Target Control. MK X SIF data carrying these codes will be processed as exercise data.

EXERCISE TRACK CORRELATION BOX: This message defines the limits of correlation to be used when associating Exercise tracks with their AMDs (flight plans).

FLIGHT PLAN DATA: This message will include the following types of information: Flight plan category (identity), aircraft call sign, message type (Initial, Revision or Drop), flight size, altitude, speed, time and point of activation.

GAT SITE STATUS: This message is used to establish and to vary the choice of GAT sites available for selection. Each message makes a site available or unavailable.

GROUP CATEGORY ASSIGNMENT: This message assigns up to six logical group display categories to the six physical group display categories. Forced displays will be associated with a logical group and transmitted to all consoles which have switch selected the assigned physical group.

INPUT CHANNEL ASSIGNMENT: This message designates, for a particular message processor, which input channels (11 thru 22) will be assigned to BOMARC Squadrons, BUIC NCCs, adjacent DC's and AADCP's.

LATERALTELL SELECTION FOR STROBE: This message defines a radar site's azimuth wedges and specifies which adjacent NCC will receive (lateraltold) the strobes falling within these wedges.

OPERATIONAL CONDITIONS FOR SIMULATION: The following messages control the simulation conditions:

1) Facility Activity Status - Establishes the operational status of the Parent DC, associated NCCs and adjacent DC's and NCC's.

2) Sensor Status - Establishes the SIM and/or LIVE status of LRRs and HFs during exercises.

3) Exercise Tape Control - Establishes how an Exercise tape will be started and which records will be read.

4) Allow SRN - Establishes which SRNs on the Exercise tape will be utilized.

5) Temporary Suppression of ECM data for Exercise tape SRNs - Allows suppression of ECM data by SRN.

6) Internal Simulation Operational Conditions - Establishes which features of the Simulation function will be used.

7) Weapons Parameters - Establishes weapons parameters to be used in automatic umpiring of intercept missions.

8) Jamming and Radar Parameters - Establishes ECM and radar model values to be used by the real-time simulation program.

OUTPUT CHANNEL ASSIGNMENT: This message designates, for a particular message processor, which output channels (1 thru 7) will be assigned to ADA facilities, Height, BOMARC prelaunch, SAGE CC, Associate NCC 1, 2, or 3, all adjacent SAGE and BUIC control facilities and height.

RADAR CHANNEL ASSIGNMENT AND HEIGHT REQUEST AVAILABILITY: This message designates, for a particular message processor, which input channels (1 thru 1Ø) will be assigned to specific radar sites. This message sets the Height Test Option for the BUIC III NCC and establishes the request line availability of designated height finders.

REGISTRATION AND COLLIMATION ERROR: This message provides the radar inputs function with SAGE reported range and azimuth errors.

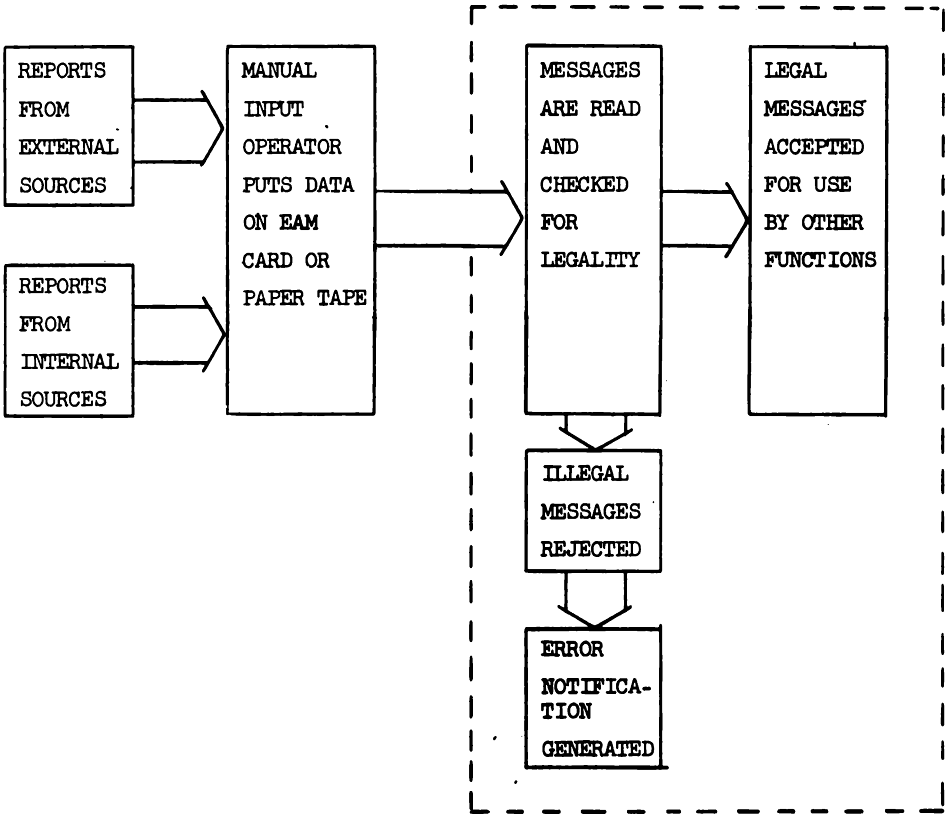
TRACK DATA: This message includes the type of request, simulation indicator, track number, telling source, speed, position, heading and time of report.

VOICE FREQUENCY ASSIGNMENT: For the designated SD or WD, this message contains the frequency family number and the number of the channel within this family.

WEAPONS STATUS: This message contains the alert status and number of manned Interceptors of a particular squadron at the airbase specified in the report.

WINDS ALOFT DATA: This message contains wind information at a particular altitude level for grid boxes of the Division's Wind Aloft Grid. The grid is oriented at an angle with Division true north and consists of a variable number of rows and columns. Wind information is provided for each 5000 foot level from 5000 to 60,000 feet.

Table 2-2. Manual Inputs Functional Block Diagram



NOTE: The manual inputs function is shown enclosed by the broken line. Specific reports and uses are identified in Table 2-1.

NOTES

CHAPTER 3

DISPLAYS

The BUIC III display subsystem provides the console operator with the information he needs at the appropriate time. The information is designed in a format whose presentation allows for minimum error on the part of the operator when reading a computer generated display. The need for simple ready-to-read formats is essential to the requirements of operators, particularly under stress conditions.

Portions of the magnetic drums are designated for "Display Drum Storage." That is, the display programs periodically prepare Situation and Tabular displays to be written out on these drum channels. Some of the channels provide continuous displays to the operator, and others provide flashing displays. A dynamic display drum allocation scheme is used in BUIC III. The scheme provides for efficient use of available drum storage through dynamic allocation of usage between channels. A priority scheme established by initial conditions determines when and how this reallocation of storage takes place.

SITUATION DISPLAYS

Situation displays may be generally classified into three types: information displays, vector displays, and radar displays. Information displays are organized into 18-character formats depicted on the scope as four-by-four displays with the 17th and 18th characters appended on either the left- or right-hand side of the bottom two rows. See Figure 3-1. Some information displays are double displays, that is, they consist of two 18-character information displays situated in such a way as to give a 36-character display of related information. Track displays and Airbase, AADCP, and LRR displays are examples of information displays.

Vector displays may be one or a series of connecting vector (straight line) messages so positioned that the display represents a graphic portrayal of significance to the operator. Division boundaries, AMD correlation boxes and routes, AADCP rings, track vectors, attention arrows, and strobes are among the types of vector displays. See Figure 3-2. Radar displays are organized into present or history data. Present data are displayed as continuous, and history data as flashing. Radar displays include symbols to represent both correlated and uncorrelated search and MK X data, as well as certain types of exercise data. See Figure 3-3.

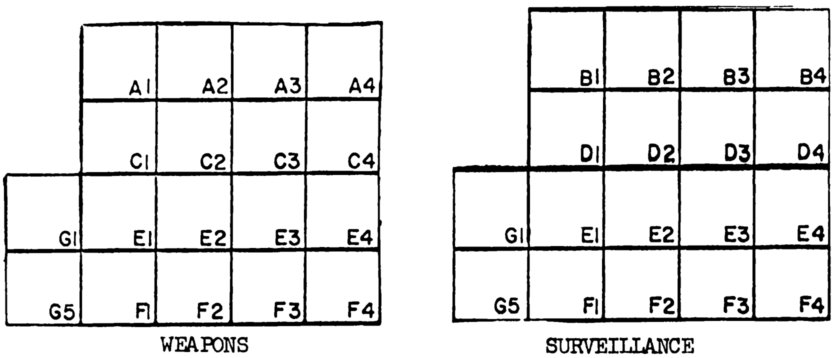


Figure 3-1. Information Display Formats

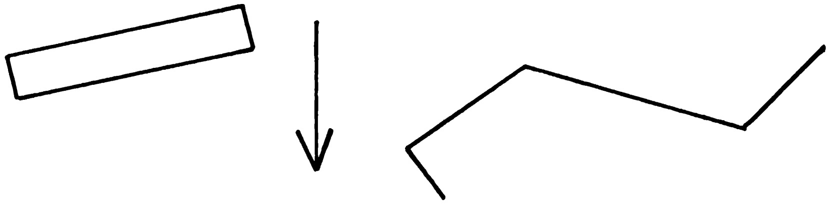


Figure 3-2. Typical Vector Displays: AMD Correlation Box, Attention Arrow, AMD Route

	Search	MK X	ARP-Reported Position[1]	See Volume 2 Air Surveillance, CGTM2385A	Exercise Matched[2]	Exercise Unmatched[3]	Exercise Unsafe
Uncorrelated	-	■	✈		\	|	⊥
Correlated	+	/	✈	✕	/	–	T

Figure 3-3. Radar Display

The function of the situation display program is to assemble information into standard drum formats recognizable to the display generating elements associated with the display scope. The program also performs required modification of display data. To accomplish this, the program must periodically: (1) determine whether a display is to be made up, removed, or modified; (2) obtain the content of each item in each display; (3) determine the location of each display and the length and direction of any necessary vectors; (4) convert each information item to its proper drum format; (5) locate each display item in the correct row and column; (6) convert the location of a display to the display coordinate system; (7) determine the beginning and ending point for vectors; (8) determine the display category; (9) determine if a light sensor can be used on the display; (10) assemble all displays into their proper formats. In addition to generating displays on the SID, the program is able to generate a message to turn the audible and visual console alarms on and off.

The situation display program operates in an environment of the outputs generated by the other operational programs. For example, track information on a particular airborne object is extracted from tables prepared by various programs that have generated this data. Similarly, weapons status information is derived from still other operational sources. The situation display program examines this output for the existence of conditions that require an attention display or an alarm to be made up. Upon detection, the appropriate display or alarm will be generated. Once a display is to be made up, the appropriate category bits of the display message are set so that they may be routed properly to all consoles. In addition, if a display is of a high priority nature such that merely routing it to a console via a category does not guarantee its display, the program may force this display to a specific console or several related consoles regardless of whether or not the operator is currently selecting its particular category. Groups of consoles may be selected by manual input in order that certain "Forced" displays may be routed to them should the situation arise. In all, sixteen of these groupings are possible. Any particular console may select only up to two group categories at a time.

Track displays are organized so that weapons and simulation operators will receive displays pertinent to their functions in the A and C features, while identification and surveillance operators will receive data pertinent to their functions in the B and D features. Airbase, AADCP and LRR displays also appear in these features as pertinent to the operator function. Attention displays referencing tracks appear in the top row of the track display (A for Weapons and B for Surveillance). Figure 3-4 shows two sets of illustrations of track displays as they would be seen by surveillance and weapons personnel. Explanations of specific characters as they appear in these and other SID diagrams can be found in the BUIC III Positional Handbook Common Appendix.

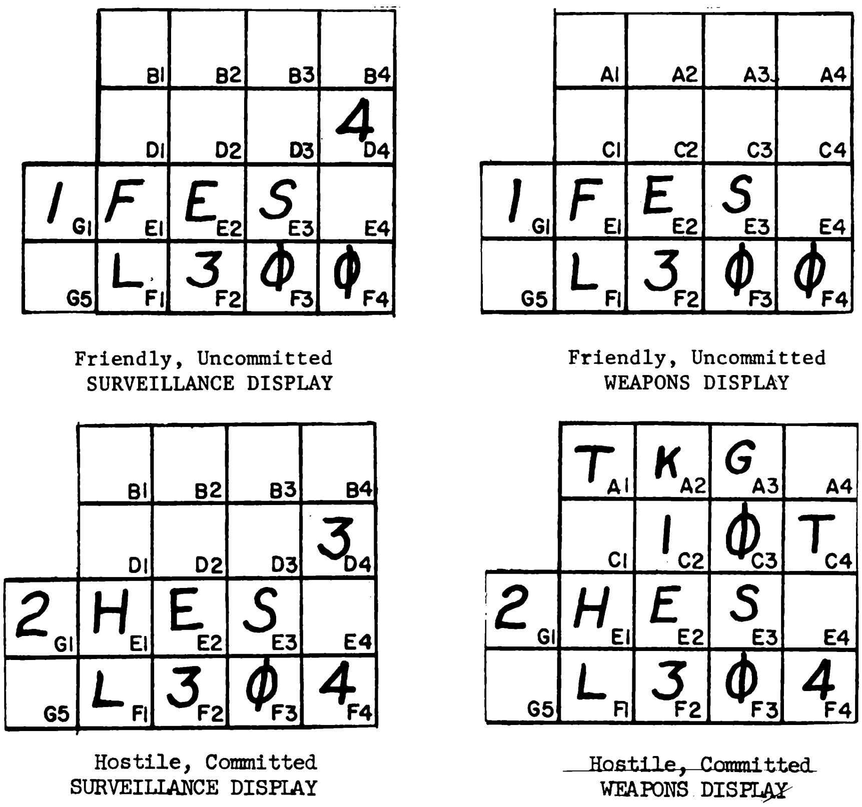


Figure 3-4. Surveillance and Weapons Displays

INFORMATION DISPLAYS

Although eighteen features exist for every information display message, it is not likely that all eighteen will contain significant data for every type of message. The circuit carrying the unused features will not be closed at the time of display generation.

In addition to the many category selections an operator may choose from, he also has feature selectability at his fingertips. That is, he may request all or part of all selected information displays by feature grouping (As, Bs, Cs, etc.). If, for example, the operator chooses to observe only his A and C features, and has selected the category that will (category 21 in Appendix) route all cities (information displays containing the abbreviated name of significant large cities within the division), he will see only the symbol represented in the G1 feature. See Figure 3-5.

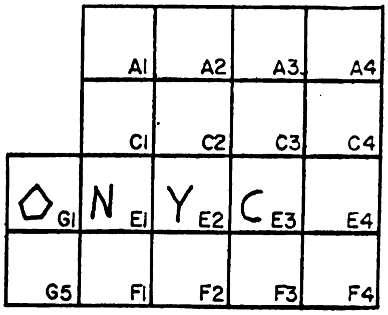


Figure 3-5. City Display

On the other hand, if the operator also was selecting the category for (category 7 in Figure) "Non-Jammer HUKP Faker Tracks", he would be able to use a number of parameters associated with that specific track, and yet additional information available in the remaining features could not be seen due to his choice of feature selection. See Figure 3-6.

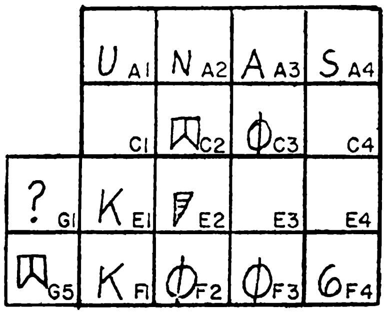


Figure 3-6. Faker Track Display

Expansions changes have no effect on the size or spacing of an information display. The light sensor bit (which designates if a particular feature may be light gunned) will be set for the G1 feature in certain displays. Some information displays are generated for continuous and others for flashing display (usually for short periods of time). Attention devices usually fall in the latter category. The lower outside corner of the G1 feature is considered the actual location of the track, airbase, LRR, etc., that the information display is portraying. For example, the situation display program will convert the coordinates of a track, as determined by the tracking program, from the division coordinate system to its display coordinates and position the G1 feature accordingly. The rest of the display will be built to the right or the left of the G1 feature according to the direction of track movement.

Within each feature or set of features of a particular information display, the program often has a choice of which parameters should be displayed when more than one meaning is assigned the particular feature. In such cases, the program relies on a priority table in which the most essential information is given first crack at the display slot, and may remain there as long as the condition prevails, or its display tie elapses.

VECTOR DISPLAYS

Vector displays are generally of two types: those that are affected by an expansion change (expandable vectors) and those which are not (nonexpandable vectors). Expandable vectors include those messages that are part of geographic displays, most commonly referred to as "Fixed Geography". Such displays include the graphic representation for boundaries of division responsibility, coastlines, or other local geographic outlines, Air Defense Identification Zone (ADIZ), and other special displays appropriate for local use. See Figure 3-7. Other nongeographic expandable vector displays include strobe representation and Air Movements Data (AMD) routes.

The most common nonexpandable vector message is the track velocity vector which originates at the origin (lower outside corner of the G1 feature) of every track information display. The direction of the vector represents the heading of the track and the length of the vector represents its speed. As an example, a track flying at 500 knots would have a one-quarter-inch vector, and a track flying at 3000 knots or more would have a one-and-one-half inch vector (the maximum size). Some vector messages have the light sensor bit set allowing for a light gun activation.

RADAR DISPLAYS

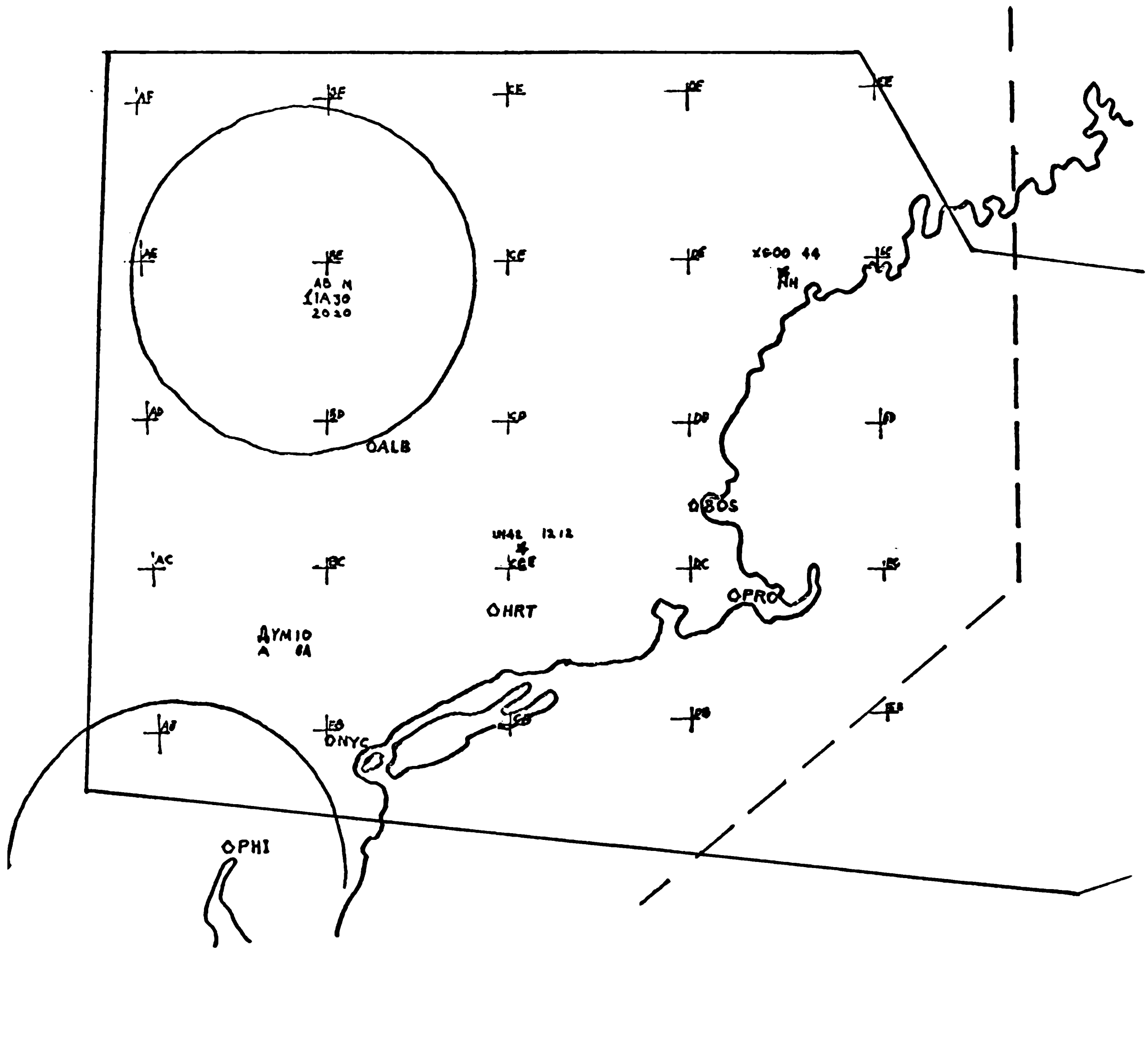
The radar display drum channels are not subject to dynamic reallocation as are most of the nonradar channels. Radar data are displayed as present data (continuous) for approximately one bi-cycle, and as history (flashing) for approximately six bi-cycles. The history data flashes in such a manner as to give the effect of movement, with the oldest data flashing first and so on until the most recent (history) data flashes. The present radar data is the only data for which the light sensor bit is set. As the operator examines the radar picture on his console, this method of displaying flashing history and continuous present data helps him determine which patterns represent actual aircraft, and their probable speed and heading.

All information, vector, and radar displays are routed on one of the many categories available at each console. It should now be evident that the situation display program provides each operator with any display of his choosing, so long as such a display has been generated by the program. It, therefore, behooves the operator to intelligently select the most appropriate displays for his particular function, since, during times of stress, a cluttered scope can be a hazard to work with. He has complete freedom in this respect, as well as in his choice of expansion levels and feature selectability. Nevertheless, the program maintains the capability to generate certain crucial displays when the situation arises.

TABULAR DISPLAYS

The function of the tabular display program is to assemble display messages in the format required for storage on the display drums. The tabular display program, like the situation display program, operates in an environment of other program outputs and obtains most of its information from these outputs.

Tabular Displays (TDs) are grouped into three classifications: requested (by switch action), forced, and always-present. These displays are routed to the Tabular display scopes (TDs) of the particular console(s) requiring them. See Figure 3-8. Each message type adheres to a particular line-by-line format and is displayed to the operator for a period determined by the nature of the display itself. In general, requested displays remain on the TD scope



(An example showing typical fixed geography displays such as boundary and landmarks, ADA ring, ADIZ, airbases, cities and Georefs).

Figure 3-7. Situation Display

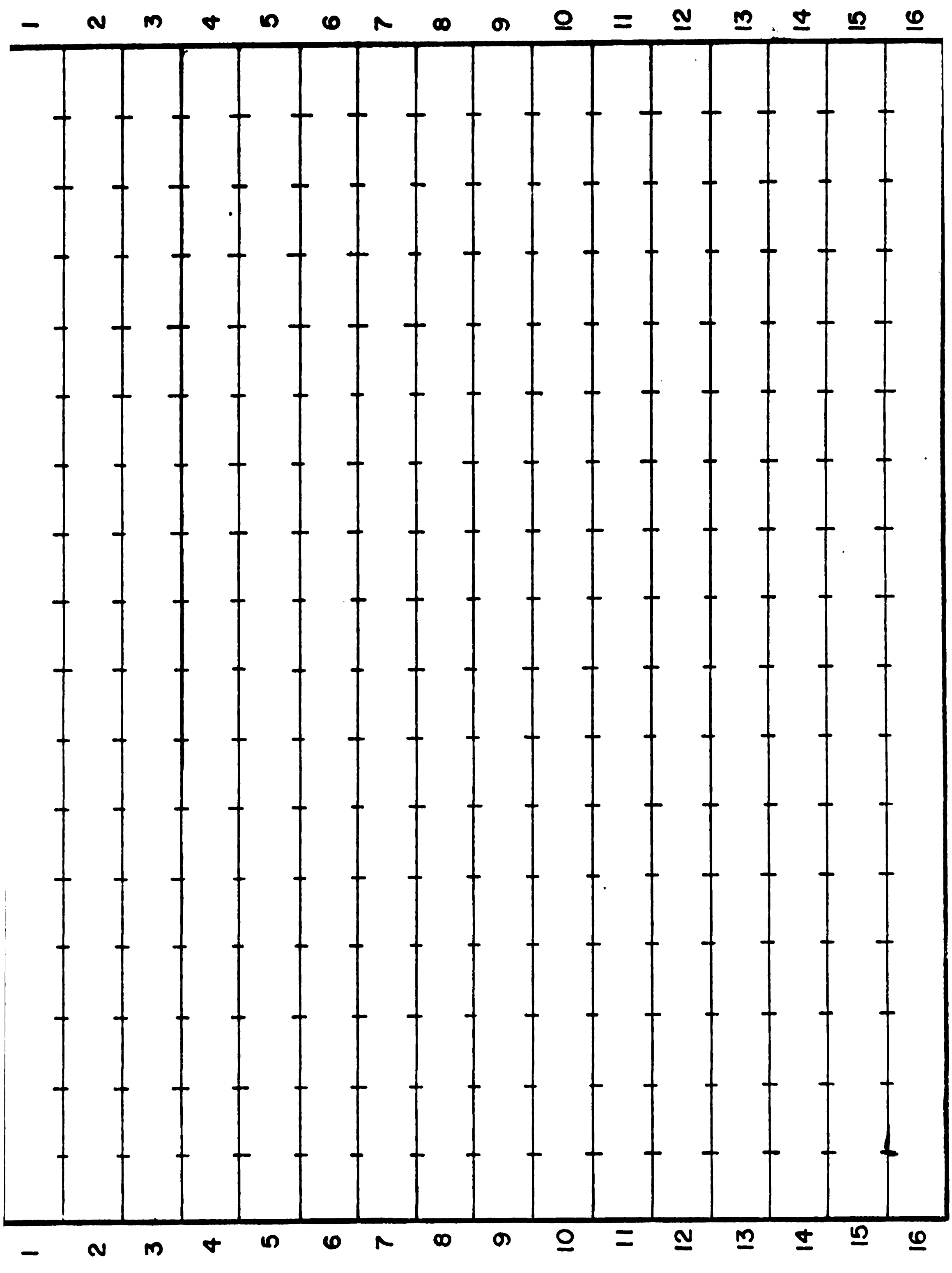


Figure 3-8. Tabular Display Format

for a fixed period and then are cleared by the program. This procedure saves the operator the trouble of clearing the display himself, and saves wear and tear on the display tube. It also keeps unneeded information from tying up registers on the display drum channels that might otherwise be allocated for special use under the dynamic allocation scheme. An example of a requested TD is seen in Figure 3-9.

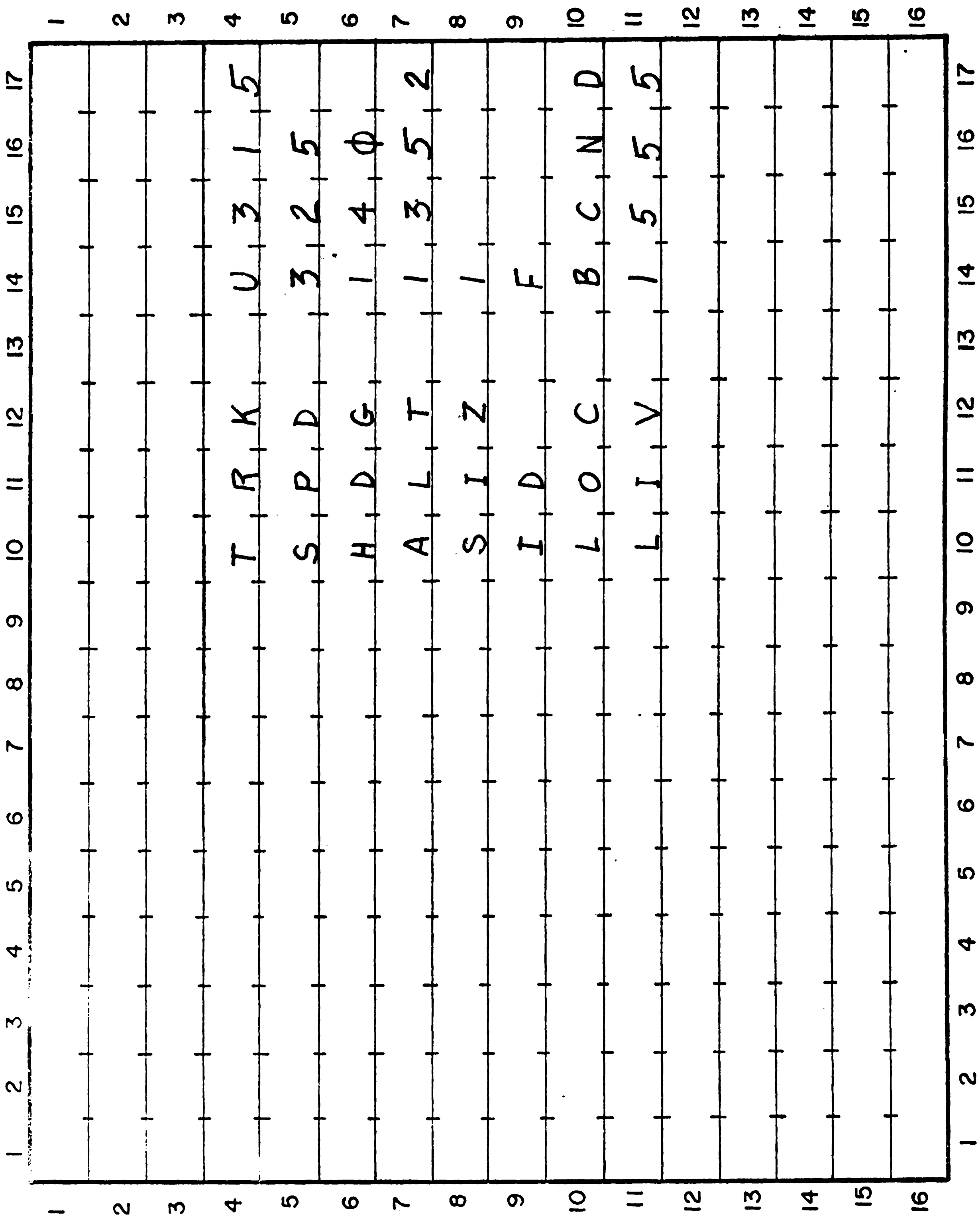


Figure 3-9. Non-Interceptor Track TD (Requested)

Forced TDs are generated by the tabular display program when a condition arises within the system that requires immediate attention by the operator. These displays are generally accompanied by an audible alarm and are presented for a short time before they are cleared. There are some forced TDs which remain on the TD scope until corrective action is taken. For example: If a Hostile track has been identified for which no weapons have been committed, an "Unassigned Track TD" is forced to the SD until he assigns it to a weapons controller or defers action on it. Another example of a forced TD is called a "Scramble TD", which is generated at the TD scope of a controlling WD when he commits an Interceptor. See Figure 3-10. Always-present TDs remain on the TD scope as long as that console is assigned the same operational function.

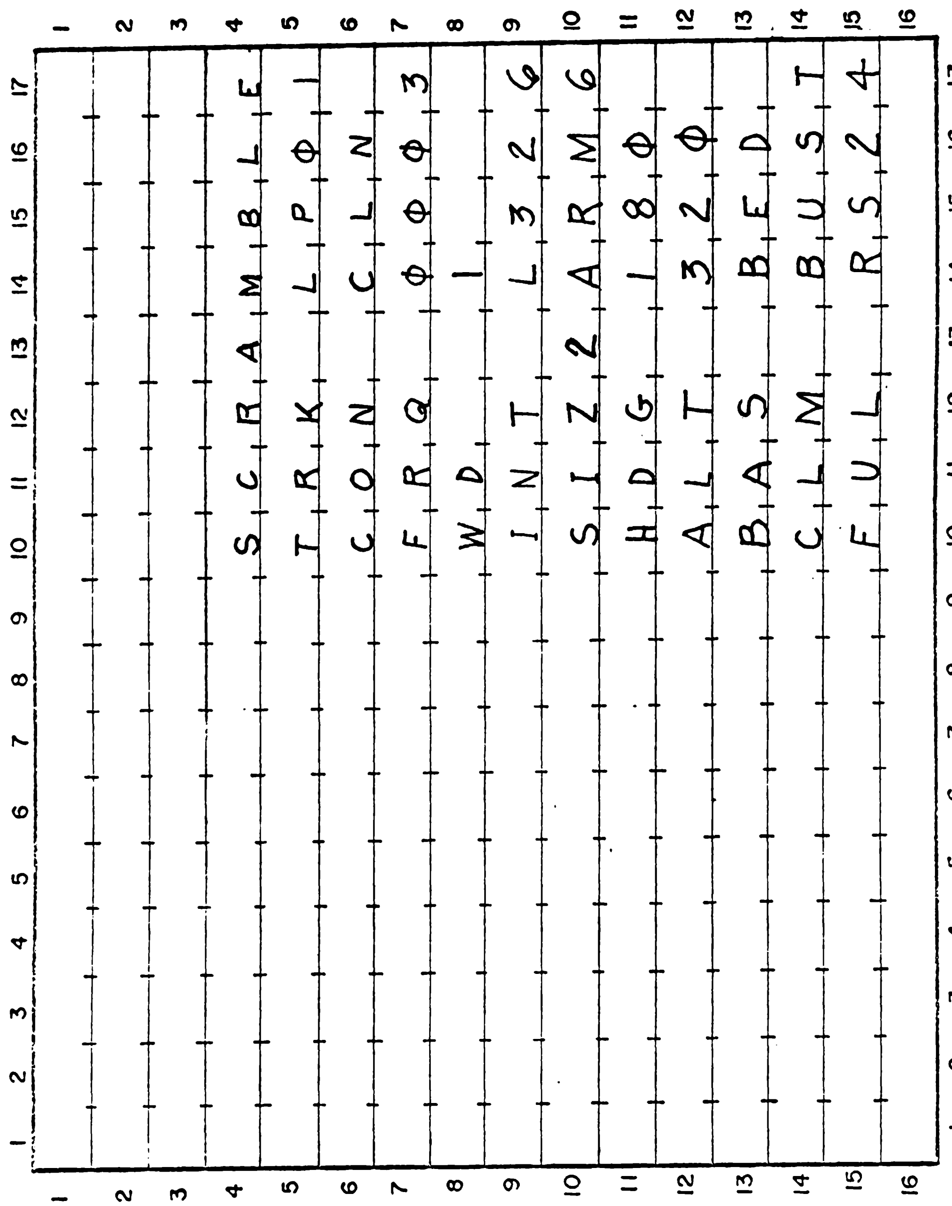


Figure 3-10. Scramble TD (Forced)

Some tabular displays are self-updating, but the majority are non-updating and are, therefore, unreliable soon after they are displayed. A self-updating display means that the program dynamically inserts the latest information in the display slots for as long as that display is on the TD scope. Such a display is generally requested when controlling precision-type intercept missions. See Figure 3-11. A non-updating TD must be recalled for the most up-to-the-minute information to be presented.

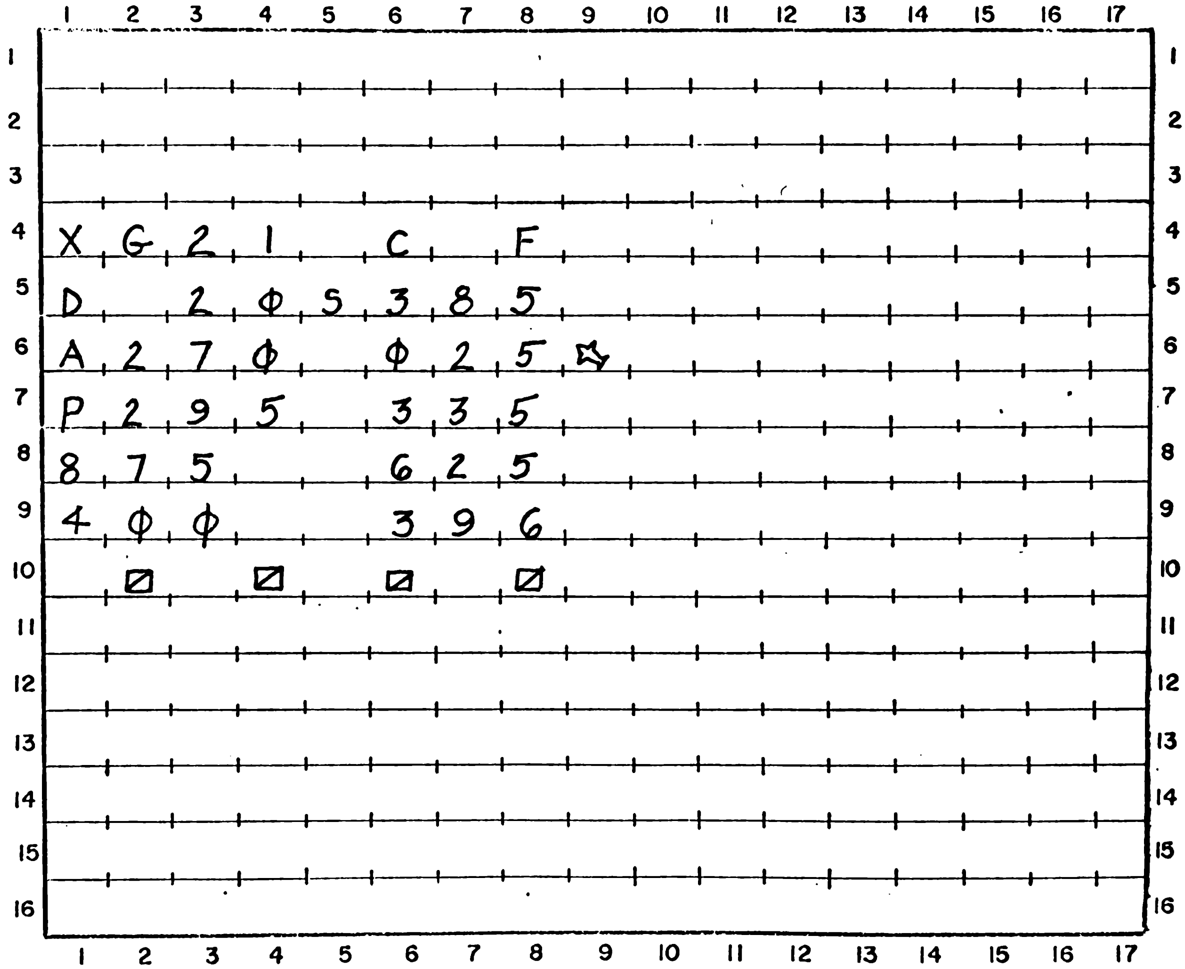


Figure 3-11. Manned Interception Mission TD.
(An example of a Requested Updating TD)

Because the TD is a matrix of 16 rows by 17 columns, more than one tabular display may be present on a scope. Those displays that require half or less of the scope horizontally are called sided displays. The operator can control which side of the TD he desires a requested sided display to be generated upon. If the operator does not wish to choose sides, the program nevertheless attempts to provide the display without altering an existing display. An example of a sided display is seen in Figure 3-12.

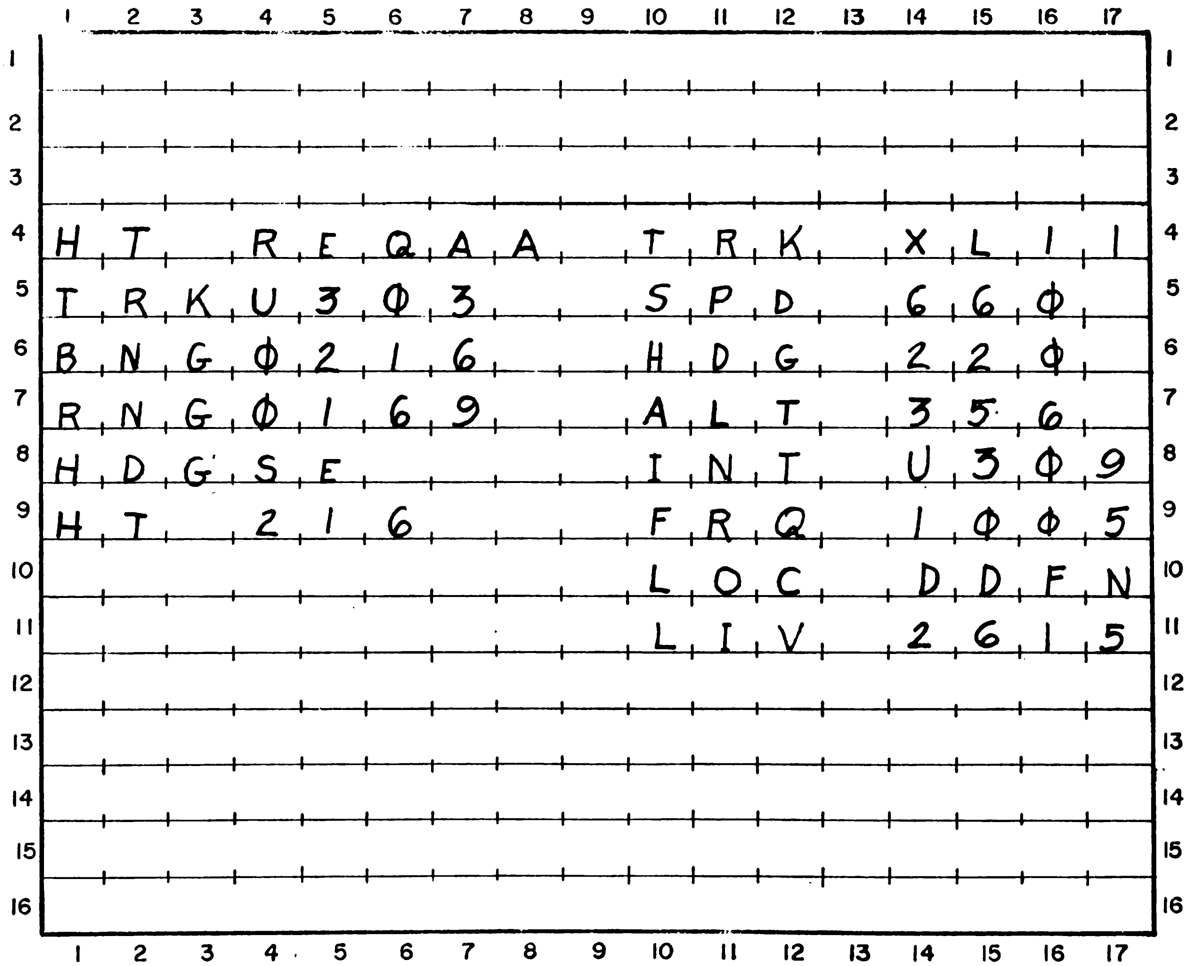


Figure 3-12. Sided TD Display
Manual Height Request TD (An example of a Forced TD)
Interceptor Track TD (An example of a Requested TD)

Conflicts between tabular displays may exist between requested, forced, and always-present types (sided or not). When they do, the program adheres to a priority table that determines the most eligible display at that time. Conflicts generally occur because parts of each display occupy the same line(s). The program will never attempt to generate only a portion of either conflicting display, but will display all of one and delete the other entirely.

For message makeup, modification, and priority adherence, the tabular display program is required to perform most of the functions encountered by the situation display program. Noticeable exceptions are coordinate conversion, vector message makeup and radar displays. For an interpretation of the TDs used in the examples, see the BUIC III Positional Handbook Common Appendix.

CHAPTER 4

RADAR INPUTS

The radar inputs function is concerned with the processing of radar data entering the BUIC III system to ensure that requirements for quality and quantity are met. If the quantity of incoming data is not properly controlled, system capacity is exceeded and the system breaks down. If the system capacity is not properly allocated among the radar sites that provide inputs, the system cannot make the most efficient use of all of its sensors. If the quality of radar inputs is unsatisfactory, the performance of all other air surveillance functions and the weapons function is degraded, or even disrupted completely. If target returns cannot be distinguished from non-target returns, hostile targets cannot be detected, located, identified, tracked, intercepted, and destroyed.

THE RADAR NETWORK

The BUIC III system uses, in general, the same network of radars that is used in the SAGE system. Radar data that is eventually transmitted to the BUIC III NCC is originally received at long range radar (LRR) sites, gap filler radar (GFR) sites, and airborne long range radar (ALRR) sites. At each of these sites, special radars and equipment are used to input needed data to the system.

Two basic systems are used to obtain radar data: reflected energy radars and the beacon system.

REFLECTED ENERGY RADARS

Reflected energy radars include both search (surveillance) radars and height finder radars. Search radars are located at LRRs, GFRs, and ALRRs. There are two height radars at each LRR and one aboard each ALRR.

The equipment used to obtain either search or height input data operates on the same basic radar principle. However, height finder beam patterns, scan, and assigned frequency channels differ from search radars. In addition, their data are processed quite differently from search data. The height function is discussed in Chapter 7 and reference to reflected energy radars in following sections of this chapter is restricted to search radars.

The radar detection of an airborne object is achieved by first transmitting directed radio-frequency energy and then detecting the energy reflected by the object. The range of the object from the radar antenna is determined by timing the period required for the energy to make the round trip. The distance between the antenna and the object is one half of this elapsed time multiplied by the velocity of radio energy (186,000 miles per second). The azimuth of the target is determined by the direction in which the rotating antenna is pointing when it picks up the reflected energy, or echo.

The process of detecting the target return is complicated by the fact that objects other than aircraft also reflect energy. For example, objects put in the atmosphere by the enemy to confuse or overload the radar, clouds, mountains, the sea, and buildings, all reflect the energy transmitted by the radar. The situation is further complicated when an enemy aircraft uses equipment that generates electronic interference in the radar system. The tactical use of such equipment is referred to as an electronic countermeasure (ECM). Search radars (and most height finders) have electronic equipment to reduce the unwanted radar data and to increase the probability of allowing the target data to pass through to the rest of the system. Techniques to offset the effects of ECM are called electronic counter-countermeasures (ECCMs).

Long-range search radars are situated at various LRR sites throughout the NORAD system in a manner designed to provide the most effective coverage. Unmanned gap-filler radars with low altitude, short-range coverage are located to fill the gaps that exist in LRR coverage. Search radar data are processed at the GFR site and transmitted to an LRR site. From there the GFR inputs are transmitted to the BUIC NCC via the LRR site's output processing equipment using the LRR site's communication lines on a multiplexed (time-shared) basis. There are two communication lines for digital data transmission between each LRR and the NCC.

The third general type of radar site, the airborne long range radar (ALRR), is located on an airborne radar platform (ARP) aircraft. These ARPs, which carry search and height radars and equipment used in the beacon system, patrol the coastal areas in certain parts of the country and thus extend the contiguous radar coverage of the U.S. and Canada beyond that of landbased radars. ARPs are equipped with an airborne data processor that prepares the radar data for transmission to an airborne long range input (ALRI) ground station. From that point, the radar inputs are sent over data link to the BUIC NCC.

THE BEACON SYSTEM

The beacon system depends on the transmission of coded pulses by aircraft or missiles equipped with transponders in response to pulsed interrogations from either an LRR or an ALRR. Data from the beacon system in current NORAD use, Mark X Selective Identification Feature (MK X SIF) of the identification friend-from-foe (IFF) system, are used at the NCC for detection and tracking purposes as well as for the identification of friendly aircraft.

The MK X SIF system consists of an interrogator-receiver unit located at the LRR site or on an ARP and a transponder located in the interrogated aircraft or missile. (Like other friendly aircraft, an ARP is also equipped with a transponder so that it can reply to SIF interrogations from LRRs.) The interrogator forms and sends out coded pulses. Then the airborne transponder, tuned to receive the coded responses, detects the pulses and automatically triggers a reply. The SIF reply is a prearranged group of coded pulses. The receiver part of the equipment receives the reply, which is then processed for transmission. Different frequencies are used for interrogations and replies so that there is no confusion between the two.

At the LRR site, the ground-based equipment sends the reply to the coordinate data transmitting set, known as the AN/FST-2, or to a common digitizer (CD), AN/FYQ-40. Both of these devices detect and decode the reply and prepare MK X SIF data messages for transmission over data link to the BUIC NCC. The AN/FST-2 prepares messages in the form required by the Air Defense Command (ADC); the CD prepares them in the form required by ADC or by the Federal Aviation Agency (FAA), or both. When mention is made of the AN/FST-2 in the balance of this guide, it should be understood that the reference applies also to sites equipped with the AN/FYQ-40.

In the case of ARP-based MK X receivers (not transponders), replies are processed for transmission to a ground ALRI station. These ALRI MK X replies do not carry SIF codes, but do distinguish between BOMARC and non-BOMARC returns. At the ALRI ground station the steerable receiving antenna group and data processor accept the replies and transmit them to the BUIC NCC over data link.

DATA HANDLED BY RADAR INPUTS FUNCTION

The radar inputs function at the BUIC NCC deals with many different types of data. Figure 4-1 summarizes the types of input data messages and their sources.

SEARCH RADAR DATA

The raw search data received at ALRR, GFR, and LRR sites must be processed before they are sent to the BUIC NCC. Search data received at the LRR are processed by the AN/FST-2 or the CD, which converts them into binary digital messages containing range and azimuth data prior to transmission to the BUIC NCC.

Processing of the data by the AN/FST-2 is performed in the following manner. There are two counters on the equipment, the range counter and the azimuth counter. The range counter is set to zero when a pulse leaves the search radar. The value of this counter is recorded when an echo is received. The distance of the object reflecting the echo can be determined from the time indicated in the counter when the echo returns. The range from the site to the object that produced the echo is recorded in 1/2-mile increments. A further determination is made as to its position in the 1/2-mile increments so that the T-2's range ACCURACY is 1/4 mile. The azimuth counter moves in small steps (4096 increments) as the radar antenna scans through 360 degrees of azimuth. It is then reset to zero. Thus, azimuth data are recorded in increments that are each equal to $\frac{360}{4096}$, or 0.088 degrees. Data coming out of the AN/FST-2, processed in these units, are referred to as fine grain data (FGD).

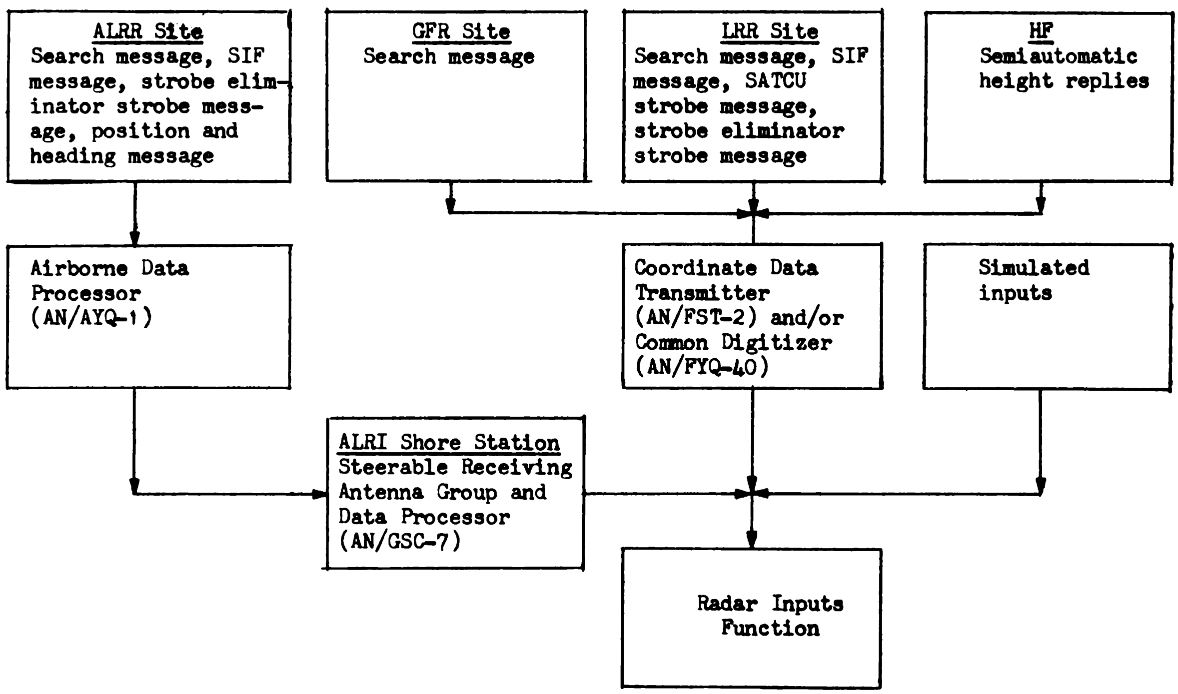


Figure 4-1. Data Types and Sources for Radar Inputs Function

Search radar data received at a GFR are quantized in a similar way, by a device known as the AN/FST-1 Coordinate Data Converter. This device quantizes the data in coarser units than the FGD, however; 1/2, 3/4, or 1 mile in range units and 1.4 degrees in azimuth units. These data are referred to as slowed down video (SDV) data.

Data received at an ALRR site are quantized by the airborne data processor (AN/AYQ-1) which produces data with range units of 1/2 mile and azimuth units of 0.35 degrees.

Another part of the search data processing that takes place at the LRR, GFR, and ALRR sites is called mapping. Mapping is a process in which unwanted radar returns, such as those from ground, sea, and weather, are filtered out of the search data input prior to transmission of the data from the site. Mapping is performed manually at the LRR sites or automatically by electronic equipment at all three types of radar sites. The RICMO/ASO directs the use of mapping equipment.

At an LRR site after the search data have been quantized and mapped, a message is prepared on each return, giving the range and azimuth of the return from the LRR site and timing information. These long range input (LRI) search data are then transmitted to the BUIC NCC over data link.

At a GFR site data that have been digitized and screened are sent to the LRR site as an intermediate step. There the data enter the AN/FST-2 or CD which makes up a GFR data message, with appropriate time corrections. The message is then transmitted to the BUIC NCC.

ALRI data that have been quantized and mapped aboard an ARP are sent to an ALRI shore station which then transmits them to the BUIC NCC over data link. ARPs send, in addition to target radar data, the position and heading of the ARP itself.

MK X SIF DATA

MK X SIF data are coded electronic responses from aircraft to interrogations from the ground. The SIF code itself is a number (up to four-digits) which is placed in the radar message by the T-2. Each SIF code helps differentiate an aircraft from others and falls into one of several basic types of codes. A unique message label is inserted into the MK X SIF message by the AN/FST-2 or CD processing equipment at the LRR site to identify the message as one of the following types of replies:

1. NO/WRONG. This message label is used when the MK X SIF data contain no code, a garbled code, or one found to have an error introduced during its transmission and reception. Any all-zero SIF message received at the BUIC NCC is considered a No/Wrong code (except for a Mode 3 zero code). Mode 1 data are also given a No/Wrong message label.

2. MODE 2. This message label is used when a Mode 2 reply is received in response to a Mode 2 interrogation. A Mode 2 code is used to identify individual Interceptors and other military aircraft. There are 2,047 legal Mode 2 SIF codes.

3. MODE 3. This message label is used when a Mode 3 reply is received in response to a Mode 3 interrogation. A Mode 3 code is used to identify civilian or military aircraft. There are 4,096 legal Mode 3 SIF codes.

4. EMERGENCY. This message label is used when an emergency MK X reply is received in response to either a Mode 1 or Mode 3 interrogation. Emergency replies within a short range of the reporting site are often unreliable. Such replies within a radius of 16 nautical miles of the reporting site are treated as No/Wrong data by the radar inputs program.

5. BOMARC. This message label is used when a BOMARC reply is received in response to either a Mode 2 or Mode 3 interrogation. BOMARC replies within a radius of 16 nautical miles of the reporting site are considered to be unreliable and are treated as No/Wrong data by the radar inputs program.

6. MODE 2 SEARCH. This message label is used when a Mode 2 return is received at the range and the approximate azimuth at which a search return is found (CD only).

7. Mode 3 SEARCH. This message label is used when a Mode 3 return is received at the range and the approximate azimuth at which a search return is found (CD only).

The complete MK X message contains range, azimuth, SIF code, message label, and time delay.

ECM RADAR DATA

Some radar data come from airborne equipment designed specifically to produce, by electronic or mechanical means, data that will confuse and overload the radar system. Two such ECMs are noise jamming and deception jamming.

Noise jamming can be described as a "brute force" method. Its purpose is to mask the radar return from the target by generating so much electromagnetic energy or noise on the frequency of the radar, that the data return from the target is lost in the noise. One type of noise jamming is known as spot jamming. Spot jammers concentrate a great amount of energy directly on the operating frequency of the radar. Rapidly changing a radar's frequency is one ECCM against spot jamming. To offset this particular ECCM, the jamming aircraft may use barrage jamming. In barrage jamming, the jamming is spread over a broad band of frequencies. However, in spreading the power over a broad range of frequencies, the jamming aircraft necessarily reduces the effective power of the jamming it is outputting on any one frequency. Sweep jamming is somewhat of a compromise between spot and barrage. In sweep jamming, a narrow band of electronic energy is swept through a wide range of frequencies. The design of modern radars provides a variety of types of ECCM circuitry, called "fixes," that are used to counteract the effects of barrage, sweep, and spot jamming.

Deception jamming is a technique used to confuse or overload the radar detection system by generating false target information. Chaff, decoys, and electromagnetically generated false signals are types of deception jamming. A common type of chaff consists of thin strips of metallic material which reflect radar energy. Without effective countermeasures, large amounts of chaff overload the system with excessive returns and provide misleading signals in the vicinity of the target. Because chaff moves at the rate of the wind as it disperses and falls, the chaff and the much faster moving aircraft that dropped it separate. Countermeasures against chaff are generally based on this principle.

Decoys are objects that have the reflective characteristics of an aircraft. One realistic decoy is a small aircraft-type vehicle that can be carried and launched by conventional bombers. These decoys may be equipped with special reflectors that provide energy reflecting characteristics of much larger aircraft.

Deception jamming may also be carried out by radiating electromagnetic energy from false target generators carried on the aircraft. By sensing the frequency of the detection radar, the Jammer can send back energy resembling radar reflections from a target. These signals are controlled to create the impression that the aircraft is at one location when in fact it is at another. Similar equipment can generate a series of false radar returns appearing all over the radar scope. Since this type of jamming must take place on the exact frequency of the radar, change of frequency by the defensive radar is one countermeasure.

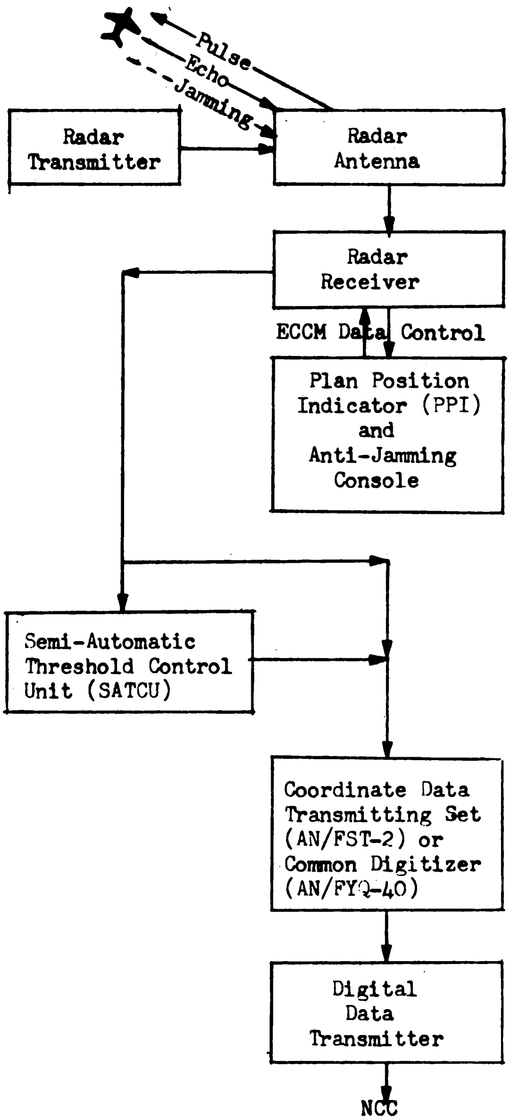
Radar data from jamming sources are initially accepted at the radar sites by receiving equipment that is unable to distinguish between real and artificial targets. Figure 4-2 shows the flow of radar inputs at an LRR site. Both search data and jamming are being received at the LRR, but no incoming messages from GFRs or height finders are shown. The data are routed to the plan position indicator (PPI) scope and anti-jamming console, where ECCM data control is accomplished.

At the PPI, data are displayed essentially in non-digitized form. Returns from search radars are displayed as spots of light, or blips, on the PPI scope face. The ECM data produced by noise jamming are typically displayed as a cluster of many returns, falling within a wedge or strobe centered on the azimuth in which the Jammer aircraft is located. Other patterns of noise jamming may also appear.

If special techniques are not used, these noise returns and data from sources such as chaff, decoys, and electronically generated false targets are processed and transmitted to the BUIC NCC in the same way as search data. These false returns degrade the air picture and may overload the system. In some cases, returns from these sources may be mapped or filtered out by special devices and procedures. The SATCU is one such device which is useful for dealing with returns produced by noise jamming. Using the SATCU, the operator is able to accept strobe information that he believes represents the location of Jammer aircraft and pass this information to the AN/FST-2 or CD. Strobe data transmitted to the BUIC NCC are defined in terms of the azimuth of the center of the strobe and the strobe width.

Strobe data are used as a means of locating the Jammer aircraft when ECM is so heavy that it prevents the use of search data from the aircraft itself. If strobe data are reported to the BUIC NCC on the same aircraft from two or more LRR sites, the strobes intersect at the location of the Jammer aircraft. The use of strobe intersections to track Jammer aircraft is called passive tracking. Data transmitted to the BUIC NCC from ALRR sites do not enter the SATCU.

The data processing equipment at LRRs and ARPs has a provision for eliminating jamming noise returns, known as a Strobe Eliminator. If noise jamming is present, a wedge of returns may be eliminated from the digitized data sent to the BUIC NCC, and a special Strobe Eliminator strobe message will accompany the data. The Strobe Eliminator (S.E.) is a data limiting feature of the coordinate data transmitting equipment at LRR and ALRI sites. When turned on, the S.E. eliminates all active data at those azimuths at which the active data count rises above a set threshold, and generates a strobe message which represents the eliminated azimuths. An S.E. message, as opposed to SATCU strobes, is rejected by the program because it is not useful for tracking.



Search radar transmits pulse and picks up reflected signal from target. Also picks up jamming signal, if aircraft is using ECM.

Receiving detects signal and sends identical data to PPI and SATCU.

PPI displays raw radar data.

ECCM Data Control:
Anti-Jamming Operator (AJO) monitors incoming data at anti-jamming console. AJO directs adjustments to radar equipment to provide improved capability for detecting real targets.

SATCU operator, supervised by AJO, identifies Jammer strobes. Strobe control message sent to AN/FST-2 or CD.

AN/FST-2 or CD performs the following functions:
digitizes and screens raw search radar data; determines Jammer strobe and target azimuth and width; prepares search, SIF, and strobe messages for transmission to BUIC NCC over data link. It also decodes SIF reply messages and causes the SIF transmitter to send an interrogation pulse pair.

Figure 4-2. Flow of Radar Inputs Data at the LRR Site

SIMULATED RADAR DATA

For training and system checkout purposes, simulated radar inputs are often introduced into the BUIC system. These simulated inputs may be put on a magnetic tape, known as an Exercise tape, that is read directly into the BUIC computer, or they may be generated by switch actions of certain simulation personnel, in a process known as dynamic flight generation. An Exercise tape is magnetic tape on which data have been stored to represent the messages received from LRRs, ALRRs, GFRs, and other air defense facilities that input via data link.

In dynamic flight generation, simulation personnel generate and control simulated radar data by means of switch actions. Simulated data that are generated in this manner are sometimes referred to as real-time simulation data, indicating that they are produced dynamically during the course of the exercise, and are perhaps contingent on immediate events that were not preplanned. Simulated search, MK X, and strobe data may be so generated.

One of the advantages of real-time generated data over magnetic tape data is that origin, speed, heading, and altitude characteristics of aircraft flights can be dynamically controlled, instead of depending on programmed, fixed flight characteristics. Real-time generated data are normally used to simulate Interceptors, as dynamic control of these flights is needed. This technique is also used to simulate other aircraft whenever dynamic control is needed, e.g., where air/sea rescue aircraft are being simulated. Real-time generated data may be used in conjunction with an Exercise tape or separately. Sometimes the dynamic flight generation approach is used for positional training, or for practice when only a few tracks are wanted.

RADAR DATA PROCESSING AT THE BUIC NCC

When the radar inputs are received at the BUIC NCC, the computer program changes the way that the location of the return is expressed, counts the data and compares the count with set and system limits imposed by the program or operator, and prepares displays for the system.

Each radar site reports return position in terms of its own position, i.e., as slant range and azimuth from the site. These site-centered position reports are changed to a common point of reference, the geographical Division center. Also, a position received as range and azimuth from the radar site is changed to x, y coordinates representing distance from the Division center. The data are also corrected for differences in position due to the altitude of the aircraft and delays from the time the data were received at the site to the time that they are processed by the BUIC computer program.

The BUIC computer program also keeps a count of the data coming in from each site, for use in automatic and manual monitoring of the system data load. There are limits on the amount of radar data that can be processed and displayed at the BUIC NCC. To prevent system saturation and also to allot available capacity in a way which will provide the best radar coverage and the most reliable data possible, data limits may be imposed on each radar, in addition to the total system limit. Separate limits apply to search, strobe, MK X, and BOMARC data. The limits placed on the LRR site also apply to its GFR data. The BUIC computer program compares the counts with the established limits and, in certain cases, automatically rejects excessive data. The program also furnishes displays for personnel concerned with monitoring the radar inputs load.

The SAGE DC performs an automatic real time quality control (RTQC) function that monitors the performances of the search, height finder, and beacon equipment at LRR and GFR sites. Among other things, this function determines search registration and SIF collimation errors. BUIC III does not have the capability of performing this RTQC function. However, the range and azimuth values computed for registration and collimation errors are transmitted by voice from the parent DC to the BUIC NCC. Each BUIC NCC in the Monitor mode accepts and uses these error reports to adjust the data received from the radar sites involved. The adjustment to the radar returns as inputs to the program via the manual inputs function. During the Active mode, the RICMO/ASO coordinates with the Manual Inputs Operator (MIO) and with personnel at the LRR site to ensure that the most current range and azimuth error values are available to the BUIC NCC program.

RICMO/ASO POSITION

Responsibilities for radar inputs functions are assigned to the RICMO/ASO and the AST. The RICMO/ASO has overall responsibility for maintaining a current picture within the NCC's assigned area. Assisted by the AST, he coordinates with adjacent Divisions and specific radar sites on tracks of interest to the NCC's area of responsibility. He supervises the actions of personnel assigned to air surveillance, identification, and manual inputs functions. His responsibilities with regard to the radar inputs function are:

1. Monitor search and beacon radar input data received by the NCC so that adequate tracking may be performed.

2. Coordinate with LRR site personnel regarding radar input data.

3. Evaluate incoming data from various LRR sites, takes appropriate actions to ensure that the most significant data are accepted and, where degradation exists, attempts to determine the extent and cause.

4. Coordinate ECCM activities in an ECM environment.

5. Evaluate the tactical threat to the NCC and makes decisions regarding the use of the various anti-jamming features.

6. Advise other Air Surveillance Team personnel of the ECM environment and radar data quality.

Equipment used by the RICMO/ASO for the radar inputs function consists of a data display console, with its associated light sensor and manual intervention switches, communication facilities, and a random access plan position indicator (RAPPI). The RAPPI provides the means for monitoring the quality of incoming radar data from any of the NCC's LRR/ALRRs. Using the RAPPI, the RICMO/ASO can obtain a display of any of the various types of radar returns sent by any selected NCC-tied radar site; and, when requested, the mapping patterns used by that site. The RAPPI display does not correspond to radar video, however.

Overall, the radar inputs job is divided into three main categories:

1. MONITORING RADAR INPUTS FOR SIGNIFICANCE OR QUALITY, and taking appropriate steps to maintain adequate standards of data. When the BUIC NCC is in the Active mode, these steps include the directing of mapping and the use of ECCM at the various radar sites.

2. MONITORING RADAR INPUTS FOR QUANTITY (data loads), and taking appropriate steps to optimize the use of system capacity.

3. COMMUNICATING with personnel at the BUIC NCC and at associated radar sites in regard to radar input data in an ECM environment.

Tasks within these categories overlap somewhat. For example, while monitoring data loads at a particular site, the RICMO/ASO is also concerned with the quality of different types of radar data appearing there, and communicates with various personnel to decide the steps to be taken, based on current needs and conditions. Nonetheless, for purposes of explanation it is useful to consider these three categories separately.

MAINTAINING RADAR DATA QUALITY

There are no simple rule-of-thumb procedures for maintaining data quality. The RICMO/ASO must have a thorough knowledge of the radar inputs function, the specific radar environment, indications of degradation in radar quality, and possible remedies.

He must have access to an accurate picture of the input situation; control the data inputs that are received and processed at the BUIC NCC; diagnose troubles; and take appropriate action to correct deficiencies. Carrying out these duties requires continual monitoring of the SID, TD and RAPPI scopes, to discover indications of input difficulty, potential difficulty, or conditions calling for action. At the SID scope, the RICMO/ASO pays particular attention to the displays of radar data and strobes. He looks for problems caused by noise, clutter, possible false targets, and the like. He may then obtain site by site radar displays on the RAPPI, or may take various actions at the data display console to clarify the situation.

Based on displayed information and that obtained from communications with appropriate operations personnel at the BUIC NCC and the radar sites, remedial steps are undertaken. After required coordination with appropriate personnel, these steps may include adjusting or changing any of the following: the status of the radar and data processing equipment at the sites, mapping patterns, the assignment of radar sets and sites that provide inputs to the BUIC NCC, or displays at consoles.

An example of one corrective procedure that can be used at the RICMO/ASO SID console is the Erase Uncorrelated Search Radar History switch action. This action removes the indicated type of data from all the BUIC SIDs. Taking this action during periods of heavy clutter may make it possible to gain a clearer picture of the correlated radar returns. Then ASOpers can observe and analyze the search history as it builds up again.

Procedures for controlling the assignment of radars that provide inputs to the BUIC NCC are described below.

THE RADAR SET STATUS ACTION. The Radar Set Status action controls the computer program use of the radar inputs received at the BUIC NCC from each LRR, GFR, and ALRR. In taking the action, the RICMO/ASO inserts the following information: (1) the site identity of the LRR, ALRR or GFR, (2) the type of radar data to be controlled (search, strobe, MK X or GFR), and (3) the status requested (On, Off, or Limited Input).

The On status action is taken when the RICMO/ASO wants to process radar data of a given type from a particular site. When search and beacon sets are On, the computer program accepts all data up to the system bi-cycle limit. Data beyond this limit are rejected. Strobe returns, however, are accepted only up to the set bi-cycle allocation limit when the strobe set is in On status.

In the Off status, no returns of the type specified are processed from the radars at the site named. The Off status is used in case of an outage or malfunction of radar equipment or when returns from a particular source are considered by the RICMO/ASO to be unreliable or unusable.

A given radar set is placed in Limited Input Status to limit the amount of radar data to be processed from that set, when it is desirable to reject a portion of its data because the set is exceeding its allocation limit. In this status, which does not apply to strobe or GFR data, returns are processed only up to a specified limit for that set.

When an LRR site is first assigned to an input at the BUIC NCC, the RICMO/ASO takes the Radar Set Status action, because all of the radars at the LRR site are automatically put into an Off status upon assignment. Whenever the ASO takes the Radar Set Status action, the change is reflected in the Radar Set Status TD and the Radar Site Load TD.

THE ON-STATION ARP ACTION. RICMO/ASO takes the On-Station ARP action to designate an ARP as On Station and allow the BUIC NCC to receive ALRI data. This action is taken whenever an ARP goes on station (in its assigned position and ready to transmit data) whether or not it is relieving another ARP. Before taking this switch action the RICMO/ASO coordinates with the ARP Airborne Operations Center (AOC) supervisor(s), to make sure that the ARPs involved are prepared to assume their respective statuses. When the On-Station ARP action is taken, ALRI search and MK X set statuses for the specified ALRR site are automatically set to On, and the on-station ARP being relieved is placed off station. (Special set status is not affected.) If the designated ARP is already on station when this action is taken, the action has no effect. Another result of this switch action is that antenna slewing messages are generated by the computer program to position the ground station air-ground data link antenna toward the new ARP. At the same time, slewing messages are terminated for the ARP going off station.

THE OFF-STATION ARP ACTION. After coordinating with the ARP AOC supervisor(s), the RICMO/ASO takes the Off-Station ARP action to designate an ARP as off station when there is no relieving ARP. As a result of this action, ALRI search, MK X, and Special set statuses for the specified ALRR site are automatically set to Off, and antenna slewing messages are no longer generated for the ARP.

MAINTAINING OPTIMAL DATA LOADS

The RICMO/ASO is responsible for maintaining OPTIMAL data quantity of radar inputs. Both excessive and insufficient returns are a major concern of radar inputs personnel. Failure to receive returns at a given site, as indicated by the appearance of the Deficient Data Attention TD is also a problem for the RICMO/ASO. This TD notifies him of input line failures from LRRs. Five different types of TDs are available to aid the RICMO/ASO in keeping a current picture of radar data loads (quantity) and deciding what changes in inputs need to be made. Each of these types of display is described below. Three of them (Radar Set Status TD, Radar Site Load TD, and Radar Count Summary TD) are switch-requested; the other two (Excess Data Attention TD and Deficient Data Attention TD) are forced to the RICMO/ASO console. These displays are primarily used for determining when data overloads, or high or low loads, have occurred. A count, based on inputs for the previous cycle is shown. After analysis of the information contained in the available displays, the RICMO/ASO takes any of the following corrective actions considered appropriate:

1. Request the LRR site to stop sending returns from one or more of its GFRs when there are excessive search returns from the LRR site.

2. Instruct the LRR site to initiate ECCM action when the excessive data appear to be from jamming aircraft.

3. Change the radar set status from On to Limited Input for certain types of radars at a given site, thus reducing the possibility of saturating the system.

4. Direct the MIO, with the authorization of the SD, to enter a new Radar Channel Assignment message, thus stopping inputs from one site and accepting them from a different one.

5. Request the LRR site to increase the area of manual mapping to reduce clutter search returns it is sending to the BUIC NCC.

6. Using the Radar Set Status switch action, change the radar set status to Off, after coordinating with the Senior Director (SD). This action is most likely to be used when there is evidence that excessive or missing returns are due to hardware malfunctions. Appropriate maintenance personnel at the radar site and/or the BUIC NCC should be notified in these cases.

THE RADAR SET STATUS TD. The RICMO/ASO or an ASOper obtains a Radar Set Status TD by taking the Request Radar Set Status TD switch action. This action should not be confused with the Radar Set Status action. The display, illustrated below, shows the radar set status that is current for all radar sites tied to the BUIC NCC. Information about 10 different LRR or ALRR sites can be displayed simultaneously in lines 7-16. Each line refers to a separate LRR or ALRR site, and displays the status for each of its types of radar sets (search, strobe, MK X, and special) and for up to five GFR sets associated with a given LRR.

RADAR SET STATUS TD

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3																	
4	R	A	D	A	R		S	E	T		S	T	A	T	U	S	
5	ɦ		S		T		M		4		A	B	C	D	E		ɦ
6																	
7	Q		L		F		N		A		F		N	N	N		Q
8	R		>		N		>		M		N	N	N	N	N		R
9	S		N		N		N		A		N	N	N				S
10	T		N		N		N		A		N	N		N	N		T
11	U		N		N		N		A								U
12	V		N		N		N		A			N		N	N		V
13	W		N		N		N		A								W
14	X		N		N		N		A		N	N		N			X
15	Y		N		N		N		A		N		N		N		Y
16	Z		N		N		N		A		N				N		Z

In the Radar Set Status TD shown above, the column headings in line 5 indicate Search (S), Strobe (T), MK X (M), and Special set status (4), plus GFR designators (A-E). Radar set status indicators are N (On), L (Limited), F (Off), ◇ (On, Excess Data), > (Limited, Excess Data), A (Automatic), and M (Manual).

Thus, LRR site Q has its search radar set in Limited Input, its strobe set turned Off, MK X set On, and its Special set status in Automatic. GFR site A is turned Off. The Search and MK X radars at LRR site R are in Limited Input with excess data.

THE RADAR SITE LOAD TD. When the RICMO/ASO takes the Request Radar Site Load TD switch action, he obtains a display showing information about the radar returns received at any one LRR or ALRR site providing inputs to the BUIC NCC. This TD presents the following information for the site designated:

1. Site identification.

2. Status of search, strobe, MK X, and special sets, using the same display codes defined for the Radar Set Status TD.

3. Number of returns accepted in the last computer bi-cycle (2 cycles) for search, strobe, MK X, and BOMARC data categories.

4. Number of returns rejected in the last bi-cycle, for search, strobe, MK X, and BOMARC data categories.

5. Number of correlated returns in the last bi-cycle, for search, strobe, MK X, and BOMARC data categories.

6. Total returns accepted from each designated GFR (up to 5 GFRs).

7. Registration error in miles and in Azimuth Change Pulse (ACP) units. Registration error is the computed difference between the position of a target reported by a radar site and the true position of the target, as computed by the real time quality control (RTQC) program of SAGE.

8. Collimation error in miles and in ACPs. Collimation error is the computer difference between the radar site's search-reported and SIF-reported position of a target, as computed by the RTQC program of SAGE and reported by telephone.

9. MK X range delay in miles. An equipment adjustment introduced at the LRR or ALRR site to permit the processing of simultaneous switch and SIF returns on the same target.

The following example illustrates how this TD might appear for LRR site R, whose status was described earlier in the Radar Set Status TD example.

THE RADAR COUNT SUMMARY TD. This display appears in response to the Request Radar Count Summary TD action taken at a surveillance console. For each LRR or ALRR site the number of returns accepted in the last bi-cycle is displayed. Separate counts are shown for search, strobe, MK X, and BOMARC returns.

RADAR SITE LOAD TD

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3																	
4	S	I	T	E	L	D		Z		8	Φ				R		M
5					S	C	H		S	T		M	K	X		B	O
6	S	T	A		>				N			>					
7	A	C	P		1	6	5		1	2			7	3			6
8	R	E	J			3	5			Φ			2	3			Φ
9	C	O	R		1	2	2			5			5	5			5
10	G	F	R				A	=	1	5			B	=	2	1	
11	E	=	1	1			C	=	2	4			D	=	1	8	
12																	
13				R	E	G			C	O	L			D	L	Y	
14	R	G	+	1	▫	Φ	Φ	–		▫	2	5	+	1	▫	Φ	Φ
15	A	Z	+		Φ			+		3							
16																	

The Radar Site Load TD shows LRR site Z-80, whose designator is R, is operating its search and MK X radars in Limited Input status (STA). The number of search, strobe, MK X, and BOMARC returns accepted (ACP) in the last bi-cycle is shown in line 7. The number rejected (REJ) is shown in line 8. Correlated (COR) returns accepted during this period for each radar set are displayed in line 9. Lines 10 and 11 indicate total returns accepted from the 5 GFRs. Registration and collimation errors, as well as MK X range delay, are shown in lines 14 and 15. Column 17 contains load information for the Special set.

THE EXCESS DATA ATTENTION TD. Whenever 90 per cent of the system radar data limit is reached, the Excess Data Attention TD is forced to the RICMO/ASO console for two cycles, accompanied by an audible alarm. This display shows which data type is excessive (search and/or MK X data, strobe data, or both of these) and, for each of 10 possible radar sites, whether there is an excess in search, MK X, or strobe data.

EXCESS DATA ATTENTION TD

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2	X	S		L	I	M		Q	R	S	T	U	V	W	X	Y	Z
3					⧄				S								
4																	
5																	

In the above Excess Data Attention TD, 90 per cent of the system limit for search data has been reached at LRR site R. The symbol (⧄) indicates that the excess involves the Search and/or MK X radars, however, the (S) under site R narrows the problem to the Search radar. Strobe excess would be shown by the symbol T.

THE DEFICIENT DATA ATTENTION TD. This display is forced to the RICMO/ASO console for two cycles when any set at a radar site has a set status of On or Limited Input, and any of the radar input lines has failed to transmit an input message for two consecutive cycles. An audible alarm accompanies the display. Failures involving either or both lines are shown for each of 10 possible radar sites.

COORDINATION WITH OTHER OPERATIONS PERSONNEL

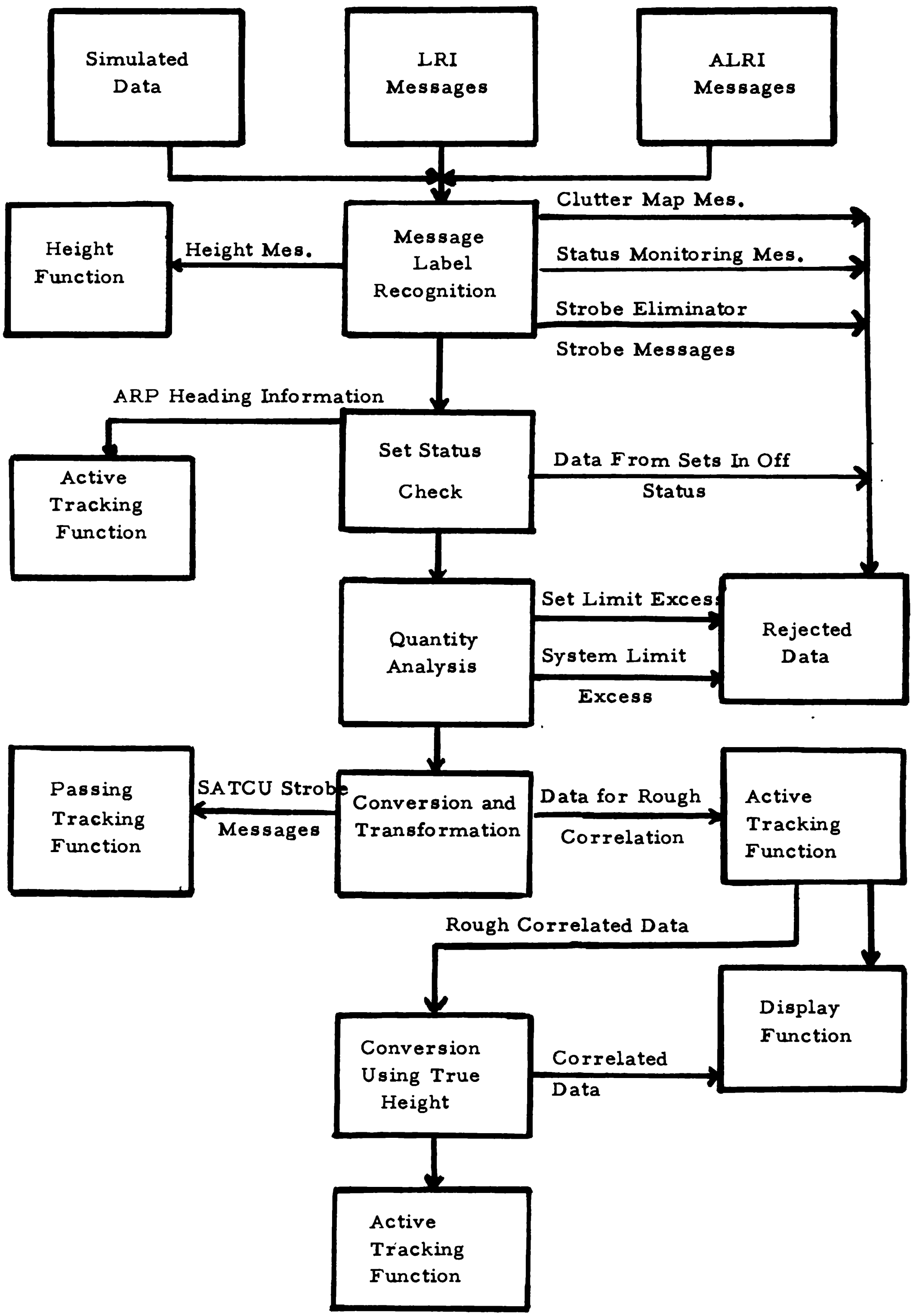
Monitoring and interpreting selected air surveillance displays and alarms, and taking appropriate actions are major portions of the radar inputs job. Another part is exchanging relevant information with other operations personnel so that they can perform their jobs effectively in the system. This communication may be in the form of a direct order to perform a specific operation; it may be merely advisory, or it may be part of a decision-making process.

If the RICMO/ASO decides to change site assignments to input lines, he requests the MIO to prepare and insert the needed cards. If changes are required in data link connections between the BUIC NCC and various sites, or if there are special problems involving the functioning of ground-based equipment, he coordinates this with the Maintenance Team.

Airborne Operations Center supervisors must be contacted whenever ARPs are going on or off station, or when there are indications of equipment malfunctions that may affect ARP surveillance functions.

Control of radar quality requires that the RICMO/ASO monitor and supervise selection of the best ECCMs as well as mapping activities at radar sites under control of the BUIC NCC. The RICMO/ASO coordinates with the Radar Mapper-Long Range (RML) through the AJO or AOC Supervisor at these sites. When he requires information concerning mapped area boundaries, the RICMO/ASO requests that the T-2 operator briefly push the Boundaries switch on the Moving Target Indicator unit (manual mapper).

The RICMO/ASO relies on the LRR site Anti-Jamming Operator (AJO) to tell him the type of jamming and ECM affecting the LRR, plus the extent to which ECM is degrading radar receiver operation. Because an AJO knows his own radar set best, he also suggests appropriate ECCMs. Based on the AJO's recommendations, plus his own knowledge of the NCC air picture and tracking requirements for best intercept direction, the RICMO/ASO instructs the AJO at each site to insert the best fix for a given condition. The RICMO/ASO also coordinates with the AJO in issuing mapping instructions for relay to the RML. In addition, he instructs the AJO to direct changes in SATCU operation; after considering any suggestions offered by the SATCUop and AJO.



RADAR INPUTS FUNCTION

Radar Inputs:

RELATED MANUAL INPUTS

a) RADAR CHANNEL ASSIGNMENT AND HEIGHT REQUEST AVAILABILITY message

b) REGISTRATION AND COLLIMATION ERROR message

RELATED SWITCH ACTIONS

a) ERASE UNCORRELATED SEARCH RADAR HISTORY

b) OFF/ON STATION ARP

c) RADAR SET STATUS

RELATED DISPLAYS

a) DATA SIF DISPLAY SID

b) MK X EMERGENCY ALERT SID

c) RADAR DATA SID

d) TRACK SIF DISPLAY SID

e) LRR SITE INTERNAL AND EXTERNAL SID

f) ARP-REPORTED POSITION DEVIATION ATTN SID

g) EXCESSIVE POSITION AND HEADING REPORTS SID

h) MISSING POSITION AND HEADING REPORTS SID

i) ARP POSITION CORRECTION TD

j) DEFICIENT DATA ATTENTION TD

k) EXCESS DATA ATTENTION TD

l) RADAR COUNT SUMMARY TD

m) RADAR SET STATUS TD

n) RADAR SITE LOAD TD

RELATED DATA LINK MESSAGES

None

NOTES

CHAPTER 5

ACTIVE TRACKING

A track is the symbolic representation of the flight of an airborne object. Tracking is the process in which tracks are used to delineate the movement of aircraft or other airborne objects. In the BUIC III system, radar data from a given airborne object are associated with tracks by the program or operator action and tracking is performed automatically.

Active tracking uses active radar data to determine the location and movement of tracks. Active data include both range and azimuth information. Passive tracking, on the other hand, uses passive radar data in determining track location and movement. Passive data, transmitted from the SATCU, includes target azimuth but not range. Passive tracking is discussed in Chapter 6.

Exercise tracks are a special kind of track used by the Positive Target Control function during missions involving live aircraft. Their origin and method of processing at the NCC are different from that of other tracks. Switch actions taken by operators other than the Target Monitors (TM) on Exercise tracks and/or Exercise Data are illegal, except that the Request Track TD action may be taken on Unsafe Exercise tracks. Exercise tracks and their data are discussed in Chapter 10.

The method by which the computer program associates radar data with tracks and then maintains the association is called automatic tracking. Automatic tracking, in turn, is made up of three distinct processes: correlating, smoothing, and predicting. Correlating, the first step in tracking, consists of determining whether radar data fall with a specified search area around the track. Radar returns that can be associated with a track are called correlated radar data; returns that cannot be associated with a track are called uncorrelated data. Smoothing is the process by which track position and velocity are determined based on the position of one or more pieces of correlated radar data and previous track information. Tracks which the program attempts to correlate and smooth have Established status. Predicting is the process of calculating the track position to be used for the next correlation attempt. Prediction makes use of smoothed position and velocity information. The logic and equations used for smoothing and predicting vary to some extent with the type of radar return, the speed of the track, and the manner in which the track is maneuvering.

The RICMO/ASO and designated ASOpers are responsible for the active tracking function. The RICMO/ASO's participation in the function is primarily a supervisory one. ASOper(AT) is the designation given to ASOpers performing the active tracking tasks.

The active tracking function is important to system performance because tracks designate aircraft location, speed, and heading, to the operators and the computer program. Decisions and actions at the BUIC NCC depend on the track accurately representing the position and velocity of the aircraft. For example, when an Interceptor is committed against a target, guidance information is transmitted to the Interceptor on the basis of the position and velocity of the Interceptor and target tracks. Missed intercepts can result if either track is not accurate.

DETECTING AND INITIATING TRACKS

Active tracks may be introduced into the BUIC system by either operator or program action at the NCC or told-in from another facility. The sequence of events for entering new tracks is shown in Figure 5-1.

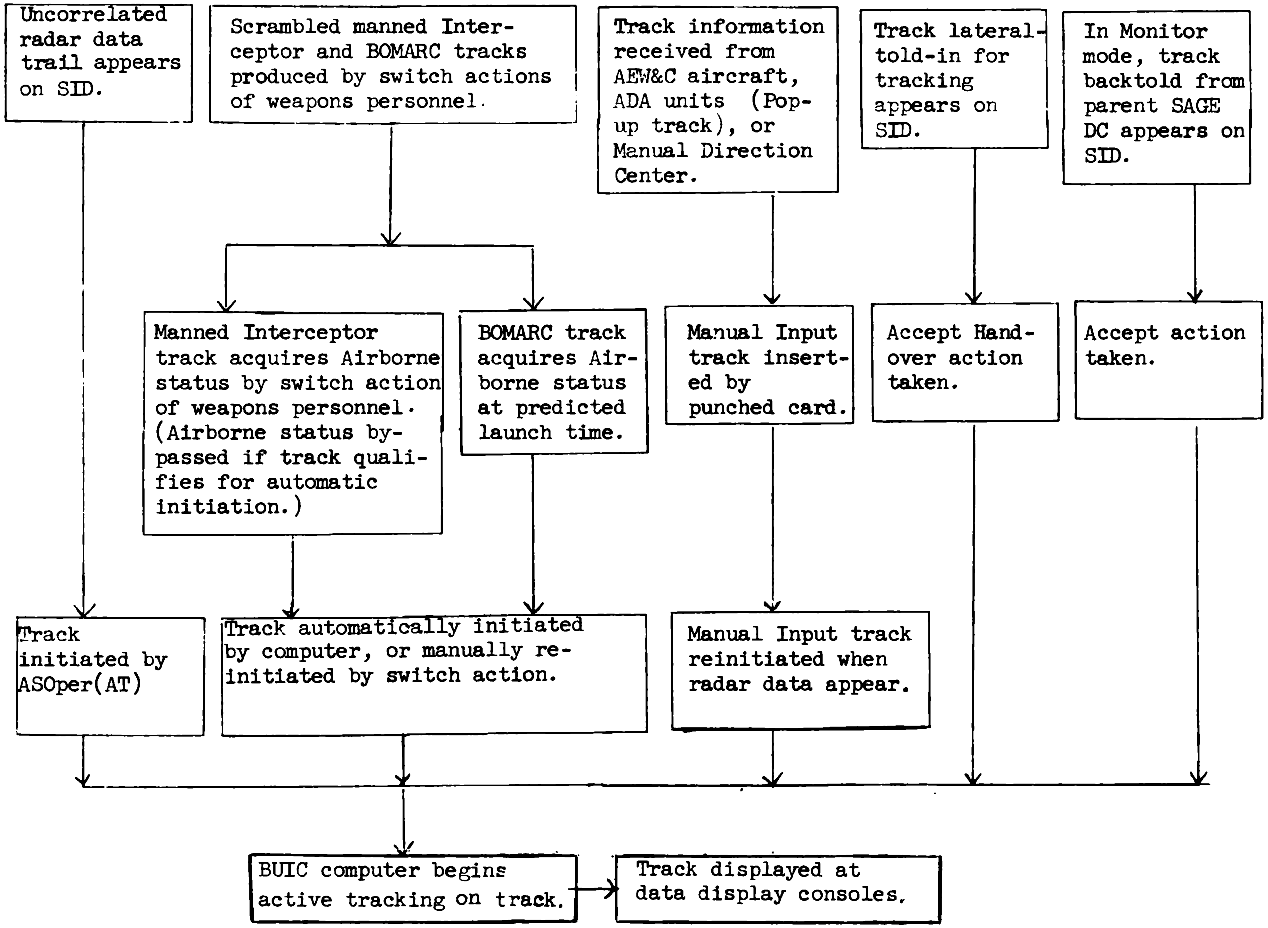


Figure 5-1. Sequence of Events for Entering New Active Tracks at the BUIC NCC.

TRACKS ORIGINATED BY INITIATE ACTION

Whether the BUIC NCC is in Active or Monitor mode, one of the basic tasks of the ASOper(AT) is to monitor the SID scope and detect new uncorrelated radar data trails that represent returns from an aircraft, differentiating such data from noise. Detection is complicated when there is heavy clutter or when the aircraft data have a low blip-scan ratio. Blip-scan ratio is the ratio of the number of actual returns received to the number of times that the radar scans the target. The radar may not receive a return each scan if an aircraft is flying at a low altitude or has low radar reflectivity because of, for example, its small size, shape, or aspect angle. No radar messages are sent from the site if the number of returns from a given number of radar pulses is too low. In such cases, the displayed radar data trail has skips or blank spaces.

When the ASOper(AT) detects what appears to be a new data trail, he enters a new track into the BUIC system by taking an Initiate action on the latest displayed radar datum currently in the trail. Before completing the track initiation, he must insert his estimate of both speed and heading. He bases the speed estimate on the spread of the history trail. The higher the speed, the farther apart are the blips. Speed needs to be estimated only roughly to allow the computer program to begin tracking with reasonable accuracy. He determines heading by noting the apparent direction of movement of the data trail. In the display of radar data history, the oldest return is displayed first, followed in rapid sequence by the next oldest, and so on until the present datum is displayed. This display gives an illusion of movement along the data trail in the direction of flight. To designate the heading, the console operator uses the rotary Heading switch.

A track number may also be inserted with the Initiate action, but this is optional. If one is entered, however, it cannot be a number presently in the system. If a track number is not inserted, a number is automatically assigned.

The Initiate action causes an Established track to appear at the location of the data on which the action was taken. If the operator has inserted a speed and/or a heading that is greatly in error, the track and radar data will separate and the Reinitiate action will have to be taken to resume the track/data association. Track identity may be inserted at the time of initiation of the track, but only at an IDOper console. This option is reserved for the IDOper because identification is his responsibility. If no identity has been switch inserted, the track identity will be displayed as Pending (P) following an Initiate action. If any action taken to enter a new track causes the remaining track capacity to be reduced to three, the Approaching Channel Capacity TD is forced to the RICMO/ASO or ASOper who took the action. The display lasts for two cycles and is accompanied by an audible alarm.

TRACKS ORIGINATED BY WEAPONS COMMITMENT

When an Interceptor has been committed prior to its takeoff, it is in Scramble status. Weapons personnel introduce Scrambled tracks into the system by means of weapons commitment switch actions. A Scramble track may represent either a manned interceptor or a BOMARC missile.

Manned Interceptors acquire Airborne status by means of an Airborne switch action taken by weapons personnel. If a manned Interceptor track with a status of Scrambled qualified for automatic initiation, its Airborne status is not displayed.

BOMARCs acquire Airborne status at the predicted launch time. Airborne tracks are predicted each computer cycle, making use of track information provided by the weapons function. Under appropriate conditions, an Interceptor track may be initiated automatically by the computer program. Otherwise, a Reinitiate action must be taken on the track in order for it to become Established.

When Scrambled or Airborne manned Interceptors or Airborne BOMARCs do not meet the criteria for automatic initiation, their tracks may be repositioned on suitable radar data by an operator who takes a Reinitiate action. This action is normally the responsibility of weapons personnel, but a weapons operator may delegate the responsibility to air surveillance personnel. After an ASOper(AT) takes the Reinitiate action, and the track's status changes to Established, responsibility for the track reverts to the delegating weapons operator.

Automatic initiation depends on the Interceptor's having an Assigned SIF code. A manned Interceptor track receives an Assigned SIF code when the weapons operator takes the Airborne with SIF Number action on the track in Scrambled status. The assigned SIF code of a manned Interceptor consists of four digits: the first two correspond to the squadron designated at the time of the commitment, and the last two are inserted by the weapons operator. The Assigned SIF code for a BOMARC is assigned automatically by the computer program when the missile is launched.

If the computer program is able to associate SIF radar data with a Scrambled or Airborne manned Interceptor track or an Airborne BOMARC track, any of which has the same Assigned SIF code as the data, the track is automatically initiated. That is, the Scrambled or Airborne track is then changed to Established, track merit becomes Reliable, and automatic tracking begins.

TRACKS ENTERED BY MANUAL INPUTS

Tracks may also be input to the BUIC III system from manual input sources, which include AEW&C aircraft, Air Defense Artillery (ADA) units (Pop-up targets), and other manual sites. (Pop-up tracks originate in a unique way and are discussed in the next section). At non-ADA sources, the radar returns are manually plotted, and track information is sent periodically to the BUIC NCC by telephone, teletype, or radio. When these reports are received by the Manual Inputs Operator (MIO), he punches the track information on cards, and inserts the information into the computer. The computer then displays the manual input track and predicts its position each cycle, based on position, speed, heading, and time indicated in the last available report.

The ASOper(AT) monitors the Manual Input track and watches for the appearance of radar data as the target comes within radar coverage of sites tied to the BUIC NCC. As soon as appropriate data appear, the ASOper(AT) takes a Reinitiation action to associate these returns with the Manual Input Track. When this action has been taken, the track acquires Established status and is tracked automatically. Subsequent tracking is then based on radar data, and further manually inserted reports on these tracks are not used by the program.

The monitoring of Manual Input tracks is important for several reasons. First of all, if the ASOper(AT) fails to recognize that the radar data trail is associated with a Manual Input track and initiates a new track, the system will carry two separate tracks representing the same aircraft. This situation could lead to confusion in other parts of the system, degrading the effectiveness of the weapons and identification functions. On the other hand, if the ASOper(AT) takes action to associate the radar data with a Manual Input track to which they do not belong, there will be one track in the system where there should be two. Delay in recognizing the error gives the aircraft added time to penetrate the area's defenses. Familiarity with the radar coverage of manual input sources, as well as with coverage of his own radars will help the ASOper(AT) to be more effective in properly entering Manual Input tracks into the BUIC system for automatic tracking.

ENTERING POP-UP ADA TRACKS

Airborne objects that are initially detected by Army Air Defense Artillery (ADA) radars, and meet certain criteria, are termed Pop-up targets. Pop-up data link messages are generated at a fire unit by activation of a switch after the Target Tracking Radar locks on the target. The first Pop-up report causes a First Pop-Up Attention TD to be forced to the SD and Air Defense Artillery Directors (ADADs). A Pop-Up Attention Track SID is generated at the positional coordinates supplied by the Army Air Defense Artillery Command Post (AADCP). If the ADAD visually determines that the Pop-Up correlates with a non-Hostile BUIC track, he takes a Hold Fire action and verbally informs the AADCP of the Hold Fire condition. If the Pop-Up does not correlate with a BUIC track, the fire unit engages the object. Should the fire unit be unsuccessful in its engagement, the Pop-Up Attention Track SID is automatically replaced by a Manual Track SID with an ADA source. The ADAD obtains target track velocity and track information from this SID and requests the Manual Input (MI) Team to originate an MI track at the indicated position. The fire unit thereafter sends position information periodically for updating and the track is processed in the same manner as other MI tracks.

TOLD-IN AND TOLD-OUT TRACKS

Tracks may be received at the BUIC NCC from other SAGE and BUIC facilities over data link. Such track information is called (1) BACKTELL, if passed from a higher level of command to a lower level, (2) FORWARDTELL, if passed from a lower level of command to a higher level, and (3) LATERALTELL, if passed between facilities at the same level of command. Computer-generated tell messages are transmitted over data link. Each BUIC NCC receives tell messages from the parent DC, the associate NCCs and all adjacent control facilities. It lateraltells to the associates and all adjacent control facilities and forwardtells to the CC.

TRACKS ENTERED THROUGH BACKTELL. In the Monitor mode, tracks are received at the BUIC NCC as backtell from the parent SAGE DC. A track may be backtold to only one BUIC NCC at a time. Backtell of non-Interceptors is manually started at the SAGE DC. Backtell of Interceptors may be manually controlled or automatic. If a target is backtold to a BUIC NCC, any Interceptors paired with the target are automatically backtold. The fact that a track is backtold is indicated by a B in the E2 character of the track SID. If the BUIC NCC receives a track from both the parent DC and another control facility, it accepts messages on the track from the parent DC and rejects those from the other control facility.

The ASOper(AT) is responsible for accepting backtold non-Interceptor tracks. Interceptor tracks are accepted by weapons personnel. The Accept action is taken on a backtold track to allow smoothing and correlation to be performed on the track. If the track is an Interceptor on intercept mission, guidance calculations are also initiated. The ASOper(AT) takes the Accept action on the backtold-in non-Interceptor track, inserting the given track number or using the light sensor on the track vector. When the Accept action is taken, the track becomes Established and begins correlating, smoothing and predicting on radar data supplied by the NCC's radars. However, backtell messages continue to be received from the SAGE DC. If, at any time, the BUIC-computed track position is more than five miles from the SAGE-reported position, the track is automatically moved to the position reported by the SAGE DC. When the track is moved in this way a Backtold Track Moved attention display, MOVE in the B1-B4 characters, is forced to all ASOper(AT) consoles for two cycles.

TRACKS ENTERED THROUGH LATERALTELL. Lateraltell is the transfer of information between associate BUIC NCCs or between the NCC and either an NCC or a DC in an adjacent Division. A BUIC III NCC can lateraltell a track for the following four purposes, in order of priority: tracking, interception, ADA, and exchange. Lateraltell for ADA is the responsibility of weapons personnel. Live tracks may be lateraltold only for exchange during Monitor mode operation. However, simulated tracks may be lateraltold for any purpose in Monitor mode.

A track can be lateraltold to an adjacent control facility simultaneously for tracking, interception, and ADA purposes. If directed to an associate BUIC III NCC, a track can be lateraltold simultaneously for all four tracking purposes (including exchange). Track data on a lateraltold track are updated as often as possible but no more frequently than once every cycle. A track can be lateraltold simultaneously to a maximum of two adjacent control facilities and two associate BUIC III NCCs. However, a track can be lateraltold for tracking purposes to only one receiver at a time.

Looking at a track SID, the ASOper(AT) can recognize a lateraltold-in track by referring to the E2 character, which shows told-in purpose. The letter T indicates a track told-in for tracking, while I, A, and C indicate Interception, ADA, and Exchange purposes, respectively. In the E4 character, the told-in source is shown by a letter designator of the Division responsible for the track, or by a symbol representing an associate BUIC III NCC.

Only one control facility has tracking responsibility for a track at one time. When a track is about to pass from the geographic area of one control facility to that of another, weapons personnel at the facility with the responsibility for the track take the Start Lateraltell for Tracking action on the track. Before an ASOper takes this action on an Interceptor, he coordinates with the SD or assigned WD.

When the Start Lateraltell for Tracking switch action is taken, lateraltelling for tracking purpose begins on a specified eligible track. As a result of this action, the selected track is lateraltold to a designated control facility and is made available for handover. The told-in non-Interceptor track is displayed at the receiving facility, with an attention display, TOLD, in the B1-B4 characters. The attention display is forced to the operator until he takes an Accept Handover action on the track. An ASOper(AT) takes the Accept Handover action only on non-Interceptor tracks that are lateraltold-in for tracking. Only weapons personnel may take this action on Interceptor tracks. When the ASOper(AT) takes the Accept Handover action on a non-Interceptor track, responsibility for the track lateraltold-in for tracking is transferred to the receiving NCC. The new facility then begins automatic tracking on the track in the same manner as if the track had originated at the BUIC NCC. The track undergoing handover changes its status from Told-in to whatever it was in the sending facility.

When the Accept Handover action is taken at the receiving facility, it automatically sends back a Request Transfer message to the sending facility's computer every cycle for a maximum of two minutes or until a Transfer, Notify Transfer, or Termination message is received on the track. All of these processes occur within the program and are not displayed to the operator.

If the receiving facility receives a Transfer message on the track within two minutes, the track handover described above takes place. If a Notify Transfer is received, this indicates that the handover will not take place, as the track has already been handed over to another facility for tracking. Likewise, if a Termination message is received, the handover does not take place because the track has been dropped from the system.

If no Transfer, Notify Transfer, or Termination message is received within two minutes, the receiving facility stops sending Request Transfer messages, and the track becomes eligible for reinitiation. When this occurs, a special symbol ✚ indicating this fact appears in the E2 character of the track SID at the receiving BUIC NCC. Take over of track responsibility occurs immediately after the Accept action is taken should the sending facility go out-of-action for any reason. The track status changes from Told-in to whatever it was in the sending facility.

A BUIC III NCC that is lateraltelling a track, displays in the track's SID the highest priority purpose for which the track is being lateraltold. The track TD for the track shows all lateraltell receivers and all purposes for which it is being lateraltold to each receiver. In each receiving facility, the track SID shows the highest priority purpose of the lateraltold-in track and the source of the track. The track TD in the receiving facility shows all purposes for which the track is being lateraltold-in and the source of the track.

The Stop Lateraltell for Tracking action is taken to discontinue this type of lateraltelling for a specific track. If the track is not being lateraltold to the control facility for any other purpose, a Termination message is sent to the receiving facility. The track SID and TD are modified to reflect any change in lateraltell status.

With appropriate restrictions, an Interceptor or non-Interceptor track is manually selected for interception purpose lateraltell to a control facility by means of the Start Lateraltell for Interception switch action. This action is available to the SD, WDs, the RICMO/ASO, and ASOpers. Coordination with weapons personnel is required when air surveillance personnel take this action.

Lateraltell for interception allows weapons personnel at a BUIC III NCC to bring specific tracks to the attention of weapons personnel at an associate BUIC III NCC or adjacent control facility, and provides for the coordination and control of an interception when the target and the Interceptor are not the responsibility of the same control facility. Lateraltell for interception can be accomplished either manually or automatically.

A track is automatically selected for interception purpose lateraltell to a control facility if it is not being told-in or in the process of being dropped, and meets the following additional criteria: the track is a target track for which the BUIC III NCC is responsible and a lateraltold-in Interceptor track is paired against it, or the track is an Interceptor track for which the NCC is responsible and it is paired against a lateraltold-in track. An automatic selection of a track for interception purpose lateraltell has priority over a manual selection of the track for the same purpose. The change in lateraltell status is reflected in the track SID and TD, but there is no special indication of whether the track is manually or automatically lateraltold.

When the Stop Lateraltell for Interception action is taken on a track, manually selected lateraltell of this type to the designated facility ceases. This action has no effect on an automatically selected lateral-told-for-interception track. The lateraltell-for-interception purposes of an automatically selected track is terminated, however, under the following special conditions: (1) the track is either an Interceptor or target track and the Interceptor is no longer paired against the target track, or (2) the track is either an Interceptor or target track and both tracks become the responsibility of the same control facility.

A Termination message is generated on the track whose interception purpose lateraltell has been stopped, if it is not being lateraltold to the designated facility for any other purpose. Any change in lateraltell status is reflected in the track SID and TD.

Exchange lateraltell is another way in which tracks get into the BUIC NCC. This form of tell is possible in both Active and Monitor modes. In the Monitor mode, exchange lateraltell provides the NCC with information on tracks that have been backtold to an associate BUIC NCC or on simulated tracks. When the NCC is in the Active mode, lateraltell for exchange purposes serves to supplement lateraltell for other purposes (tracking, interception, and ADA). In addition, exchange lateraltell may be used to obtain height and identity information on tracks. An NCC cannot exchange lateraltell information on a lateraltold-in track.

The Start Exchange Lateraltell action is available at the RICMO/ASO, ASOper, and TgM consoles. If a track number is not specified with the action taken by a surveillance operator, all non-Interceptor, non-Exercise tracks, are lateraltold. If a track number is specified, only that track is told. The TM controls exchange lateraltell of Exercise Tracks in a similar fashion.

The Stop Exchange Lateraltell action may be taken to discontinue lateraltelling of a particular track for exchange purposes to an associate NCC, if a track number is specified. If no track number is specified, exchange lateraltell is terminated for all non-Interceptor tracks. For each track that is terminated, a Termination message is sent to each receiving BUIC NCC, unless the track is being lateraltold for any other purpose to that NCC. The track SID and TD are modified to indicate the current lateraltell situation.

TRACK MONITORING

The process of track monitoring is aimed at keeping a current and accurate air picture. ASOpers are responsible for assisting the program in maintaining this air picture. They do this by initiating new tracks, repositioning existing tracks closer to appropriate radar data, permitting or denying correlating and smoothing attempts, and dropping tracks no longer required for air defense purposes. The ASOper(AT) has access to information about individual tracks in the system from displays available at his console. He takes actions based on his information to improve the effectiveness of the active tracking process.

RADAR DATA DISPLAY

Active radar data transmitted from a radar site are displayed on the SID scope as shown in the box below. Data that the BUIC NCC or SAGE DC associates with established tracks are termed correlated data. The most recent radar datum received is called a present datum, while those received over approximately the last six bi-cycles are referred to as history data. The light sensor will activate a switch action on present data only.

	Search	MK X
Uncorrelated	-	■
Correlated	+	⁄

TRACK SITUATION DISPLAY (SID)

The basic unit of information displayed on NCC situation display scopes is the track SID for Friendly, Hostile, and Interceptor class tracks.

A track SID is composed of a velocity vector and alphanumeric symbols providing information about the track. Each symbol location is called a character space and is assigned an identifier (e.g., the E1 character space). The character format for a surveillance track SID is shown below:

	B1	B2	B3	B4
	D1	D2	D3	D4
G1	E1	E2	E3	E4
G5	F1	F2	F3	F4

All track SIDs appear with a vector indicating speed and heading that originates at the G1 character. The G1 and G5 characters appear on the left-hand side of the display if the track is heading westerly; otherwise on the right-hand side.

TRACK NUMBER. In any track SID, the track number is displayed in the last line. All tracks received at a BUIC NCC are identified by a four-character alphanumeric designation. For a non-Interceptor track the track number consists of a letter followed by three digits. The letter indicates the NORAD Division in which the track originated. The digits indicate the originator of the track. These decimal digits are unique to the track and are assigned sequentially from the blocks of numbers allocated to specified types of air defense installations, according to the following scheme:

001 - 299 SAGE DCs and ADA Units
300 - 699 Manual DCs, BUIC NCCs, and Early Warning Network Units
300 - 499 BUIC NCCs
600 - 699 AEW&C Aircraft

If there are several units of the same type within a given NORAD Division, each is assigned only part of the block of digits indicated above. A track maintains the same track number as it passes through various NORAD control areas.

An Interceptor track is designated by two letters followed by two digits. For manned Interceptors, the two letters identify the squadron of the aircraft. The assigned digits range from 01 through 31, when the BUIC NCC is in Active mode. These digits are automatically assigned as the manned Interceptors are scrambled. When the BUIC NCC scrambles simulated manned Interceptors (for training) in the Monitor mode, the digits 32 through 62 are used in the track number. For a BOMARC track, the first letter indicates the squadron to which it belongs, and the second letter is always M.

If a non-Interceptor aircraft has been made a Specially Designated Interceptor, the first letter of its track number indicates the originating Division, and the second letter is always J. (A non-Interceptor may be made a Specially Designated Interceptor when it is necessary to give it guidance information, as, for example, when an aircraft is used on a search and rescue mission.) The track number is automatically assigned unless the ASOper(AT) inserts one. If the track number is inserted manually, it must be different from any other track number in the system at that time or the action is illegal. The ASOper(AT) may want to insert the track number, for example, when initiating a track on radar data previously assigned to a track that was dropped through error. Exercise tracks, discussed in Chapter 10, always have a track number prefix of T.

TRACK STATUS. The term track status refers to the designated relation of an airborne object to its track data. Track status is shown on a track SID in the E2 character. The following track statuses are used:

AIRBORNE - The track status of a manned Interceptor that has been reported off the ground, but which has not been associated with sufficient radar data to become Established; or the track status of a BOMARC that is assumed to have left the launching pad, but has not been associated with SIF data.

ESTABLISHED - The track status of (1) a track newly initiated or reinitiated by light sensor at the BUIC NCC, (2) an automatically initiated track, (3) a backtold track on which the Accept action has been taken at a BUIC NCC that is in Monitor mode, (4) a track previously lateraltold-in for tracking which was Established in the telling facility which was acquired by a BUIC NCC by an Accept Handover action and (5) a track formerly in a Monitor mode BUIC NCC whose last reported status in the parent SAGE DC was Established, when that NCC is placed to Active mode.

EXTRAPOLATED - The track status of a track that is being predicted without correlation so as to avoid correlating with noise returns.

LOST - The track status of a track which formerly was Established, but consistently had tracking difficulty due to a lack of usable radar data.

MANUAL INPUT - The track status of a track received from a manual facility, (an AEW&C aircraft for example), and inserted into the computer program at the BUIC NCC by punched card.

SCRAMBLED - The track status of an Interceptor-class track that has been ordered to take off on an air defense mission but has not been reported to be airborne.

TOLD-IN - The track status of a track that is being lateraltold to a BUIC NCC from an adjacent or associate BUIC NCC or an adjacent SAGE DC, or is being backtold from a parent SAGE DC. Also, the status of a track in a BUIC NCC that hands over the track to an adjacent or associate BUIC NCC or SAGE DC.

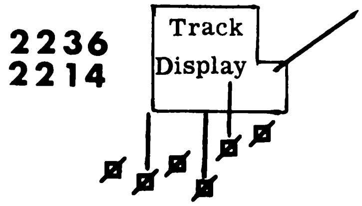
TRACK MERIT. Track merit, appearing in character E2 of a track SID, is an assessment of the performance of the automatic tracking function in tracking an individual Established track at the BUIC NCC. There are two types of track merit:

RELIABLE - An evaluation assigned to an Established track that is being tracked without difficulty.

UNRELIABLE - An evaluation assigned to an Established track that is being tracked with difficulty. On the SID, Unreliable merit for one to four bi-cycles is displayed as the symbol (∇). Unreliable merit for five to nine bi-cycles is displayed as the corresponding digit (5-9). Unreliable merit for 10 cycles is displayed as the symbol (≫). If the track merit is Unreliable for more than 10 bi-cycles, the track status changes to Lost.

TRACK SIF DISPLAY SID

If an operator wishes to determine the code of SIF data associated with a track and to locate radar data with the same SIF code, he may take the Request SIF Display action on the track. When this action is taken, a Track SIF Display appears beside the specified track, and up to eight half-inch vectors appear marking other data having the same SIF code. These vectors point upward and originate at the matching data. A total of five of these Track SIF displays may be requested at a time. The example below illustrates a Track SIF display as it appears at the side of an Interceptor Track SID.



The Assigned SIF code (if any) is displayed in the D characters of a Track SIF Display. The Computer SIF code (if any) is displayed in the E characters. The meaning of these terms is discussed below.

A track for which a SIF code has been assigned by the weapons controller for a manned Interceptor, automatically by the computer program for a BOMARC, or by manual inputs for an Exercise track, is called an Assigned SIF track. The computer program gives priority for tracking an Assigned SIF track to MK X data having the same SIF mode and code as the code assigned the track. These are called Category I data. As long as tracking is based on Category I data only, the track is said to be in the Assigned SIF-Only data selection mode.

When the Assigned SIF track fails to correlate with Category I data for one bi-cycle, the track enters the Assigned SIF-Plus data selection mode. In the latter mode, and in general, the program selects radar data for automatic tracking in the following order of priority: (1) Ground SIF data with matching Assigned SIF code, (2) Ground SIF data with matching computer SIF codes but not the assigned code of the track, (3) Ground SIF data which does not match either the Assigned SIF or Computer SIF code of the track (referred to as beacon data), (4) ALRI beacon data, (5) Ground search data, and (6) ALRI search data.

If an Established track is not in the Assigned SIF-Only mode, it may acquire a Computer SIF code. If such a track correlates for three consecutive bi-cycles with SIF data, all with the same code, the track acquires this code number as a Computer SIF code. If this track is not an Assigned SIF track, it is called a Computer SIF track and enters the Computer SIF-Only mode. It is possible for an Assigned SIF track to also acquire a Computer SIF code during a period in which it is in an Assigned SIF-Plus mode. It is then called an Assigned/Computer SIF-Only track, and the Track SIF display will show both codes. If a Computer SIF track fails to correlate with Computer SIF code data or appropriate ALRI MK X data for one bi-cycle, it enters the Computer SIF-Plus mode. After three consecutive bi-cycles of such non-correlation, the computer SIF code is dropped and the track becomes a Beacon track.

A Beacon track is a track that consistently correlates with No/Wrong SIF data or other beacon data considered to have an unreliable code. (In general, No/Wrong is the term used to describe LRR MK X SIF data messages containing a garbled code or other non-meaningful characteristics). A track that is initiated on ALRI SIF data is a Beacon track, because the data do not contain a SIF code. A computer SIF track which fails to correlate with matching code SIF data for 3 consecutive bi-cycles is another example of a Beacon track.

THE DATA SIF DISPLAY SID

When the operator wishes to obtain a SID display of the SIF code and site designator for the nearest SIF radar return to a specified radar datum, he takes the Request SIF Display action on the radar datum. (This should not be confused with the Request SIF Display action described in the preceding section in which a specific TRACK is designated.) As a result, the SIF code of the nearest beacon (SIF) datum within 10 n.m. appears in the Data SIF Display SID over the indicated datum.

This procedure is repeated automatically for a total of three successive cycles with the display being built up from one to three rows during the total display period. If no SIF data are found for a given cycle, the word NONE is displayed. The word BAD appears for a no/wrong return. The display is cleared after three cycles following the display of the third datum position or after three cycles where no SIF data are found.

THE MK X EMERGENCY ALERT SID

If an aircraft is transponding a SIF Emergency code, a special symbol (V) is displayed on the SID scope. This display consists of two perpendicular 3/4-inch vectors which originate at the G1 character of the track SID.

If no track is correlating with the SIF data, the MK X Emergency Alert SID is displayed with the associated radar data. If there is no track associated with the data, the ASOper should take the Initiate action and notify the RICMO/ASO or SD. Should the aircraft go down, manual inputs personnel may be requested to insert a zero-velocity track at the location to assist in the vectoring of search and rescue aircraft.

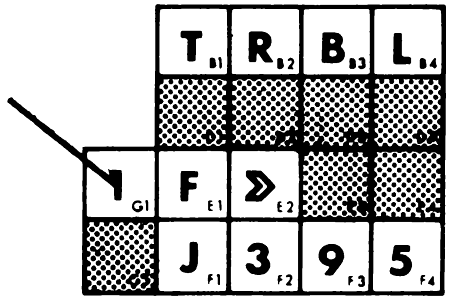
SURVEILLANCE TRACK ATTENTION DISPLAY

Surveillance Track Attention Display appear in the B characters of an Interceptor or non-Interceptor track SID. All of these displays are forced to appropriate consoles, although one, Tracking Trouble, is also category selectable at all consoles for non-jammer tracks. Neither the feature selection nor the category selection switches need to be activated for a forced attention display to appear. The attention displays flash when presented, and some are accompanied by the Forced SID attention TD plus an audible alarm.

There are approximately 15 surveillance track attention displays. Those related directly to other functions, such as height and identification, are not described here. The two which are of interest to the ASOper(AT) are the Tracking Trouble and No Updating Information for Two Minutes attention displays.

The first of these is forced in the B characters of any track that is now experiencing or has had, a certain level of difficulty within the automatic tracking program. When a track has had Unreliable merit for 5 or more bi-cycles, or has a track status of Extrapolated or Lost, it is termed a Trouble track. The program alerts the operator to this condition by forcing a Tracking Trouble Attention display to all consoles displaying such a track. The display itself consists of the letters TRBL.

When an ASOper(AT) is assigned the primary task of monitoring Trouble Tracks, he can set his console category selection switches to display Non-Jammer Partial: Trouble/MI SIDs. This will display Trouble Tracks only. The Tracking Trouble Attention display appears with tracks in this category.



The No Updating Information for Two Minutes attention display is forced to a surveillance operator, an ASOper(TL), whose console has been designated by manual input message to receive telling displays. The display appears when no telling message has been received on a Told-in track for two minutes.

Additional information about a track can be obtained by taking the Request Track TD switch action. Any console operator may take this action on an existing track (Exercise tracks carry certain restrictions). Two basic forms of track TDs are available to air surveillance personnel: The Interceptor Track TD, and the Non-Interceptor Track TD. The latter is the one most often used by the ASOper(AT). The TD allows an operator to determine for a Non-Interceptor track:

1. Whether the track is designated as simulated or live.
2. To whom a track is being told and the purpose of the tell.
3. Ground speed of the track.
4. Altitude of the track.
5. How altitude was determined or time since last determined.
6. Whether it is a Jammer track, Jammer raid, or a possible Jammer track.
7. The Tell source of told in tracks.
8. Location of the track in terms of Georef.
9. Status with regard to ADA action.
10. Special status.

The following is an example of a Non-Interceptor Track TD:

	10	11	12	13	14	15	16	17
1								
2								
3								
4	T	R	K		K	3	4	5
5	S	P	D			6	8	Φ
6	H	D	G		3	4	2	
7	A	L	T		3	8	5	2
8	S	I	Z		1	J		
9	I	D			H			
10	L	O	C		A	G	J	H
11	L	I	V		4	1	3	2
12	I	A	—	T				
13								
14								
15								
16	⊀	P						

<u>Non-Interceptor Track TD</u>

Line	
4	Track no. K345
5	Speed 680 mph
6	Heading 342 deg.
7	Altitude 38,500 ft, 2 min. since height was measured
8	Flight size 1, Jammer track
9	Identification Hostile
10, 11	Georef location AGJH 4132
11	Live track
12	Told-in from Division A, NCC 1, for tracking
16	Passed to ADA

MONITORING ARP TRACKS

Although only a limited number of BUIC NCCs are concerned with ARP tracks, maintaining an accurate representation of an ARP's position is an important monitoring function of air surveillance personnel at these NCCs. There are three different automatic tracking methods which the computer program can employ for ARP tracking. The method used is dependent on the quality of radar data then available for ARP tracking. The methods are: (1) SAGE tracking mode, (2) Heading-Adjusted Velocity (HAV) tracking mode, and (3) Position and Velocity (PAV) tracking mode. The latter two modes make use of Position and Heading (P&H) reports automatically transmitted by the ARP and are considered back-up methods to the SAGE mode. The position derived from the P&H report is displayed on the SID scope by the (⛶) symbol. Present data of this type are displayed when the Present MK X category switch is On. History data for ARP-reported positions are shown as a series of (⛶) symbols, when the History MK X category is selected.

The ARP carries MK X SIF equipment and is tracked with ground radar returns as a Computer SIF (Mode 2) track whenever possible. In the SAGE tracking mode, ARP tracking uses ground-based search and/or SIF data to compute position and velocity of the track. If the merit becomes Unreliable for two bi-cycles, however, the program automatically switches to the HAV tracking mode. In this mode only the heading portion of the P&H report is used for correcting the predicted velocity. The track position is predicted ahead using its old speed and the latest radar data position available. The program continually attempts to correlate the track with radar data. If successful, or if a Reinitiate action is taken on the ARP-reported position or a radar datum, the program automatically reverts to SAGE tracking.

The PAV mode uses both the position and heading from the P&H report. The PAV mode is only entered by use of the PAV switch action, taken when search or MK X returns are not useful for tracking the ARP. In this mode, the program makes use of the reported position and heading information calculated and transmitted by the ARP. When adequate radar data become available, the surveillance operator returns the program to normal SAGE mode tracking by taking the PAV Off action. The on-station ARP remains in PAV mode until this action is taken, regardless of any Reinitiate actions which the operator may use.

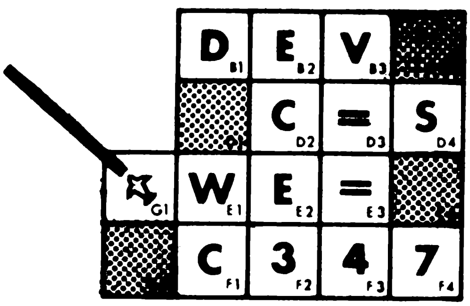
If more than three consecutive bi-cycles occur with no position and heading reports from an on-station ARP, the RICMO/ASO receives a forced Missing Position and Heading Report attention display and alarm. The display appears as MIS ☈ in the top (B character) row of the ARP track symbology. The RICMO/ASO should contact the ARP AOC Sup when this occurs.

If more than three position and heading reports are received in a single bi-cycle, the RICMO/ASO is forced an Excessive Position and Heading Reports attention display. This condition is symbolized by an EXS ☈ in the top row of the track symbology at surveillance consoles.

One remaining situation can cause a forced attention display for ARP tracks. When the position reported by an ARP differs from that of the ARP track by more than 10 n.m., the RICMO/ASO receives a forced ARP-Reported Position Deviation attention display (DEV) for as long as the 10 n.m. limit is exceeded. This display is a cue to the RICMO/ASO that corrections need to be made to the navigation equipment on board the ARP. The RICMO/ASO or ASOper can obtain the necessary corrections by requesting an ARP Position Correction TD. Information displayed in this TD is transmitted by voice radio to the ARP AOC Sup for entry into the auto-navigator equipment.

The same switch actions that are used on other Friendly-class tracks are generally applicable to ARP tracks, and radar data representing the ARP are displayed in the normal manner.

An on-station ARP is indicated by the symbol (☈) in the G1 character. As mentioned earlier, the ARP tracks' identity code is W and is displayed in the E1 character space. The ARP tracking mode is shown in the D4 character, where S, H, P, or a blank are displayed to represent SAGE, HAV, PAV, or Off-station tracking, respectively. The example shows a surveillance track SID for an on-station ARP.



ARP Track SID

ARP (E1) track C347 is reporting its position in excess of 10 n.m. from the BUIC track position (B1-B3).

The track is correlating with AMD (D2) and is emitting a Mode 2 SIF code (D3), is in SAGE tracking mode (D4), is Established (E2), and is being tracked on computer SIF Mode 2 data (E3).

THE REINITIATE ACTION. The Reinitiate action is normally taken for any one of three reasons: (1) to move a track to the position of designated radar data, (2) to change track status to Established, or (3) to commence active tracking on Jammers.

When an operator at a surveillance console wishes to take a Reinitiate action, he inserts the track number of an existing track and light-sensors the radar datum that he wants associated with that track. Optionally, he may also insert speed and heading. When the Reinitiate action is taken, the following results occur:

1. The track is moved to the position of the radar datum that was light-sensored.

2. The track is given the inserted speed and heading. If one or both were not inserted, previously computer speed and heading are used; if computed values are not available, told-in speed and heading are used.

3. Track status becomes or remains Established, and track merit is set to Reliable.

4. If the track is an Assigned SIF track with a prior status of Established, the E3 character is not changed. If the prior status of the track is other than Established, the indicator is set to Assigned SIF-Plus.

The Reinitiate action should be taken whenever a track and its associated radar data separate significantly from each other. The Reinitiate action is also used to initiate Manual Input tracks that are already in the system but have not been Established. This action will cause the computer program to use radar data in tracking rather than the track information sent from the manual source. The ASOper(AT) inserts the track number of the Manual Input track and light-sensors the uncorrelated radar data trail near the track that is from the same aircraft. Before initiating on uncorrelated search data, the ASOper(AT) checks nearby areas for Manual Input tracks or tracks with tracking difficulty, such as those with Unreliable merit or Lost or Extrapolated track status. If the data appear likely to be from one of these tracks, a new track should not be initiated. Instead, the Reinitiate action should be taken. This switch action moves an existing track to the position of the light-sensored datum instead of introducing a new track. Before initiating on MK X SIF data, the ASOper(AT) checks nearby Interceptors and other SIF tracks for tracking problems. If there is a doubt concerning whether the MK X data belong to a given track already in the system, he can take the Request SIF Display action to obtain a special SID display to determine if the data have the same code as the specified track.

The Reinitiate action is used also when no response is received within two minutes to a request for the handover of tracks being lateraltold-in for tracking. In this case, a special symbol appears on the track SID to let the ASOper(AT) know when the Reinitiate action may be taken.

The Reinitiate action may be used to begin active tracking on a Jammer track or raid. Such action should be coordinated with the ASOper(PD). Reinitiation procedures to be followed when an Active track begins jamming, and for Jammer tracks and raids, are discussed in Chapter 6, on Passive Tracking.

During periods of overload, the ASOper(AT) may be asked to assist weapons personnel in reinitiating Interceptor tracks. To ensure that action is taken on the proper uncorrelated MK X SIF data, a track SIF SID may be requested.

The Reinitiate action may not be taken on a track that has the status of Told-in when the BUIC NCC is in the Monitor mode. In the Active mode, the track must not be a Told-in track unless there has been no response to a request for handover for two minutes.

THE EXCHANGE ACTION. The Exchange action is used to exchange the track symbology of two Established tracks that have been interchanged through error. When two tracks cross or come close together, the automatic tracking program may, in error, interchange their track symbologies. The ASOper(AT) has several means for checking to see if such an error has occurred, if he did not actually observe the interchange taking place. He may compare altitudes and speeds on both tracks. He may check with the IDOper to see whether the tracks are following the proper flight plans or have the proper identities. In some cases, taking the Request SIF Display action on each track will reveal that one track is tracking with the SIF data of the other.

In taking the Exchange action, one track must be designated by track number and the other by light sensor activation. Neither track may be a Jammer track or Jammer raid nor an on-station ARP. The distance separating the two tracks must not exceed 40 nautical miles. When the Exchange action is taken, the symbologies of the two tracks are exchanged, and the track merit of each track is set to Unreliable.

THE EXTRAPOLATE ACTION. The Extrapolate action on a track causes the computer tracking program to use the current or inserted track velocity for the prediction of the track position. No attempt is made by the program to correlate the track with radar data. The Extrapolate action may be needed if the track is experiencing tracking difficulty due to excessive radar data or clutter. This action may also be needed when there is an insufficient number of radar returns from the aircraft for automatic tracking purposes, as might occur in the case of a low altitude aircraft. The Extrapolate action may be taken on any class of track except an on-station ARP or a Told-in track.

Extrapolation of the track continues until a Reinitiate action is taken on it, or until the track reaches the edge of the X1 display. The ASOper(AT) monitors an Extrapolated track and attempts to establish it again with radar data as soon as possible so that tracking can be resumed.

TRACK TERMINATION

A track displayed at the BUIC III NCC may be terminated either automatically by the computer program or manually as a result of the Drop Track action. In either event the track is dropped from the system. Tracking and telling for the track stop, and displays at the BUIC NCC are modified to reflect the drop.

MANUAL. The Drop Track action, available at all NCC consoles, results in the track specified being dropped from the system. Tracking stops, and displays on the track are no longer available. Tracks which are terminated within the NCC's area of responsibility are dropped by this action. Also, Friendly-class tracks for which available radar data are not adequate to maintain reliable tracking may be dropped manually. As the system approaches track capacity, the SD may authorize the ASOper(AT) to drop less critical Friendly tracks to make channels available for tracks of greater importance. When less than three tracking channels remain, an alarm sounds and the Approaching Channel Capacity TD is forced to a surveillance console at which action is taken to enter a non-Interceptor track. Remaining channel capacity can be determined at any time from the Operational Conditions SID (E characters), which is available to all consoles by category switch selection.

The Drop track action may not be taken on an on-station ARP or a CAT track. A CAT track is one that has been associated by the IDOper with a manual input call sign. They assist the IDOper in monitoring peacetime SAC traffic. CAT indicates call sign associated tracking. CAT tracks display a ⊐ symbol in the E1 identity character of their track symbology. Exercise tracks can only be dropped by the TgM. Otherwise, this action may be taken on any track in the system. Air surveillance personnel should not drop Interceptors or target tracks, including those for which responsibility has been transferred to another facility, without receiving authorization from weapons personnel.

AUTOMATIC. Tracks are dropped automatically under certain conditions. If a Termination message is received on a Told-in or a Manual Input track, the track is automatically dropped. If a track acquires Told-in status in a receiving BUIC NCC that performed handover, and no telling message is received for two minutes, the track is automatically dropped. All tracks (except on-station ARP and CAT tracks) that reach the edge of the X1 display area are automatically dropped. A BOMARC track is automatically dropped when the maximum flight time has elapsed. All tracks (except on-station ARP tracks) are automatically dropped when a BUIC NCC changes from Active to Monitor mode.

OPERATIONAL STATUS MONITORING

The Adjacent Division Operational Status TD, a requested display, shows the operational status of the parent DC, adjacent DCs, adjacent BUIC NCCs, and associate BUIC NCCs. Possible statuses are coded as:

A - Active

□ - No operational status message for 2 minutes

⧄ - Out of action

M - Monitor (NCCs only)

When changes occur in the operational status of these facilities, an Adjacent Division Operational Status Change TD is forced to the SD and to surveillance consoles receiving telling displays, along with an audible alarm. The receipt of this TD and the alarm serve as a signal to the operator to request the Adjacent Division Status TD to learn the location and nature of the status change. The change may have important implications for NCC transition and lateraltell and handover procedures.

If a BUIC NCC is operating in the Monitor mode and fails to receive an Operational Status message from its parent DC for approximately two minutes, an audible alarm and the Adjacent Division Operational Status Change TD are forced to ASOper(TL). When a total of four minutes go by without receipt of such a message, the Status Change TD and alarm are again forced. The Status TD, if displayed, is updated each time there is a change.

The SD also receives these forced displays and is the operator who initiates a response. If he determines that the outage is only in communication lines, he uses alternate routing. If the SD determines that the DC is disabled, he initiates procedures for transition to Active mode. Surveillance operators assist in the procedures as directed. Should the NCC receive a status message from its out-of-action parent, the Status Change TD and alarm are forced a third time and the DC's new status is shown in the Status TD.

RECORDING THE SYSTEM'S OPERATION

In the BUIC NCC, recordings may be made of system operations. These data are used for evaluating system activities and performance, for program testing, and for equipment tests. The data are automatically collected and output on magnetic tape. A processing program is then used to produce printouts of the data.

Either the RICMO/ASO or an ASOper can take the recording actions: Record On, Record Off, Record Track, and Stop Record Track. The Record Track and Stop Record Track actions may be taken by the TgM as well. Recording actions are typically assigned to ASOper(AT), under the direction of the RICMO/ASO. Recording can also be controlled by manual input card.

The Record On action is used to begin recording of a broad class of data which are specified in advance through a Recording Specification Table (RST) entered by manual inputs action. The RST is a table of programmed messages for the computer that specifies to the recording function what data are to be recorded, as well as when, and for how long the data are to be recorded. The Record Off action is used to terminate all BUIC NCC recordings. This action may be taken either upon completion of recording or to conserve cycle time during overload conditions.

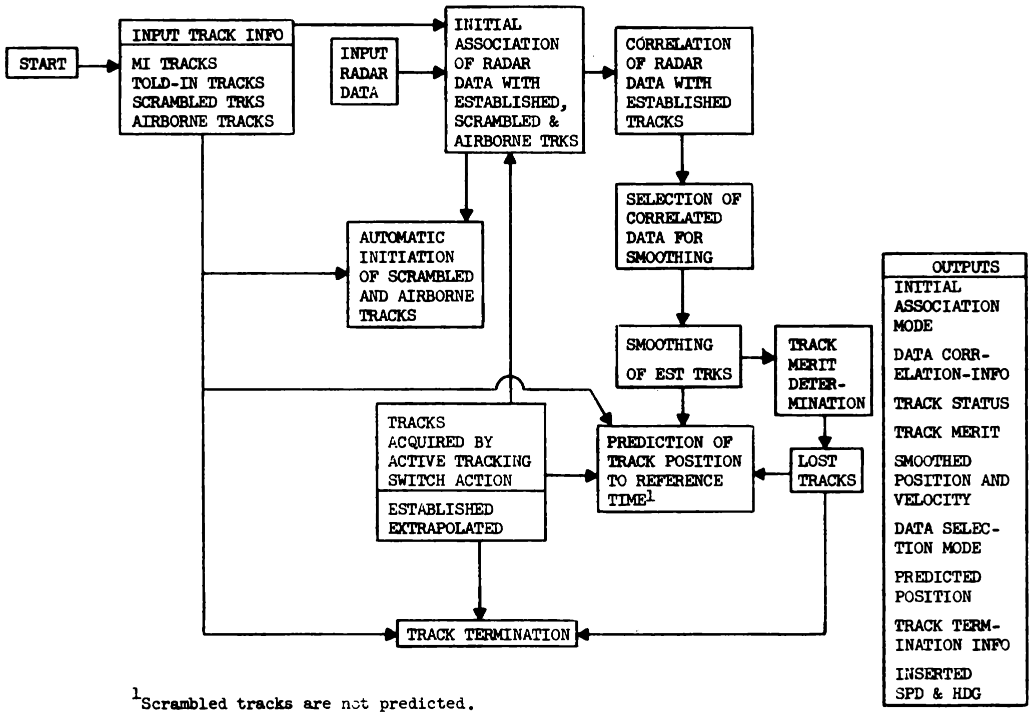
The Record Track action is taken to record the correlated radar data (search, MK X, or strobe) on a specified track. This action may be directed by the RICMO/ASO whenever needed for detailed evaluation of a specific track is anticipated. Tracks undergoing an identification intercept or experiencing an in-flight emergency are examples. The Record On action must be taken before the Record Track action. In order for the Record Track action to function properly, appropriate entries must be listed in the Recording Specification Table. This table is routinely maintained and entries are made only to change recording requirements. They do not need to be repeated prior to each recording situation. The number of tracks recorded simultaneously may not exceed 16. Track recording continues until the Stop Record Track action is taken or the track is dropped.

Air surveillance operators can determine which tracks are currently being recorded by the program through the Recorded Track List Display action. The Recorded Track List TD appears in response to this action. A list of track numbers currently being recorded, each opposite its track identity, is displayed. If no tracks are being recorded, the display reads NONE.

COORDINATION WITH OTHER PERSONNEL

ASOpers(AT) work under the direction of the RICMO/ASO, who supervises the active tracking function as a part of his general responsibility for maintaining adequate air surveillance in the assigned area of responsibility of the BUIC III NCC. The RICMO/ASO may need to coordinate with others, typically the SD, on critical active tracking decisions.

Within local guidelines for coordination, active tracking personnel should receive authorization from the SD before dropping less critical non-Interceptor tracks. They may reinitiate airborne Interceptor tracks or initiate Interceptor tracks dropped through error, only after coordination with appropriate weapons personnel. Active tracking personnel are also expected to help Weapons Team members in the coordination of track lateraltell, when called upon to do so. The RICMO/ASO or ASOpers may coordinate by phone with tracking personnel in other control facilities on problems of lateraltell and handover. Following computer recycling, tracking personnel in adjacent control facilities may assist the NCC in rebuilding the air picture by lateraltell and voice coordination.



[1]Scrambled tracks are not predicted.

UNCLASSIFIED

Functional Block Diagram for Active Tracking

Active Tracking:

RELATED MANUAL INPUTS

a) TRACK DATA message

RELATED SWITCH ACTIONS

a) AIRBORNE/AIRBORNE WITH SIF

b) ASSIGN SIF NUMBER

c) COMMAND TRACKING ON/OFF

d) EXCHANGE

e) EXTRAPOLATE

f) INITIATE

g) REINITIATE

h) ACCEPT

i) PAV/PAV OFF

RELATED DISPLAYS

a) FRIENDLY, ROUND ROBIN, SPECIAL, BEE, YOKE, ARP TRACK SID

b) HOSTILE, UNKNOWN, FAKER, PENDING TRACK SID

c) NON-INTERCEPTOR TRACK SID

d) NON-JAMMER PARTIAL: TROUBLE/MI TRACK SID

e) BACKTOLD TRACK MOVED ATTN SID

f) TRACKING TROUBLE ATTN SID

RELATED DATA LINK MESSAGES

a) TRACK

b) REQUEST TRANSFER

c) TRANSFER

d) NOTIFY TRANSFER

e) TERMINATION

NOTES

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CHAPTER 6

PASSIVE TRACKING

Passive tracking is the process of detecting and estimating the position and velocity of aircraft in an electronic countermeasures (ECM) environment of sufficient intensity to mask normal active radar returns. The passive tracking process uses the jamming energy transmitted by an aircraft to provide tracking information. The aircraft is called a jammer and its jamming energy is converted into strobe information by specially adapted equipment at the radar sites. The data are transmitted to the NCC in strobe messages which contain azimuth but no target range information. The directional information contained in a strobe message is displayed at NCC consoles as a vector originating at a radar site.

Strobes intersecting on the SID scope may be derived from a single jammer or from two separate jammers. Intersections caused by two separate jammers are called ghost intersections and the ASOper(PD)'s basic task is to distinguish these from the intersections that are valid representations of jamming aircraft locations. When the ASOper(PD) judges an intersection to be valid, he manually initiates a passive track at the intersection in a manner similar to initiation of tracks on active data. If the width of either of the intersecting strobes indicates that the jamming source represents more than one aircraft, the program automatically generates a Passive raid rather than a Passive track. Passive tracks and raids are correlated with incoming data and their positions are updated so as to provide dynamic tracking.

Passive tracks are associated with incoming passive data by means of the automatic correlation process. Data that have correlated with a track can be used to update (smooth) the position and velocity of the track. The present position and velocity are in turn used to predict the track position in time. A tracking merit score is maintained for Passive tracks by the passive tracking function, and the track merit is displayed in the SID symbology associated with the track.

An estimate of the number of aircraft represented by a Passive track, based on height-finder replies and strobe data characteristics, is also maintained by the program for display in the SID symbology associated with the track.

In order to assist the operator in identifying ghost tracks (tracks erroneously initiated on ghost intersections), the program maintains a confirmation score designed to indicate the probability that a given track is a ghost. The confirmation score is a function of height replies, track behavior, and operator judgments and is displayed in the SID symbology associated with the track. Tracks that the operator is reasonably certain are ghosts are manually dropped from the system.

The essential difference between the duties of passive tracking personnel and those of active tracking personnel is that the former deal with jammers and the latter deal with non-jammers. The capabilities of the ASOpers(AT) and ASOpers(PD) are quite similar, each operates air surveillance consoles using nearly identical switch actions and displays. Most of the activities of both may be described within the same general framework. With regard to tracking based on strobe data, passive tracking personnel are responsible for: (1) entering new Jammer tracks or raids, (2) maintaining these tracks or raids, (3) transferring information, (4) recording, and (5) terminating Jammer tracks or raids. In addition, they must maintain the quality of data inputs to the passive tracking function of the BUIC computer program through appropriate deghosting and data control techniques.

The Passive tracking function is of vital importance to system performance when ECM makes tracking based on active data difficult or impossible. In a heavy ECM environment, commitment of weapons and their successful guidance to targets may depend to a significant degree on the training and experience of passive tracking personnel. The effectiveness of the passive tracking program is directly related to the skill with which these operators perform their jobs. Because much of the material on this subject is classified, this chapter can provide only a general discussion of passive tracking.

SOURCES OF PASSIVE DATA

Passive data are obtained from an operator-controlled Semi-Automatic Threshold Control Unit (SATCU) located at each LRR. The SATCU equipment provides a display of the jamming environment at the radar site. These devices allow a SATCU operator (SATCUop) to select, by means of a controllable threshold, strobes presented on an azimuth versus amplitude display. The SATCUop manipulates a control which causes data below a certain level (threshold) to be rejected. The SATCU output, which consists of strobes accepted by the operator, is routed to the AN/FST-2 or AN/FYQ-40. The data processor determines the center azimuth and run length (width) of each strobe, automatically prepares a strobe message from this information, and then sends it over digital data link to the BUIC NCC.

PASSIVE TRACKING AT A BUIC NCC

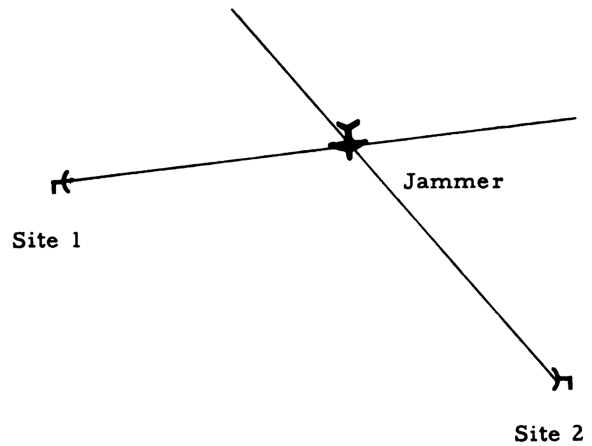
STROBE INPUTS

The passive tracking program classifies strobes as either overdense or underdense for purposes of correlation and display. A strobe that has a run length greater than a given value for the transmitting site is classified overdense. All other strobes are underdense. The exact run length used to distinguish between overdense and underdense strobes is called the strobe width criterion and is specified for each radar site. An overdense strobe is usually generated by two or more jamming aircraft at approximately the same azimuth, while an underdense strobe is probably from a single jamming aircraft.

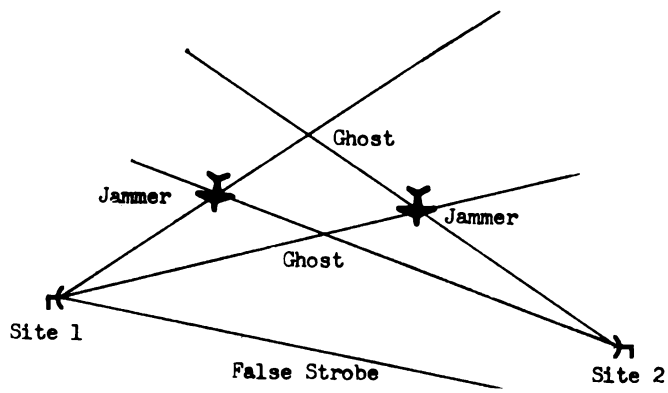
The NCC strobe display consists of four expandable vectors emanating from an LRR site. Overdense strobes are distinguished from underdense strobes by a gap between vectors on the overdense strobes. If a strobe is correlated with a Passive track or raid, it flashes off and on. Uncorrelated strobes remain steady. The following table summarizes the coding used:

	UNDERDENSE	OVERDENSE
UNCORRELATED	No Gaps/Continuous	Gaps/Continuous
CORRELATED	No Gaps/Flashing	Gaps/Flashing

At the BUIC NCC, strobe data are displayed on the SID scope as strobes radiating from the radar site. When strobe data are received from two sites on the same jamming aircraft, the intersection of the two strobes indicates the possible location of the jammer as illustrated. (The aircraft symbol is included in these illustrations for clarity; it is not displayed on the SID.)



However, when there are two or more jamming aircraft in the system, not all strobe intersections actually represent locations of jammers. One strobe may be from one aircraft and the other from a second aircraft. The intersections of the strobes in such cases are called ghosts. Should the SATCUop incorrectly distinguish the azimuth at which a jammer is located, a false strobe will result. The illustration below shows an example of valid and ghost intersections and a false strobe.



MEANING OF ACTIVE, PASSIVE AND JAMMER TERMS

Since the terms active, passive, and jammer are frequently used in describing passive tracking, it is important that the ASOper(PD) have a clear understanding of their meanings in regard to track classification. Passive tracks and raids like Active tracks are, by definition, tracks/raids having a status of Established. A track/raid becomes Established as a result of the Initiation, Reinitiation, or Accept Handover actions. In Monitor mode, a backtold track/ raid is assigned Established status by an Accept action. The program classifies all Established tracks as either Active or Passive in order to determine which type of radar data (active or passive) is to be given preference for tracking. Concurrent with the classifications Active and Passive, all tracks regardless of status, are also classified as either Jammer or non-Jammer; terms which denote whether a track has shown a capability to jam system radars.

A track is classified as Active when initiated or reinitiated on active data, or when smoothed on active data as a result of the active/passive data selection logic. Established BOMARC tracks are also classified as Active tracks. (A told-in track that is placed in Established status as a result of handover becomes an Active track in the receiving NCC if it is an Active track in the sending facility. Since correlation is not attempted for tracks that have a status other than Established, the term Active is not relevant to non-Established tracks.)

A track is classified as Passive when initiated or reinitiated on passive data. If both strobes are underdense, initiation or reinitiation results in a Passive track; if one or both of the strobes is overdense, a Passive raid results. A track is also classified as Passive when smoothed, as a result of the active/passive data selection logic, on passive data. (A told-in track that is placed in Established status as a result of handover becomes a Passive track or a Passive raid in the receiving NCC if it is a Passive track or a Passive raid in the sending facility. Since correlation is not attempted for tracks that have a status other than Established, the term Passive is not relevant to non-Established tracks.) Reinitiation of Interceptors, ARPs, and Exercise tracks on strobe data is illegal, and no attempt is made to correlate these tracks with strobe data; consequently, Interceptors, ARPs, and Exercise tracks are never Passive.

A track or raid is automatically classified as a Jammer when it becomes Passive, and a Manual Inputs track may be manually classified as a Jammer by the sender. The Jammer retains its Jammer classification until dropped from the system. Established Jammers may be either Active tracks or Passive tracks or raids depending on the type of data used for smoothing purposes. However, since the terms Passive and Active apply only to Established tracks, and the term Jammer is independent of track status, a Jammer track or raid need be neither Active nor Passive. The E3 character in the Jammer SID symbology indicates whether the Jammer is Passive, Active, or neither (a non-Established Jammer track would be neither). An R or a Possible Track indicator is displayed for Jammer raids. Interceptors, ARPs and Exercise tracks are never Passive and therefore never Jammers.

DEGHOSTING AND INITIATION/REINITIATION

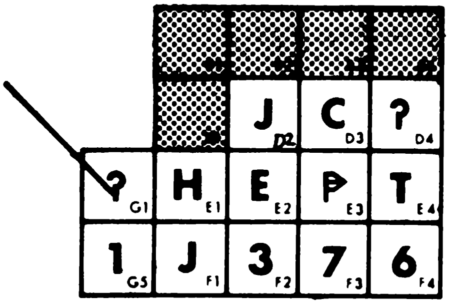
Passive tracking operations at the NCC commence upon receipt of the first strobe message displayed on the SID scope. Intersections formed by this and subsequent strobes are deghosted by the ASOper(PD) and Passive tracks and raids are initiated, or Active tracks reinitiated at those intersections judged valid. As soon as a Passive track or raid is initiated, or an Active track is reinitiated on passive data, or a track automatically transitions to a Passive track, automatic passive tracking begins.

One of the primary responsibilities of the ASOper(PD) is to study the strobe intersections on his SID scope and attempt to distinguish those which probably represent the location of a Jammer from those which are ghosts. Deghosting is a difficult task if there are many aircraft jamming a number of radars. On strobes forming an intersection which he believes to be the location of a jammer and not a ghost, the ASOper(PD) takes the Initiate (or Reinitiate) Jammer Track or Raid action. The initiation procedure includes light sensoring each of the two strobes (not their intersection) and inserting an estimated speed and heading. The reinitiation procedure includes speed/heading only as an option.

The ASOper(PD) initiates a Passive track or raid by taking an initiate action; he modifies a Passive track or raid through a reinitiate action. If initiate (or reinitiate) action is taken on two underdense strobes, a Passive track is initiated (or reinitiated) at the strobe intersection. If one or both of the strobes is overdense, a Passive raid is initiated (or reinitiated) at the intersection. Speed and heading must be assigned for initiation; they may be assigned when reinitiating.

TRACK MONITORING

The ASOper(PD) monitors tracking of jammer tracks and raids in order to avoid or resolve tracking difficulties which arise from crossing or splitting tracks and raids, poor data quality, and numerous other circumstances that may require operator intervention. The ASOper(PD)'s monitoring activities include: reinitiating Passive tracks and raids that have deviated excessively from their data-indicated positions; reinitiating raids that are consistently correlating with underdense strobe data; temporarily restricting Passive tracks from selection of active data when the operator believes that such data do not represent returns from the jamming aircraft; extrapolating tracks and raids through regions in which radar data have become too poor or ambiguous for adequate automatic tracking; reinitiating split Passive tracks and raids; and dropping tracks and raids that are lost or suspected as ghosts.



Jammer Track SID

J376 is a confirmed (D3) Jammer track (D2), altitude is unknown (D4), flight size is unknown (G1), identified Hostile (E1), Established status and Reliable merit (E2), restricted by ASOper(PD) to tracking on passivd data only (E3), told out for tracking (E4), and assigned to WE 1 (G5).

FLIGHT SIZE AND MINIMUM RAID SIZE. The number of aircraft comprising a Jammer track is determined on the basis of flight size information received from the height finder radars. When available, flight size is displayed in the G1 character of track symbology. For flight size greater than 5, a (») is displayed. If no flight size is available, a ? is displayed. For a Jammer raid, the program estimates the minimum number of aircraft comprising the raid on the basis of flight size information and strobe run length. This estimation is called minimum raid size (MRS) and is displayed in the G1 character of the Jammer raid symbology. MRS is displayed as 2, 3, 4, 5, or greater than 5 (2-5 or »).

CONFIRMATION SCORE. When a track or raid is classified as Passive as a result of initiation or reinitiation on passive data, or as a result of automatic transition to passive tracking, the maintenance of a confirmation score is begun for the track/raid. This score serves as a deghosting aid to the operator in that it provides a visual indication of whether the track/raid has been confirmed as a probable non-ghost, is suspected as a probable ghost, or has not been identified with any degree of certainty as either. The values of the score are thus Confirmed, Suspected Ghost, and Tentative. These values may vary either automatically (as a function of track status change, speed variations, or merit change), or manually as a function of operator switch action.

In the case of manual actions, the ASOper(PD) may take either the Score Confirm action or the Score Suspected Ghost action. The Score Confirm action is used to set the confirmation score of a designated Jammer track or raid to Confirmed when the operator has reason for believing that this score is justified. The Score Suspected Ghost action is used to set the confirmation score of a designated Jammer track or raid to Suspected Ghost, when the operator believes this score is appropriate. For either type of action, the designated track must not be tracking on active data.

The Confirmation Indicator is displayed in the D3 character of a Hostile-class track SID. The letters C, G, and T, which may appear there, stand for Confirmed, Suspected Ghost, and Tentative, respectively. A non-alphabetical symbol displayed there means that the specified type of track (C, G, or T) is one of two or more passive tracks that is eligible for smoothing on the same strobe. Such a display is intended to call the operator's attention to a situation in which two tracks are correlating with the same strobe, a situation which often occurs when one of the tracks is a ghost. No symbol appears in the Confirmation Indicator character if the track is an Active track. The confirmation score continues to be maintained and displayed for the track/raid until the track/raid is dropped from the system or is reclassified as an Active track. The Confirmation Indicator symbols which can appear in the D3 character are as follows:

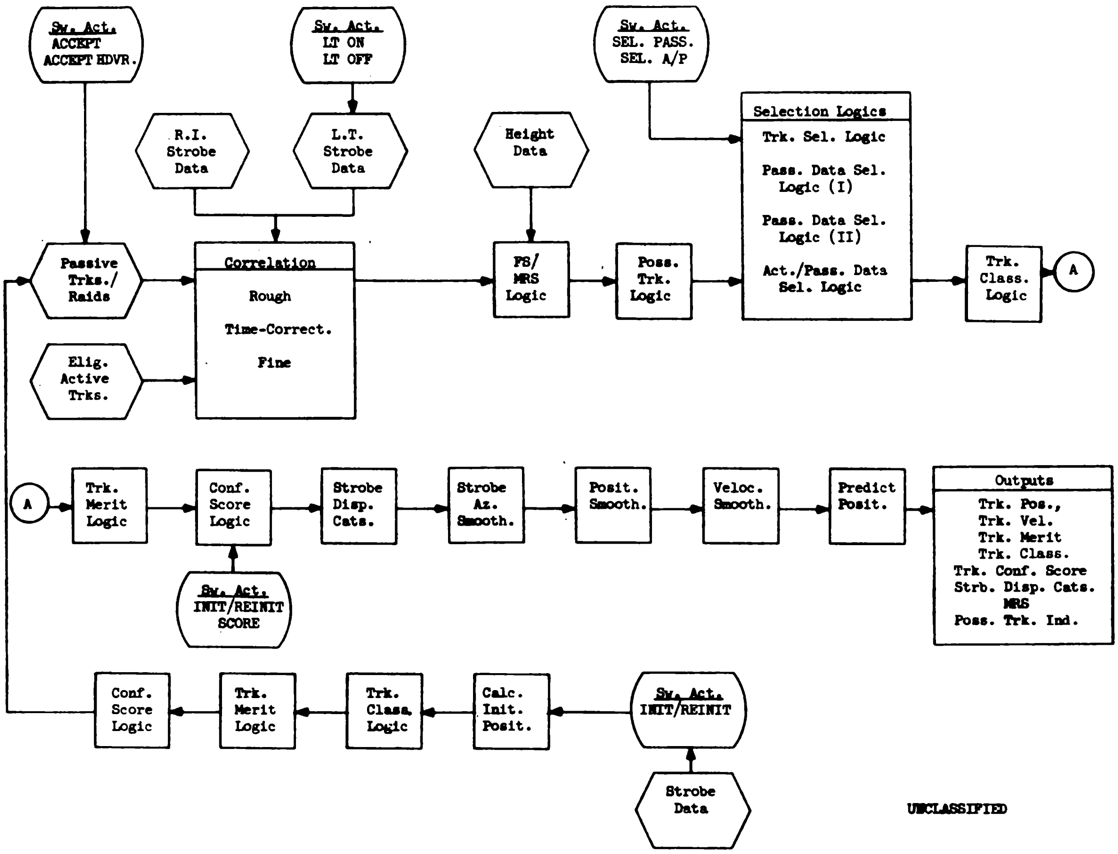
- **C** - Confirmed
- **≡** - Confirmed when track is one of two or more Passive tracks eligible for smoothing on the same strobe.
- **T** - Tentative
- **=** - Tentative when track is one of two or more Passive tracks eligible for smoothing on the same strobe.
- **G** - Suspected ghost
- **—** - Suspected ghost when track is one of two or more Passive tracks eligible for smoothing on the same strobe.
- Blank - Active track

POSSIBLE JAMMER TRACK. The program alerts the operator to the possibility that an apparent Jammer raid should, in actuality, be a Passive track. This would occur, for example, if the raid was initiated using an overdense strobe arising from the merging of underdense strobes. When the program detects that a Passive raid has correlated with underdense strobes in three out of four consecutive bi-cycles, a Possible Jammer track symbol (◇) appears in the D2 character of the SID symbology associated with the raid. Its purpose is to alert the operator to the fact that he should consider reinitiating a Passive track on the raid. The possible track indicator is cleared when no underdense double-strobe data have correlated with the raid in two of four consecutive bi-cycles.

LATERALTELL OF STROBES AND PASSIVE TRACKS. Automatic lateraltell of strobes is accomplished by the program in order to provide strobe intersections in areas where an NCC's internal radar coverage is insufficient to provide such intersections for initiation and tracking. Passive tracking personnel at each BUIC NCC can designate in advance the selected radar sites from which lateraltell strobe data are to originate, plus the azimuth wedges around a site within which strobes may be told, and the BUIC NCC which is to receive the strobe lateraltell. The ASOper(PD) coordinates with his counterparts at adjacent NCCs on this subject, so as to select the azimuth wedges for each site for which strobes are to be lateral-told. This coordination should take place before the NCCs enter Active mode, while there is still time for adequate planning. The ASOper(PD) at an NCC receiving lateraltell strobes can choose whether or not his facility uses the told-in strobe messages, through the Strobe Lateraltell On (or Off) action. The Strobe Lateraltell On action enables the NCC to process strobes lateraltold-in from a designated external radar site (not tied to the NCC) or a designated BUIC NCC. The Strobe Lateraltell Off action prevents such processing. The LRR and GAT Site-Internal, and LRR Site-External SIDs for the affected radar sites reflect whether or not strobes are being lateraltold and accepted, respectively.

In addition to strobe lateraltell, the ASOper(PD) also assumes responsibility for lateraltell and handover of Jammer tracks and raids. These actions are identical with those described for the lateraltell and handover of Active tracks, as described in the preceding chapter.

TRACKING DATA CONTROL. Should the ASOper(PD) believe that the program's use of active data for smoothing a particular Jammer track is not desirable, he can prevent the use of such data for smoothing by taking a Select Passive Only action. The ASOper(PD) takes this action when he believes that the active data do not represent actual returns from the jamming aircraft. While this restriction is in effect, a passive-only indicator (Ᵽ) appears in the E3 character of the Jammer track symbology. To reverse the effects of the Select Passive Only switch action and allow the selection of active data for smoothing the Jammer track, he takes the Select Active/Passive switch action. As a result, the passive-only indicator in the track symbology is cleared.



Functional Block Diagram for Passive Tracking

Passive Detection:

RELATED MANUAL INPUTS

a) LATERALTELL SELECTION FOR STROBE message

RELATED SWITCH ACTIONS

a) INITIATE JAMMER TRACK OR RAID

b) REINITIATE JAMMER TRACK OR RAID

c) SCORE CONFIRM

d) SCORE SUSPECTED GHOST

e) SELECT ACTIVE/PASSIVE

f) SELECT PASSIVE ONLY

g) STROBE LATERALTELL ON/OFF

RELATED DISPLAYS

a) STROBE DISPLAY SID

RELATED DATA LINK MESSAGES

a) STROBE

NOTES

CHAPTER 7

HEIGHT

The height function provides the BUIC system with altitude, flight size, and interference information (e.g., presence of jamming, chaff, or clutter) on aircraft being tracked by the NCC. Knowledge of the altitude and number of targets is necessary to weapons personnel in allocating weapons and conducting intercepts. Similarly, the identification of a track is frequently aided by the knowledge of the track's altitude. In an ECM environment, height is useful to passive tracking in deghosting. Active tracking is also assisted by this additional information which, in effect, changes the two-dimensional air picture based on track position and velocity to the more complex three-dimensional one that includes altitude.

The height function is normally controlled by one of the ASOpers at the BUIC NCC, although the RICMO/ASO can assume this responsibility himself. Any operator who is receiving the forced displays associated with the height function, as the result of a manual inputs console assignment message, has the letters (HT) after his job title. The Height Range Indicator Operators (HRIOps) at LRRs report to the ASOper(HT) when the NCC is in Active mode. There are two HRIOps at each of the Long-Range Radar (LRR) sites under the NCC's control, one for each height finder (HF). There is only one height operator on each ARP.

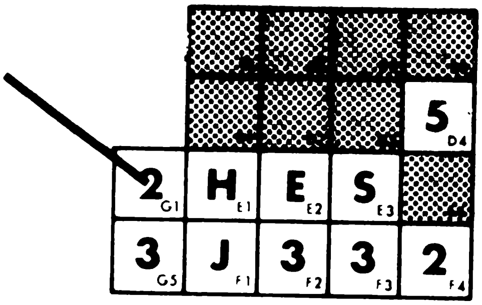
Height and flight size information is obtained primarily from land-based LRR and Airborne Radar Platform (ARP) height finders, but some data may also originate in reports from Interceptors or Friendly class aircraft. The land-based sites, which include ground receiving stations serving as ARP HF relay stations, transmit height data in either digital or voice form to the NCC via telephone lines. The ground receiving stations communicate with the ARPS by voice radio.

In order to obtain coverage in every direction, the land-based sites have two HFs (always referred to as A and B). The nearby surveillance antenna and other obstructions in the area block an HF's antenna so that it cannot transmit signals in these directions. Therefore, the HFs are so located relative to each other that one can transmit in the azimuths in which the other cannot. Any segment of azimuth in which a HF cannot transmit signals is called a shadow area. The shadow areas are defined for each HF in the BUIC computer program so that no request to obtain the height of a target within its shadow area is ever directed to an HF.

Request for height measurement of a track may be initiated automatically by the program or manually by ASOper or RICMO/ASO action. The sequence and frequency of obtaining height and flight size on selected tracks are determined by a priority scheme based on a track's importance. Frequency of request is further regulated by time delays so as to prevent system overloading. Requests are assigned to HFs on the basis of range and coverage criteria to ensure that the selected HF will be able to see the target.

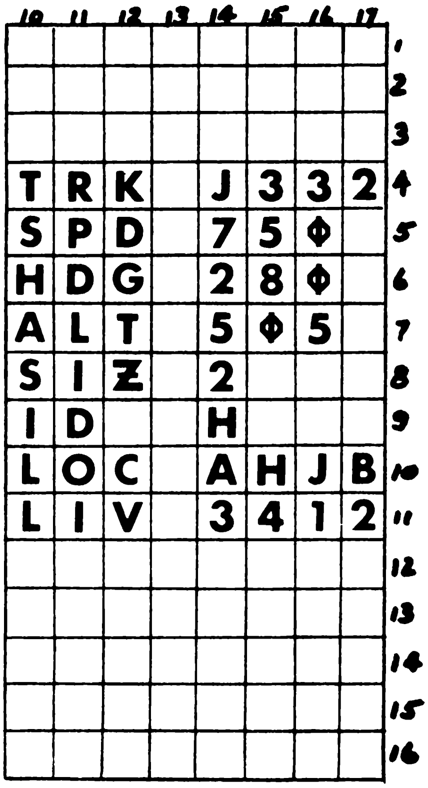
When a height request on a track is made up by the program, the information needed to locate the track is transmitted to the selected HF by voice communication or automatically via data link. The height and flight size of the track are determined by the operator at the radar site and the reply information is transmitted to the NCC. The reply is transmitted in the same manner as the request was received, and upon receipt at the NCC is either automatically or manually entered into the program for processing.

Once processed by the program, basic monitoring information for height and flight size is displayed to console operators in Track SIDs and Track TDs. The two illustrations below present an example of each type of display for J332, a Hostile track.



Non-Interceptor Track SID

Altitude of J332 is 50,000 ft (D4); flight size is 2 (G1). (Altitude is shown to the nearest 10,000 ft.)



Non-Interceptor Track TD

50,500 ft altitude is shown on line 7. Line 8 indicates a flight size of 2.

In the Active mode both live and simulated tracks are processed by the height function. Only simulated tracks are processed in the Monitor mode. Height data on live tracks in the Monitor mode are obtained from the parent DC, because an HF can input data to only one control facility at a time. In Monitor mode, the SAGE DC is the control facility; it makes all height requests to and receives all height replies from, LRRs and ARPs.

In the Active mode, a BUIC NCC can process a track message lateraltold-in for exchange purposes that includes a request for altitude on a track. If the receiving NCC is able to determine the altitude, it transmits this information automatically to the sender, where the new altitude is displayed. The altitude is also displayed at the NCC receiving the tell as long as the track is being lateraltold. Lateraltold height requests can result from ASOper switch action or program action, when it is necessary to obtain height and flight size information from an HF at an associate BUIC NCC.

HEIGHT REQUESTS

AUTOMATIC REQUESTS

In each bi-cycle, the tracks are selected for which automatic height request are to be attempted. Their selection is based on eligibility restrictions, priority requirements, and selection frequency limits. The eligibility restrictions limit the selection of tracks to those for which height measurement is allowed. BOMARC and Exercise tracks, for instance, do not undergo height measurement.

The priority requirements ensure that the most important tracks are processed first. Those tracks that are the subject of a WD Differential Altitude request are given a higher priority than newly initiated tracks, for example, because they involve a target intercept. In this way, height requests are attempted by priority with additional consideration given to those tracks that have gone the longest time since their last height measurement.

Finally, the selection frequency-limits control the frequency of measurement of tracks to lessen the possibility of overloading the height system. The frequency of height measurement of a track varies depending upon the importance of the track. Depending on its priority, a time delay of from 0 to 20 cycles is imposed between a positive reply and the next automatic height request on a given track.

OPERATOR REQUESTS

In addition to program-initiated height requests, there are three types of height requests which originate with console operators when a special situation arises which the automatic height function fails to cover. These are radar height requests, lateraltold height requests, and differential altitude requests.

1. A RADAR HEIGHT REQUEST is initiated by the RICMO/ASO or ASOper Radar Height Request switch action. It is a request for both height and flight size information on a track specified by the surveillance operator. The operator may also specify the HF (A or B) and/or LRR site to which the request is to be sent. The results of the Radar Height Request are reflected in the Height Request Feedback TD, presented to the requesting ASOper. If the operator has specified an HF which is not eligible for the request (due to shadow area restrictions, for example), the request is not transmitted, and the reason for its denial is shown in the Height Request Feedback TD, accompanied by an audible alarm. Example 1 on the following page illustrates this situation.

For requests which are legal, the word TRANS appears in the feedback display while the request is being processed. When a height reply to a Radar Height Request is received, the feedback display differs somewhat depending on whether the reply is positive or negative and whether it is from a Standby or non-Standby mode HF. Example 2-5 below illustrates a Height Request Feedback TD as it might appear under these various conditions:

Height Request Feedback TD

Example 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	1
H	T		R	E	Q		J	3	3	2							2
S	H	A	D	O	W			h									3
																	4

ASOper Radar Height Request on track J332 cannot be transmitted because track is in shadow area of HF.

Example 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	1
H	T		R	E	Q		J	3	3	2							2
T	R	A	N	S				h									3
																	4

Height request on J332 is being transmitted.

Example 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	1
H	T		R	E	Q		J	3	3	2			4	9	Φ		2
								h									3
																	4

New height for J332 is 49,000 ft. (Positive reply from non-Standby HF.)

Example 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	1
H	T		R	E	Q		J	3	3	2			4	9	Φ		2
								h		S	A		3	5	5		3
																	4

New height for J332 is 49,000 ft. Display of old height (35,500 ft.) indicates HF A at site S is in Standby mode.

Example 5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	1
H	T		R	E	Q		J	3	3	2							2
N	E	G		R	E	P		h									3
																	4

Negative height reply received on J332.

A number of situations can lead to an ASOper needing to take a radar height request action. Height information is not updated automatically more often than once every 1-1/2 to 3 minutes for the majority of system tracks, and an NCC operator may wish to obtain more current data on a track. An operator believing that current altitude on a track is incorrect, therefore, may request a new reading. During ECM operations, the ASOper(PD) may request a height measurement as an aid to deghosting. Height system accuracy checks are conducted by taking measurements on a known altitude track.

2. A LATERALTOLD HEIGHT REQUEST is a request for height measurement of a track by an associate BUIC NCC. The track is specified by the ASOper in the request initiated by the Lateraltold Height Request switch action. The request is commonly taken when height information on a track is required but the ASOper believes the track to be out of coverage of his assigned HFs and in view of the HFs of the BUIC NCC receiving the request. The request initiates automatic exchange of information between the NCCs until a reply is received.

3. A DIFFERENTIAL ALTITUDE REQUEST is a request for the altitude difference between a manned interceptor and its target, measured consecutively by the same HF. The request is initiated by a Weapons Director (WD) Differential Altitude switch action, which may be taken when a manned Interceptor is assigned to him. Reply information is displayed to the WD in an Interceptor Attention display.

HEIGHT FINDER OPERATING MODES

Individual HFs may be designated by the ASOper(HT0 at the NCC as operating in one of the Semi-automatic modes or in the Manual mode. The selection of HF operating mode is based largely on the operating condition of the system data link, including the AN/FST-2. In the Semi-automatic modes (Normal, Standby, and Override), height requests and replies are transmitted over digital data link, including the AN/FST-2 or AN/FYQ-40. In the Semi-automatic modes (Normal, Standby, and Override), height requests and replies are transmitted over digital data link from the BUIC NCC to the LRR site. In the Manual mode, height requests and replies are made by operators at the NCC and LRR sites, respectively, using voice telephone lines. An ARP HF operates only in the Manual mode. Since operations are slower and less efficient in the Manual mode, it serves as a backup to the Semi-automatic modes in case of a breakdown of digital data link between the NCC and LRR.

The Height Status TD, an always present display for the ASOper(HT), indicates the current operational mode of all of the NCC's height finders plus the cause of any operating difficulty associated with height replies. The latter are called Reply Trouble Indicators and are used by the ASOper(HT) in diagnosing the reason for possible operator or equipment problems that may degrade the height function. The illustration below shows an example of a Height Status TD as it might appear in an Active mode NCC.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																	6
																	7
																	8
																	9
H	E	I	G	H	T		S	T	A	T	U	S					10
	S	I	T	E			P	Q	R	S	T	U	V	W	X	Y	11
		H	F	A			A	A	A	A	A	A	A	M	M	A	12
							6	8	9	9	5	7	9	8	6	7	13
																	14
		H	F	B			A	A	A	A	A	A				A	15
							4	3	6	9	9	9	8			9	16

Height Status TD

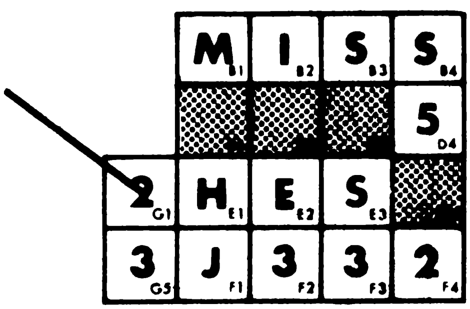
Lines 12 and 15 show all HF operating in Normal mode except radar sites W and X (ARPs). Lines 13 and 16 indicate the number of positive height replies from each Semi-automatic HF in the last 9 requests.

In the semi-automatic modes of operation, the NCC and LRR site use ground-to-ground data link for information transfer. Requests for height information are automatically sent by the computer program to the AN/FST-2 or AN/FYQ-40 at the LRR site. The receipt of a new request transmitted by the program to the HF triggers the reply to the previous request.

The request message contains the necessary information to automatically position the HF antenna to the expected azimuth of the target, and sets the range and elevation lines on the HRIOp's scope to the predicted location of the target. The HRIOp then makes any antenna azimuth adjustment (called slewing) that is necessary, manually centers the elevation line over the target blip, and indicates the completion of this operation by pushing a read-in button. The read-in action encodes the height reply. To transmit a flight size greater than one, the HRIOp also pushes a button that automatically encodes the larger flight size into the reply message. The HRIOp can enter information about the presence of jamming and weather or ground clutter by pushing one of the Interference Indication buttons.

The time allowed for a reply from an HF is controlled by the computer program. The HRIOp must reply within approximately three to eight cycles depending on the type of request. He is informed of the request type by the lighting of indicator lights on his console when the request is received. If the HRIOp makes no response within the allotted time, a Negative reply is transmitted to the NCC. A Negative reply is one that contains a zero height. There are three types of Negative replies: Operator, Interference, and System.

An Operator Negative reply is one that is caused by the HRIOp's failure to make any reaponse to a height request. An Interference Negative reply indicates that zero height is transmitted by the HRIOp due to the presence of frequency jamming, chaff, weather clutter, or ground clutter. Finally, a System Negative reply is transmitted automatically when a slewing bit is set which indicates that the HRIOp searched for the target (by slewing the antenna) but was unable to find it. Since failure to obtain height information is of prime concern to the ASOper, the program forces a Missing Track situation attention display to him when two consecutive, non-Operator Negative replies are received to a height request. The Missing Track attention display consists of the word MISS in the B1-B4 characters of the associated track display as illustrated.



Missing Track Attention Display

Top row indicates that two consecutive, non-operator negative replies have been received to a height request on J332.

The display continues until a positive height reply for the track is received or until the operator takes an Acknowledge Missing Track Alarm switch action.

The selection of a semi-automatic mode of HF operation is dependent on the presence of operational difficulties in receiving correct replies from each HF.

NORMAL MODE. The ASOper(HT) selects the Normal mode of HF operations by means of the Normal Mode Assignment switch action. This is the operating mode used for a properly functioning, ground-based HF. In this mode all types of automatic and operator height requests may be sent to the HF and normal reply processing occurs, including automatic programming to the Standby mode.

STANDBY MODE. Although the Standby mode can be selected manually by the ASOper(HT) through his Standby Mode Assignment switch action, an HF is normally put in Standby mode by automatic choice of the computer program. Both the Standby and Override modes offer the ASOper(HT) a way to maintain semi-automatic operation for an HF experiencing difficulties, instead of reverting to manual operation.

During operation of the height function, the computer program continually monitors and evaluates the replies, or lack of replies to height requests from HFs in the Semi-automatic modes. The purpose of this monitoring is to detect errors or failures associated with individual HFs. When an HF in Normal mode shows evidence of operational difficulty caused by either the equipment or the operator, the computer program may automatically place the HF in the Standby mode. In this mode, the program does not automatically request height and flight size information from the malfunctioning HF. The only requests possible are Dummy requests and those made by the ASOper in a Radar Height request switch action. Dummy requests are those automatically sent to an HF operating in one of the Semi-automatic modes to trigger the reply to a previous request when no other request is available. The HRIOp does not take any action on Dummy requests.

Furthermore, if the HF is operating in Standby mode because of operator switch action, or equipment malfunction, a positive height reply to a Radar Height request to the HF is not directly used by the program. Instead, the new altitude is displayed (above the old altitude) in the Height Request Feedback TD. If the ASOper desires to use the newer figure, he enters it into the program through the Insert Height and/or Flight Size action. If subsequent monitoring by the program indicates that the trouble is no longer present, the HF is automatically put back into Normal mode. If the Standby mode was selected by switch action, it must be changed by switch action.

OVERRIDE MODE. The override mode is selected manually by the Override Mode Assignment switch action available to the ASOper(HT). This mode is used primarily to make an HF available for normal program operation after it has been placed in the Standby mode by computer action. The ASOper(HT) also takes this switch action when equipment failures are occurring that intermittently cause the HF to automatically switch between the Normal and Standby modes. An HF in Override mode is eligible to receive all types of height requests (except lateraltold-in) that it would in the Normal mode, and the height reply information is used even though the HF may be returning inaccurate replies. The HF mode of operation is not switched automatically from Override to Standby as the result of any further operational failures, but any such failures continue to be displayed in the Height Status TD. The HF can only be taken out of the Override mode by ASOper(HT) switch action.

MANUAL MODE

The Manual mode provides a backup mode in the event of data link malfunction of an HF operating in the Semi-automatic modes, or if longer HRIOp reply times are required when an HF is assisting in deghosting during passive tracking operations. In the Manual mode the BUIC

NCC and the HF exchange information via voice communications. Therefore, the Manual mode is the only one available for ARP HF operation. To initiate operation of an HF in this mode, the ASOper(HT) takes the Manual Mode Assignment switch action. He can take the HF out of the Manual mode by taking any other mode assignment switch action.

Requests intended for Manual mode HFs are generated either automatically by the program or manually, through the Radar Height Request switch action. In either event, the Manual Height Request TD is forced to the requesting console when height information is required, provided that this console has been designated through manual inputs as a height console. (If the height request is initiated by the program or by switch action taken at a non-height designated console, the Manual Height Request TD is forced to the first ASOper(HT) encountered by the program.) The ASOper(HT) uses this TD in his telephone request to the height operator. The TD contains information similar to that transmitted to the LRR site by the program in the Normal mode. The diagram below contains an example of a Manual Height Request TD.

	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4	H	T		R	E	Q	U	B		
5	T	R	K	J	3	3	2			
6	B	N	G	1	8	6	5			
7	R	N	G	1	6	6				
8										
9	H	T		3	8	5				
10										
11										

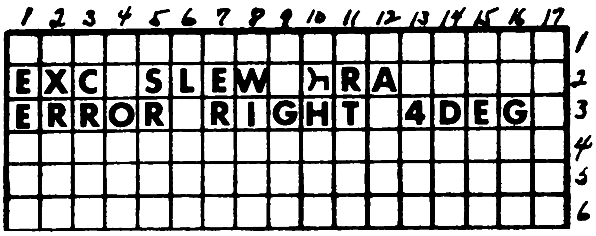
Manual Height Request TD

Height information requested on track J332 from HF B at LRR site U. Bearing from site U is 186.5 deg., range 166 n.m., old height 38,500 ft.

When this display if forced to the ASOper(HT), he calls the appropriate HRIOp (or ARP height operator) and reads the azimuth, range, and old height information from the TD to him. The HRIOp in turn takes the necessary action to slew the HF antenna to the reported azimuth of the target. He locates the target on the RHI and measures the altitude. He then verbally makes a height reply to the ASOper(HT) giving the new height and flight size. The ASOper(HT) enters the new information into the program by taking an Insert Height and/or Flight Size switch action. The program updates height and flight size on the track based on the information received and clears the Manual Height Request TD when the ASOper(HT) inserts the new information, or within a fixed time limit. The time allotted for a reply varies from 6 to 8 cycles, depending on the type of request. If the display is cleared because the allotted time has elapsed, a System Negative reply results, indicating that the operator searched for the target but was unable to find it.

OFF MODE

In the Off mode, a HF is not available for operation to the height function. Normally, a HF is put in Off mode through ASOper(HT) switch action. However, if the program detects that the HF has a slewing error of five degrees, the HF is automatically programmed to the Off mode and a P (Programmed Off) is displayed in the Height Status TD. The program corrects for slewing errors in one degree increments. An error of three, four, or five degrees causes the HF Slewing Error Alarm TD to be forced to the ASOper(HT). The ASOper(HT) should inform maintenance personnel of consistent or excessive slewing errors.



HF Slewing Error Alarm TD

HF A at LRR site R has an excessive slewing error to the right of 4 degrees.

TROUBLE INDICATORS

The Height Status TD displays a series of indicators to give the ASOper(HT) diagnostic information on operating difficulties which may affect height replies. Understanding these Reply Trouble Indicators can tell the ASOper(HT) a great deal about an HF's operation. These indicators are of five types: interference negative, system negative, operator negative, aborted reply, and bit failure.

INTERFERENCE NEGATIVE INDICATORS

When the HRIOp pushes one of the Interference Indicator buttons on his message panel to show that the target of a height request is obscured by some form of external interference, this information is transmitted to the NCC along with the height reply. As a result, one of four possible interference negative indicators appears in the Height Status TD under the appropriate LRR site designator. The four TD indicators and their meanings are: (W) Weather, (J) Jamming, (C) Chaff, and (G) Ground Clutter.

SYSTEM NEGATIVE INDICATORS

In the event that the HRIOp is unable to find the target, even after searching for it by varying the azimuth setting of the HF antenna, a negative height reply is transmitted to the NCC and one of two possible system negative indicators is presented in the Height Status TD. If the track is reinitiated while the request is at the HF, or if it is being extrapolated, the NCC computer program considers that the negative reply is caused by tracking difficulty and displays a (T) as the Height Status TD trouble indicator. On the other hand, if neither of those conditions is present, a No-Excuse (N) System Negative indicator appears.

OPERATOR NEGATIVE INDICATOR

When a zero reply is received, and the HRIOp has not indicated the presence of interference nor made any changes in HF azimuth setting, an operator negative indicator (P) appears in the Height Status TD.

ABORTED REPLY INDICATORS

Aborted replies are height reply error conditions caused by equipment malfunction or other unusual situations. They can occur only for HFs operating in the Semi-automatic modes. There are four types of aborted replies; their definitions and Reply Trouble Indicator symbols which are displayed for two cycles, are as follows:

1. LOST MESSAGE (L) - This reply condition exists whenever the NCC computer fails to receive any reply from the LRR before the established time limit expires.

2. REQUEST NUMBER MISMATCH (R) - When the reply number does not match the computer's request number, a mismatch occurs. This situation can arise from equipment failure, incorrect assumption that the NCC has control of the HF rather than the parent DC, or when the previous reply was a Lost Message.

3. UNASSOCIATED REPLY - Should a reply be received when there is no record of a request being sent, the program labels this an Unassociated Reply and takes no action on it. This situation occurs if the track is dropped while the request is at the HF. No Reply Trouble Indicator appears for this type of reply.

4. EXTRANEOUS REPLY (X) - An Extraneous Reply indicator appears when several replies are received from one HF during a single reply period.

BIT FAILURE INDICATORS

The computer program uses a special form of height reply processing to periodically check for equipment malfunctions and transmission continuity for HFs operating in the Semi-automatic modes. In addition to triggering the reply to a previous height request, a Dummy request also can initiate an automatic check of equipment and the data link loop between the NCC and LRR. This special check is made whenever there is no previous height reply to be triggered by a Dummy request. It is made by comparing bit values actually received in the reply message (called a No-Action reply) with the expected bits. By comparing the values transmitted with those received, it is possible to determine whether certain bits are being incorrectly obtained or dropped in the process. For example, a stuck button on the HRIOp console can be identified automatically in this manner. When errors of this type are found by the program, a normal mode HF is automatically placed in Standby mode and an alarm is given to the ASOper(HT) in conjunction with the Height Status TD. Replies are also checked to determine if HFs operating in Standby mode because of equipment malfunction can be automatically returned to the Normal mode.

In summary, Bit Failure Indicators identify the portion of a height reply message containing a bit which is incorrectly dropped or added. The ASOper(HT) should report bit failures to LRR maintenance personnel to aid them in locating the equipment trouble. Bit Failure Indicators are displayed as follows in the Height Status TD:

1. Height (H)

2. Flight Size (F)

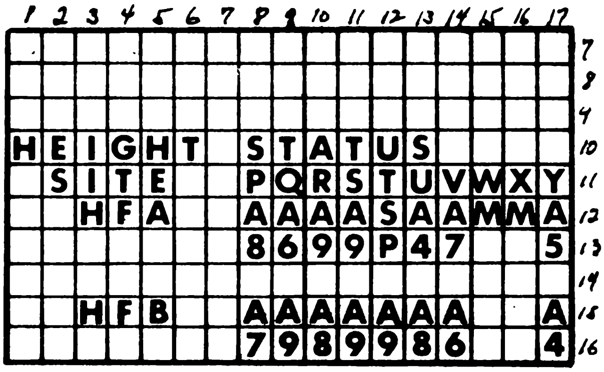
3. Slewing (S)

4. Interference (K)

5. Special Reply (Z)

USING REPLY TROUBLE INDICATOR INFORMATION

To illustrate the use of Reply Trouble Indicators, suppose that the ASOper(HT) receives an audible alarm alerting him to the fact that height finder A at site T was automatically programmed into the Standby mode. The illustration on the following page shows the Height Status TD as it might appear in this situation.

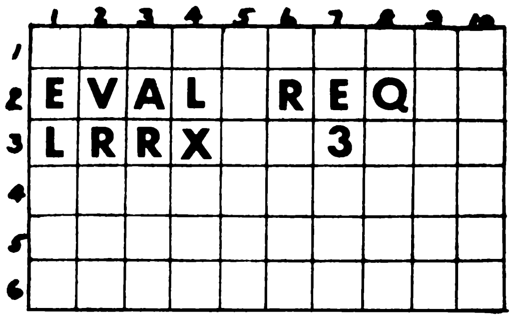


The Reply Trouble Indicator (P) signifies that a zero height reply was received from HF A and that the HRIOp has not indicated that any interference is present, nor has he attempted to search for the target by changing the HF azimuth setting. The receipt of two such Operator Negative replies in succession causes the program to place the HF in Standby and alert the ASOper(HT). In response to this situation, the ASOper(HT) might try to contact the HRIOp involved and obtain an explanation for the apparent lack of attention.

Similarly, other Reply Trouble Indicators inform the ASOper(HT) of equipment problems varying from minor to major in their impact on the HF's efficiency. Many such problems are minor and clear themselves in a short time. For persistent or more serious equipment troubles, the ASOper(HT) would notify the LRR maintenance personnel. His explanation of the trouble indicator display would prove valuable for troubleshooting and repair.

EVALUATION REQUESTS

Although not directly related to his primary job of obtaining height and flight size information on tracks, the ASOper(HT) also assists the Identification Operator (IDOper) by relaying certain ID information between the BUIC NCC and ARPs. The information to be transmitted is presented to the ASOper(HT) in a forced Evaluation Request TD. When he receives this display, he notes the information required by the IDOper for the special ID evaluation and transmits it to the designated ARP via radio. The IDOper is unable to do this himself because he has no ground-to-air radio equipment. The display is cleared by the Acknowledge Evaluation Request TD action. The illustration below shows an Evaluation Request TD.



Evaluation Request TD

LRR X (an ARP) should be requested to scan quadrant 3.

NOTES

Height:

RELATED MANUAL INPUTS

a) RADAR CHANNEL ASSIGNMENT AND HEIGHT REQUEST AVAILABILITY message

RELATED SWITCH ACTIONS

a) ACKNOWLEDGE MISSING TRACK ALARM

b) DIFFERENTIAL ALTITUDE REQUEST

c) INSERT HEIGHT AND/OR FLIGHT SIZE

d) LATERALTOLD HEIGHT REQUEST

e) NORMAL MODE ASSIGNMENT

f) OFF MODE ASSIGNMENT

g) OVERRIDE MODE ASSIGNMENT

h) RADAR HEIGHT REQUEST

i) STANDBY MODE ASSIGNMENT

j) MANUAL MODE ASSIGNMENT

RELATED DISPLAYS

a) MISSING TRACK ATTN SID

b) HEIGHT REQUEST FEEDBACK TD

c) HEIGHT STATUS TD

d) HF SLEWING ERROR ALARM TD

e) MANUAL REQUEST TD

RELATED DATA LINK MESSAGES

a) TACTICAL DATA CHANGE - HT.

NOTES

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CHAPTER 8

IDENTIFICATION

Identification is the determination of an airborne object's identity in accordance with criteria set forth in NORAD/CONAD regulations. Currently approved criteria include track behavior, response to electronic interrogation, area of origin, direction of movement, visual recognition, and adherence to a prefiled flight plan or authorized route. Each track in the BUIC III system is assigned an identity based on as many of the above criteria as possible. For any one track, the more criteria satisfied, the greater the probability of positive identification. When the BUIC III NCC is operating in the Monitor mode, only simulated tracks may be identified or reidentified by the appropriate personnel.

The Identification function is manned by one or two Identification operators (IDOpers). They must ensure that identification procedures follow the current directives, and take any necessary switch actions.

The NORAD/CONAD requirements for identification vary according to the state of air defense readiness. During maximum readiness (Air Defense Emergency), all aircraft penetrating or operating within the NORAD/CONAD system must be positively identified. During normal readiness, any unusual air activity within the perimeter areas of the North American Continent which might indicate an imminent air attack must be detected and identified. To meet this requirement, Air Defense Identification Zones (ADIZ/CADIZ) have been established, and stringent rules have been imposed to facilitate the identification of all traffic entering these zones. Under this concept, unknown tracks are visually identified by interception as far from the target area as is operationally feasible. This emphasis on perimeter identification allows the air defense system to relax the requirements for identifying air traffic operating within the Defense Areas during periods of normal readiness.

The following track identities are designated in the BUIC system, and may be assigned by operator switch action, or in some cases by automatic program function. (The letter designator represents the display symbol used in the track information SID display):

ARP (W) — The track identity of an Airborne Radar Platform that is on-station or is enroute to or from its station.

Bee (B) — The track identity of a known SAC aircraft participating in training flights and Unit Simulated Combat Mission (USCM) flights exclusive of Emergency War Order (EWO) flights or SAC missions designated by NORAD as YOKE tracks.

BOMARC (D) — The track identity of a BOMARC missile.

Faker (K) — The track identity of a Friendly Class aircraft simulating a Hostile Class track during an air defense exercise.

Friendly (F) — The track identity of an aircraft based upon established criteria indicating the aircraft to be of ones own or allied forces.

Hostile (H) — The track identity of an aircraft based upon established criteria indicating it to be that of the enemy.

Interceptor (C or T)	The track identity of a manned aircraft assigned to a specific air defense mission.
Pending (P)	The track identity of a track awaiting identification.
Round Robin (R)	The track identity of a friendly class aircraft that maneuvers in a specified area and then proceeds to a known destination.
Special (S)	The track identity of a friendly class aircraft that is of special interest to NORAD.
Unknown (U)	The track identity of an aircraft that cannot be positively identified within the time limits prescribed by NORAD.
Yoke (Y)	The track identity of a SAC aircraft that is on an Emergency War Order Mission (EWO) or peacetime flights of special interest to NORAD.

Tracks are classified into three identification categories as follows:

Friendly Class	Friendly, Round Robin, Yoke, Bee, Special, and ARP
Hostile Class	Hostile, Unknown, Faker, and Pending
Interceptor Class	Manned Interceptor and BOMARC

When a weapon is committed by weapons personnel, the program assigns the appropriate identity of Manned Interceptor or BOMARC. The IDOper cannot take identification action on interceptor class tracks. All other identities, with the exception of Pending, may be switch-inserted as the track is initiated or subsequently. If the identity is not so inserted, the program assigns a Pending identity to the new track which will also be reassigned automatically when an Established friendly class track begins to smooth on passive data.

All Friendly class tracks (except ARPs) may be reidentified by switch action to another identity within their own class or the Hostile class. Likewise, a Hostile class track may be reidentified within its own class or within the Friendly class. Interceptor class tracks cannot be reidentified, and in no case can non-Interceptor class tracks be reidentified as Interceptor class tracks.

In determining the identity of a track, the IDOper uses many types of information obtained from various sources. Such sources include MK X SIF codes, visual information obtained from Interceptor pilots, and track characteristics such as altitude, speed, heading, and origin. A track's origin can be of significant importance if the Division has, within it, a NORAD specified area called a Free Area. Under less than emergency conditions, all air traffic originating and remaining within the boundaries of such an area may be identified as Friendly in accordance with pre-arranged procedures. Tracks may also be automatically identified if they originate within so many miles of a known SAC base, which is another example of identification by origin (IDBO). If correlation occurs between SIF data and a track with similar prestored code, the identity of the track is automatically changed to Yoke.

The principal method of identifying flights in the Friendly class is by means of flight plan correlation. Flight plans describe the intended route and time of flight of an aircraft, and are submitted by pilots to Air Route Traffic Control Centers (ARTCCs) operated by the

NOTES

Federal Aviation Agency (FAA). The flight plan may be filed before takeoff and can later be revised by in-flight reports. The Air Movements Information Section (AMIS) of the ARTCC transmits the flight plans to the manual inputs function at the NCC by teletype or voice. The flight plan data are punched on cards, and inserted into the computer. The identification function stores data to a maximum of 50 flight plans. Approximately nine minutes before the active time of a flight plan, the program generates an inactive Air Movement Data (AMD) display at the IDOpers SID. This display shows a minute-by-minute countdown until activation time. When activated, the program extrapolates the position and symbology along the flight plan route. See Figure 8-1.

If an IDOper decides that a track matches the displayed AMD, he may pair the track with the AMD by taking an Identification with Correlation Switch action and assigning it a Friendly class identity. Such a track will correlate with a flight plan, providing its position is within five minutes flying time along the heading of the flight plan, and is within 10 nautical miles if over land, and 20 nautical miles if over water. The program provides a display called a correlation box to aid the operator in this monitoring task. A track is considered out-of-correlation if it exceeds the limits of the flight plan. The IDOper is informed by a display when this situation arises.

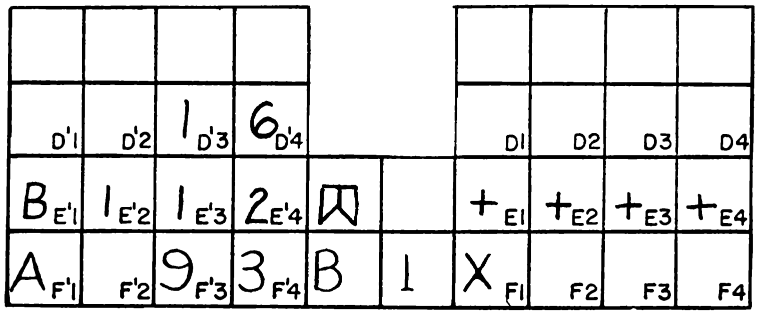


Figure 8-1. Air Movement Data Display. (An Example of a Back-to-Back Situation Display)

Another manual method of identification available to the IDOper involves the use of air movement data provided directly to him by telephone from FAA. In this manner a designated track is paired with an aircraft call sign. When the IDOper determines which track on his scope represents the aircraft specified in the telephone call, he identifies it (Identification without correlation switch action) and coordinates with manual inputs, in order to insert a Call Sign Association card for that track. This card contains meaningful information about the track, and tracks handled in this manner are called Call Sign Associated (CAT) tracks.

Identification:

RELATED MANUAL INPUTS

a) CALL SIGN ASSOCIATION DATA message

b) FLIGHT PLAN DATA message

RELATED SWITCH ACTIONS

a) DROP AMD

b) EVALUATE

c) IDENTIFICATION WITH/WITHOUT CORRELATION

d) MANUAL FULL SCAN

e) SITE INTERROGATION STATUS: OFF/ON

f) START/STOP AUTOMATIC FULL SCAN

g) START/STOP IDBO FUNCTION

h) START/STOP VALID

i) STOP REQUESTED SID DISPLAYS

RELATED DISPLAYS

a) AMD SID

b) AMD ROUTE SID

c) AMD IN DELAY AREA SID

d) AMD CORR BOX SID

e) CALL SIGN ATTENTION DISPLAY SID

f) CAT TRACK CALL SIGN SID

g) PARTIAL PENDING TRACK DISPLAY SID

h) SYSTEM TRACK SIF CODES SID

i) PENDING TRACK ATTN SID

j) OUT OF CORRELATION ATTN SID

k) CAT TRACK ATTN SID

l) EXCHANGE TRACK REIDENTIFIED ATTN SID

m) EVALUATION SITUATION ATTN SID

n) DUPLICATE TRACK CALL SIGN SID

o) AMD TD

p) EVALUATION REQUEST TD

RELATED DATA LINK MESSAGES

a) TACTICAL DATA CHANGE - IDent

b) CALL SIGN TRANSFER

c) IDENTITY EVALUATION REQUEST

CHAPTER 9

INFORMATION TRANSFER

The Information Transfer function provides the capability for a BUIC III NCC to transmit data to, and receive data from, other air defense facilities within the SAGE and BUIC system in order to maintain air defense continuity. The information transfer function consists of three kinds of Information Transfer: backtell, lateraltell, and forwardtell. Backtell is the transfer of information to a BUIC III NCC from the parent DC. Lateraltell is the transfer of information between associate BUIC III NCCs or between a BUIC III NCC and a BUIC III NCC or SAGE DC in an adjacent division. Forwardtell is the transfer of information from a BUIC III NCC to the Region CC. Backtell, lateraltell, and forwardtell are accomplished via digital data link. In an emergency situation, forwardtell can also be accomplished via voice phone. See Figure 9-1.

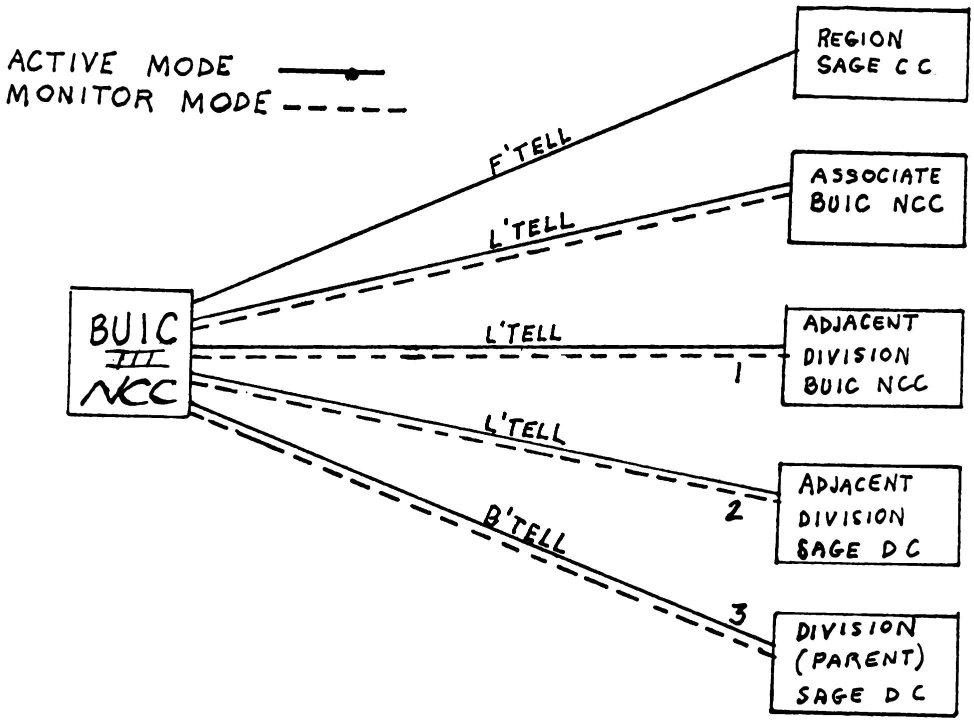
The transfer of information is controlled by both weapons and air surveillance personnel, all under the supervision of the SD. Forwardtell is solely the responsibility of the SD. Lateraltell of interceptor and target tracks are normally the responsibility of the SD or an assigned WD. The RICMO/ASO or ASOpers are generally responsible for all unassigned non-Interceptor class tracks, as well as properly handling backtold tracks. The ADAD is responsible for tracks specifically told for purposes of ADA. The TM has the responsibility for Exercise tracks.

MONITOR MODE

Monitor mode information processing includes the processing of backtold messages from the parent SAGE DC, and lateraltell input/output processing to/from eligible facilities. There is no forwardtell capability in the Monitor mode. The purpose of a Monitor mode NCC is to maintain the most current and pertinent information of the air picture, so that, in the event of an emergency take-over (Activating of the BUIC III complex), the control, guidance, and tracking of Interceptor tracks and the tracking of non-Interceptor tracks may be continued without degradation by BUIC III. To do this, the BUIC III system has been designed to maintain only those live tracks for which SAGE has designated the backtell function as relevant when the BUIC III NCC is operating in the Monitor mode.

BACKTELL IN MONITOR MODE

A track of any identity can be backtold to a BUIC III NCC from the parent SAGE DC. All such tracks are assigned a status of Told-in at the Monitor mode NCC. The track's position is updated by the receipt of the latest backtold coordinates. To perform correlation and smoothing on these tracks, the Accept switch action must be taken on the track. This action changes the status of the track from Told-in to Established, thereby making the track eligible for active or passive tracking. However, the track is still considered backtold and SAGE backtell reports on this track continue to arrive periodically. The BUIC III program compares the SAGE-reported position with its own calculated coordinates and as long as less than a five-mile discrepancy exists, the BUIC III track position is used. When the difference exceeds five miles, the SAGE-reported position is inserted in the tracking tables, and the program alerts the operator that the track position is being moved. See Figure 9-2.



1- OPERATIONALLY UNLIKELY BUT NOT RESTRICTED BY PROGRAM DESIGN

2- OPERATIONALLY UNLIKELY BUT NOT RESTRICTED BY PROGRAM DESIGN

3- OPERATIONAL STATUS MESSAGE WILL BE ACCEPTED IN THE ACTIVE MODE

Figure 9-1. BUIC III Information Transfer by Data Link

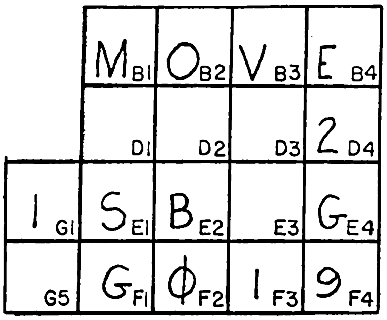


Figure 9-2. Backtell Track Move Attention Display

If a Termination message is received from the parent DC on a backtold track, the track is dropped at the NCC regardless of whether or not the Accept action had been taken. If no updating messages have been received on this track for approximately two minutes, the operator at the NCC is alerted, which means that the track is eligible to be dropped.

The DC also backtells a special type of message called an Operational Status message. This message is automatically transmitted by SAGE's output program approximately every 15 seconds. Receipt of an Operational Status message indicates to the BUIC III NCC that the parent DC from which the message came is operative. The DC also relays Operational status messages from adjacent control facilities.

LATERALTELL IN MONITOR MODE

Lateraltelling of tracking in the Monitor mode can exist for four specific purposes: Tracking, Interception, ADA, and Exchange. A track may be told for more than one purpose and to more than one receiver, each designated by switch action. Lateraltell for Tracking, Interception, and ADA are the only purposes available when transferring track information to eligible adjacent facilities. In addition, Lateraltell for Exchange is available if an associate BUIC III NCC is selected as a receiver. In general, when the BUIC III NCC is in the Monitor mode, all lateraltell is performed on internally generated simulated tracks only (non-backtold tracks specifically), and will therefore be discussed in the Active mode sections. Lateraltell for Exchange is the one exception and will be discussed in both sections.

To be able to Lateraltell for Exchange in the Monitor mode, there must be an operative associate NCC in the same Division. Tracks told for this purpose may be transmitted selectively or unselectively; that is, as an individual track message or as a block of all eligible tracks. This method of exchanging track information allows each associate NCC to monitor parts of, or the entire air situation of, the other NCC. This buildup of the air picture is necessary because the parent SAGE is unable to designate more than one receiver of a backtold track at the same time.

TRANSITION

Transition occurs when the transfer of Division control passes from the DC to the BUIC III NCC. This takeover of operational responsibility enables the BUIC III NCCs to conduct active air defense operations when the parent DC is unable to do so. Specifically, when the NCC is operative in the Monitor mode, it periodically processes incoming Operational Status messages from its parent DC. Failure to receive this message for a period of about two minutes causes an alarm and an attention device to be generated to the SD and appropriate personnel. The SD must then establish by voice communication whether this failure is due to an outage of the communication lines, or whether the parent DC is disabled. In the former case, new communication lines are established. In the latter case, the NCC makes the necessary preparation to go into the Active mode. When four minutes have elapsed without the receipt of an Operational Status message, the program again alerts the SD by informing him that the parent DC is considered out of action. During this latter two minute period, the SD supervises the orderly process of adjustment necessary to enable the NCC to take over active air defense, if this route is to be taken. This adjustment (transition) period includes acquiring the proper circuitry connections to the appropriate external sites.

Transition to the Active mode is concluded when the SD takes the Active mode switch action. This places the NCC and any associate NCC (via an Operational Status message) into the Active mode. As a result, the BUIC III NCC is cleared of any simulated information, and all the backtold tracks automatically revert to the status they had at the SAGE DC.

ACTIVE MODE

In the Active mode, the BUIC III NCC performs the following functions: It can lateraltell to its associate NCC for purposes of Tracking, Interception, ADA, or Exchange. It can lateraltell to an eligible adjacent facility for any purpose except Exchange. It can forwardtell to the Region Combat Center.

LATERALTELL IN ACTIVE MODE

Lateraltell for Tracking is initiated by switch action and used to provide tracking continuity as a track passes from facility to facility. Only tracks told for Tracking may be "handed over" to the receiving facility.

The Handover function is initiated by an Accept action in the receiving facility and is terminated when the track drops from the sending facilities system.

Lateraltell for Interception is used to coordinate weapons direction functions between facilities. Tracks told for Interception cannot be handed over unless subsequently told for tracking, but may be committed against by weapons in the receiving facility. Lateraltell for Interception may be accomplished manually or automatically.

ADA-purpose lateraltell enables ADA personnel at a BUIC III NCC to bring specific tracks to the attention of ADA personnel at another facility, and provides for the coordination and control of an ADA engagement. ADA-purpose lateraltell can be accomplished manually or automatically.

Lateraltell for Exchange in the Active mode is used to exchange track information between associates and to facilitate the Height and Identification functions. Tracks told in for Exchange may have their altitude measured and/or be reidentified. Such action on the part of the receiver causes special height/identity messages to be triggered back to the associate NCC.

The following messages are regularly lateraltold in either the Active or Monitor modes:

LINE STATUS MESSAGE: This message is lateraltold to all tied control facilities every three cycles and contains specific route status information for each control facility in the SAGE/BUIC system.

OPERATIONAL STATUS MESSAGE: A BUIC III NCC includes, in the Operational Status Message, information indicating whether it is operating in the Active or the Monitor mode.

The following messages are lateraltold in the Active mode as the need arises:

STROBE LATERALTELL MESSAGE: A BUIC III NCC lateraltells strobe information to specified BUIC III NCCs when strobes fall within specific azimuths of certain radar sites. A manual input message is used to determine the azimuth wedge and the radar site, and to designate the NCC that is to receive strobe lateraltell.

DATA LINK RELAY: Transmitted to an associate BUIC III NCC when a GAT site controlled by that NCC has been selected for data link transmission by the NCC controlling the Interceptor.

FORWARDTELL IN ACTIVE MODE

Forwardtell is a semi-automatic function for the BUIC III system. It occurs in the Active mode only and is used to coordinate Surveillance and Weapons functions within the Region. The NCC periodically forwardtells tracks and certain summaries that are relevant to the air picture. The collection of summary data includes: Manned Interceptor Squadron Summary, BOMARC Summary, AADCP Summary, and an Air Situation Summary.

The transition from the Active mode back to the Monitor mode begins when the NCC is first alerted that the DC is operational. This usually results from the receipt of an Operational Status message. The SAGE DC then builds up the air picture using information backtold from the CC and, in some cases, voice told from the NCC. When the parent SAGE DC informs (by voice) the BUIC III NCC that they have reestablished the communication links necessary to take over active air defense, the SD at the NCC will take the Monitor mode switch action. Within one cycle after this action, all tracks, except on-station ARPs, are automatically dropped. In addition, forwardtell ceases, and no further live height replies are processed. This action causes an associate BUIC III NCC to revert to the Monitor mode as a result of a newly transmitted Operational Status Message.

In general, the transfer of track information between facilities is precluded by the following restrictions: (1) should the incoming track message contain a track number already being used in the system, the track message is rejected. (2) If the track coordinates are such that they fail to fall within the X1 display area of the receiver, the track message is rejected. (3) If the number of channels remaining in the tracking tables are limited, the track message is rejected. The employment of such measures allows for strict program control over the flow of information into and out of the BUIC III system.

INFORMATION TRANSFER

1. Data Link Operations:

RELATED MANUAL INPUTS

None

RELATED SWITCH ACTIONS

a) HIGH PRIORITY

b) RESET KILLS

c) SEND/STOP SEND TO COC

RELATED DISPLAYS

a) FORWARDTELL CHANGE ATTN TD

RELATED DATA LINK MESSAGES

a) AIR SITUATION SUMMARY

b) MANNED INTERCEPTOR SQUADRON/AIRBASE SUMMARY

c) BOMARC SQUADRON SUMMARY

d) AADCP SUMMARY

e) AIRBASE WEATHER SUMMARY

2. Communication Links:

RELATED MANUAL INPUTS

a) INPUT CHANNEL ASSIGNMENT

b) OUTPUT CHANNEL ASSIGNMENT

RELATED SWITCH ACTION

None

RELATED DISPLAYS

None

RELATED DATA LINK MESSAGES

a) LINE STATUS message

b) OPERATIONAL STATUS message

3. Lateraltell:

RELATED MANUAL INPUTS

None

RELATED SWITCH ACTIONS

a) ACCEPT HANDOVER

b) START/STOP ADA LTL

c) START/STOP EXCHANGE LTL

d) START/STOP LTL FOR INTERCEPTION

e) START/STOP LTL FOR TRACKING

RELATED DISPLAYS

a) HANDOVER IMMINENT TD

b) TOLD-IN DUPLICATE TRACK # TD

RELATED DATA LINK MESSAGES

None

NOTES

125	Foldout in Back of Book
127	Foldout in Back of Book
129	Foldout in Back of Book
131	Foldout in Back of Book
133	Foldout in Back of Book
135	Foldout in Back of Book
137	Foldout in Back of Book
139	Foldout in Back of Book
141	Foldout in Back of Book
143	Foldout in Back of Book

CHAPTER 10

WEAPONS

INTRODUCTION

BUIC NCC WEAPONS FUNCTIONS

The BUIC weapons function coordinates and controls the employment of air defense weapons within the NCC's geographic area of responsibility. These weapons may include manned Interceptors, BOMARCs, and Air Defense Artillery (ADA). The primary inputs to the weapons function are the air picture received from the surveillance function, weapons and equipment status information received from external air defense facilities, and directives and early warning information received from higher echelons of command. Primary outputs of the weapons function are: directives to employ Interceptors, guidance commands to Interceptors, track information to Army Air Defense Command Posts (AADCPs), status information to external facilities, and track and summary data to the Region Combat Center (CC).

The role of BUIC weapons personnel varies according to the mode of operation of the NCC. In the Monitor mode, the weapons personnel play a passive role in the air defense of the Division. It is the responsibility of the NCC to maintain a complete and accurate picture of the air situation in order to be able to take over the active air defense on short notice. Weapons personnel must know the location and capabilities of available weapons; know the position, mission, and method of control for all airborne weapons; and monitor the status of essential external equipment such as ground-to-air transmitter sites. In the Active mode, weapons personnel are responsible for the employment of the Interceptor weapons available for the air defense of the NCC's area. They are responsible for the NCC's ability to combat additional waves of the attack and for controlling Interceptors to ensure successful completion of missions and integrating ADA into the overall defense of the Division. Also in the Active mode, weapons personnel are responsible for forwardtelling track and status summary information to the Region CC.

The BUIC III weapons function can be divided into three logical areas: assignment and commitment, weapons direction, and ADA. The assignment and commitment area include threat evaluation, track assignment to directors, and weapons commitment. Weapons direction involves the ground control of manned Interceptors and BOMARC missiles on air defense missions. The ADA area involves the passing of tracks to AADCPs and the coordination of ADA operations with overall air defense activities.

WEAPONS PERSONNEL

The Senior Director (SD) is responsible for air defense functions within a BUIC NCC and is assisted by a Senior Director Technician (SDT). The SD also has the capability of performing a weapons direction function. Weapons direction is normally conducted by four Weapons Teams, each team consisting of a Weapons Director (WD) and a Weapons Director Technician (WDT). One of the WDs may be designated a Weapon Assignment Officer (WAO) to assist the SD with assignments and commitments. The number of Weapons Teams at each NCC depends upon the quality of radar inputs, the number of weapons sources, and the number of NCCs in a Division. Up to six consoles may be assigned to the weapons direction function. Usually one, and at most two, ADA teams have responsibility for the ADA function. Each team consists of an Air Defense Artillery Director (ADAD) and an Air Defense Artillery Technician (ADAT). ADA teams are not assigned at those NCCs without ADA responsibilities.

SENIOR DIRECTOR (SD)

Supervision of the weapons function is primarily the responsibility of the SD. In performing this function the SD assisted by the SDT is required to:

1. Supervise and monitor all activities at the BUIC NCC.
2. Evaluate threats.
3. Assign tracks and commit weapons.
4. Assign personnel to operational functions.
5. Coordinate the use of ADA weapons.
6. Coordinate the exchange of track information and requests for commitment of weapons with adjacent facilities.
7. Coordinate with higher echelons of command.
8. Authorize the employment of nuclear weapons.
9. Authorize low-altitude BOMARC intercepts.
10. Forwardtell track and summary data to the CC.

In order to properly perform these duties he must have a detailed knowledge of the environment of his Division including Division geography, performance characteristics of weapons under his command and at adjacent facilities, characteristics of anticipated enemy weapons and attack routes, and the directives under which he must work.

WEAPONS ASSIGNMENT OFFICER (WAO)

During periods of high activity, the SD may require assistance in making assignments and commitments. By a switch action, he may designate one of his WDs as a Weapons Assignment Officer (WAO). The WAO has the same assignment and commitment capability as the SD and receives displays normally forced to the SD. This will be an added responsibility for a WD in that he continues to conduct intercepts while assuming part of the SD activities. All discussions relative to track assignment and commitment in this document referring to the SD are also applicable to the WAO unless specifically stated otherwise.

WEAPONS DIRECTOR (WD)

The WD is responsible for the successful completion of his assigned mission and the safety of any pilot involved. Except for the fact that he has the capability to commit manned Interceptors and BOMARCs, his responsibilities and capabilities correspond to those of an Intercept Director (IND) in SAGE.

To ensure the safety of the pilot of a manned Interceptor that is being controlled*, the WD must be aware of correct radio procedures, techniques used for hazardous situations, areas within the Division where flight is restricted or hazardous, location of recovery bases and the methods of handling flight emergencies.

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*During live air defense exercises, a specialized surveillance function, known as positive target control or target monitoring, must be performed. In this function, a Target Monitoring Team is responsible for surveillance and control of exercise target aircraft and for ensuring the safety of all participating aircraft.

The Target Monitoring Team consists of an Exercise Director and a Target Monitor (TM). These positions are not full-time. They are manned by qualified WDs when exercises involving live aircraft are being conducted.

To ensure the successful completion of assigned missions, the WD must know the characteristics of the weapon he is controlling. When controlling a manned Interceptor for example, the WD will need information such as turn and climb characteristics and the fuel consumption rate. When conducting an intercept mission, he must be concerned with other Interceptor characteristics, such as the armament carried by an Interceptor, the tactics that may be used with the armament, and speed restrictions that may be temporarily imposed upon this type of Interceptor.

In addition to the characteristics of the weapon being controlled, the WD must be aware of a number of characteristics of the Division environment. Examples of these would be the location of probable ground targets and the associated bomb release lines, coverage patterns of the radio sites that will be used to conduct the mission, location of recovery bases, terrain features that could affect the conduct of the mission, and local procedures for Weapons commitment.

AIR DEFENSE ARTILLERY DIRECTOR (ADAD)

Through displays, telephone communications, and switch actions, the ADAD and the ADAT monitor computer ADA operations and engagement activities, select appropriate tracks for passing to AADCPs or for ADA lateraltell, impose fire control restrictions as directed by the SD, and coordinate with assigned AADCPs.

TRACK ASSIGNMENT, WEAPONS COMMITMENT AND FORWARDTELL

This chapter describes the methods of assigning tracks and the procedures for commitment and recommitment of manned Interceptors and BOMARCs. A description of the BUIC III forwardtell functions is also presented. Since the employment of ADA weapons is significantly different from Interceptors, the ADA function at the NCC is described in Chapter 6.

The track assignment and weapons commitment function involves the evaluation of a threat posed by penetrating aircraft, the selection and commitment of weapons to be used to combat the threat, the assignment of personnel to direct the weapons, and the continual evaluation of commitments.

Threat evaluation and weapons employment strategy differ according to Division environment and local directives. They are mentioned briefly to place the other weapons functions into proper perspective. A number of factors must be considered in determining the method of dealing with aircraft penetrating the NCC's area of responsibility. They include the flight characteristics of the penetrating aircraft, the state of air defense readiness, and intelligence information. NORADM 55-5, (U) NORAD Tactics, Procedures and Methods of Conducting the Air Battle, describes the basic concepts of threat evaluation and weapons employment.

TRACK ASSIGNMENT

Weapons personnel are responsible for each Hostile, Unknown, Faker, Manned Interceptor, and BOMARC (HUKID) within the NCC's coverage area. Track assignment is the process by which responsibility for a track is given to a specified Senior Director or Weapons Director. For HUK tracks, the assigned director is required to monitor the track, commit an Interceptor against it if required, and see that it is identified and/or destroyed. When assigned an Interceptor track, the director is responsible for its safe guidance. On occasion, by reassignment, track responsibility may be transferred from one director to another.

Tracks are assigned to directors either manually by switch action or automatically by the program. When a HUKID track is unassigned, its symbology and a flashing attention display is forced to the SD. The Unassigned Track Attention Tabular Display (TD), accompanied by an audible alarm, is also forced to the SD. The displays remain until the track is assigned to a director. Once a track is assigned, it is forced to the assigned director's console as long as the assignment is in effect.

Manual assignment of track responsibility to a director may be accomplished by the following switch actions:

1. Commit/Recommit - The Interceptor track is assigned to the director taking this action, or the SD may specify a WD assignment with this action.

2. Assign/Reassign - After coordinating with the SD, a WD uses this action to reassign his Interceptor to another director. With this action a WD assigns to himself an unassigned Interceptor told-in from an adjacent facility. The SD assigns a WD the responsibility for any track by specifying the WD in the action but is assigned the track himself if a WD is not specified.

3. Defer - The Defer action on an unassigned HUK track assigns the track to the director taking the action. The action indicates that the director is aware of the track but does not wish to commit against it at the time.

The program attempts to assign an Interceptor and its target track to the same director. Automatic track assignment is made for the following circumstances:

1. When a paired Interceptor and target track are told-in from other control facilities and one is manually assigned to a director, the other is automatically assigned to the same director.

2. When the SD/WD takes a Commit/Recommit action against a track, the target track, if unassigned, is assigned to the director responsible for the Interceptor.

WEAPONS COMMITMENT

Weapons commitment is the initiation of an Interceptor mission. Weapons are committed by the SD/WD Commit action for Interception of specified tracks or for patrol purposes. The decision to commit weapons is normally made by the SD or WAO but the SD may verbally authorize WDs to commit weapons at certain times, such as when the NCC is saturated or nearly saturated with invaders.

In determining the number and type of weapons to commit against a given target, the SD must rely largely upon his experience. The commitment must be adequate to ensure successful completion of the assigned mission. At the same time, the SD must avoid overcommitment of weapons in order to prevent a possible shortage of weapons in the Division. The number of manned Interceptors or BOMARCs to be committed under various circumstances is often governed by local or regional procedures. However, these are normally only guidelines which the SD must adapt to each situation. It may be, for example, advisable to defer the commitment of weapons when a target does not pose an immediate threat and WDs are already heavily burdened with commitment. Training missions provide an excellent opportunity to develop a commitment plan.

Various factors influence the decision as to which weapon to commit. In some NCCs, there may be only one squadron from which Interceptors may be committed. In most NCCs there will be a mixed arsenal of weapons, and the SD will have more latitude in deciding which weapons to use. Time is the primary consideration for commitment and, unless overriding factors prevail, a target should be intercepted by the weapon with the shortest time-to-go.

The relation between target altitude, target speed, Interceptor type, Interceptor armament, and Interceptor tactics also influences the choice of weapons. The program automatically selects the tactics and armament at the time of the Commit action. In order to obtain the evaluation of an Interceptor pairing without actually committing the weapon, a director can take a switch action to request a Commitment Assistance Display (CAD) on a specified target track. The program calculates the intercept capabilities of the designated weapon and presents the CAD results on the Situation Display (SD) scope of the requesting director. If the intercept is possible, the CAD appears at the predicted intercept point; if it is impossible, it appears next to the target track display. The CAD is particularly valuable for BOMARC commitment since, unless a delay has been calculated, it is impossible to stop a launch once it has been initiated.

```
    C   8 B
    4 6 B G
O       1 5
D Y P
```

Figure 10-1. Commitment Assistance Display--Possible Intercept

In Figure 10-1, a CAD has been requested for the YP Squadron at Airbase BG against a target track. The first line indicates that the intercept has been calculated using a clean configuration (no tanks), and a Buster (economical) climb and that there are eight YP aircraft on 5-minute scramble alert at the base. The second line shows that there will be 4600 pounds of fuel remaining after the intercept. The next lines show that the intercept is possible (0) and that it will take 15 minutes for interception using a double-offset stern attack (D).

Using a new weapon, a new CAD may be requested on the same target. The new CAD appears in addition to the first for comparison. Any subsequent request for a CAD on the same target results in the last CAD being replaced; the oldest or first remains. CAD requests on a different target causes all previous displays to be cleared.

Unless specified otherwise in the CAD request, the program will assume a clean configuration and a Buster climb to cruise altitude for manned Interceptors. The director can change either or both the configuration and the climb in a CAD being presented by taking an Alter CAD action. The program recalculates the intercept using the inserted values and changes the CAD accordingly.

The CADs for manned Interceptors are also calculated on the basis of a standard tactic and primary armament for the Interceptor type. In cases where it is appropriate to use nonstandard tactics and/or the secondary armament, the director may take a Commit or Recommit action and then take switch actions to change the attack option and/or armament. The program calculates the intercept using the switch-inserted changes.

Manned Interceptors can be committed to either intercept or combat air patrol (CAP) missions. When a Commit action is taken by a director, the program generates displays for the Interceptor track and sets up information concerning the committed weapon.

When a manned Interceptor is committed to an intercept mission, intercept calculations are performed and a Scramble Track SID appears at the departure base on the scope of the assigned director. A Scramble Track TD, containing the information required to initiate a scramble, is forced to the committing director's console.

The committing director checks the Scramble TD to ensure that it reflects his decisions and that the scramble is advisable. If the initial intercept calculations result in an impossible intercept condition (insufficient speed or fuel), this condition is reflected in the last line of Scramble TD (after the fuel reserve), in the manned Interceptor track symbology, and in the Offset/Intercept Point display. The committing director must then evaluate the situation and decide if he wants to attempt the mission with the selected squadron. There are no program restrictions to prevent a director from attempting a manned Interceptor mission even though an impossible intercept condition was calculated. For example, a director may anticipate a probable target turn to a heading more favorable for the intercept. When the director decides to initiate the scramble, his technician calls in the necessary information to the Fighter Interceptor Squadron Combat Alert Center (FISCAC) by voice phone.

10	11	12	13	14	15	16	17	
								1
								2
								3
S	C	R	A	M	B	L	E	4
T	R	K		L	P	1	2	5
C	O	N		T	N	K		6
F	R	Q		3	5	4	Φ	7
W	D			4				8
I	N	T		A	3	5	6	9
S	I	Z	2	A	R	M	A	10
H	D	G		Φ	3	5		11
A	L	T		4	5	Φ		12
B	A	S		B	O	G		13
C	L	M		B	U	S	T	14
F	U	L		R	S	4	5	15
								16

Figure 10-2. Scramble Tabular Display (TD).

Figure 10-2, as indicated on the fourth and fifth lines of the TD scope, is a Scramble TD for manned Interceptor track LP12. Other lines are interpreted as follows:

6 Configuration Tanks
7 WD Radio Frequency 354.0 Megacycles

8 Assigned WD 4
9 Intercept Mission against Target Track A356
10 Flight Size 2 Armament AIM 4A
11 Command Heading 35 Degrees Magnetic
12 Command Altitude 45,000 feet
13 Departure Airbase "BOG"
14 Type of Initial Climb Buster or Military Power
15 Fuel Remaining After Interception 4,500 pounds

Using the Scramble TD in Figure 10-2, a Scramble Order call-in might be as follows:

"Scramble Lima Papa 12" (1), "Flight Size of 2" (2), "Heading 035" (3), "Climb Buster" (4) "to Angels 45" (5), "Contact JARTOP ALPHA 04" (6) "On 354.0, Backup 364.2" (7), "Controller Extension 211" (8).

1) Aircraft Call Sign
2) Flight Size
3) Scramble Heading
4) Type of Climb
5) Command Altitude
6) Controlling Facility Call Sign and WD Number
7) Primary and Backup Radio Frequencies
8) WD Telephone Extension

Should the director decide to cancel the mission, he will take the Drop Track action. This action clears the track symbology from the SID scope. In order to maintain accurate weapons status, the director should notify the Manual Inputs Section to increase the number of Interceptors on five-minute alert by the flight size of the Dropped track. Such Manual Inputs notification is not necessary, however, if the Bypass Status had been specified when the Commit action was taken. Under these conditions weapons status is not reduced by the flight size of the scrambled track.

CAP missions are used to position manned Interceptors beyond the minimum line of interception but within ground control range. CAP provides for initial engagement of invaders at the maximum distance from probable targets and may be used to augment areas of poor radar coverage.

In committing a manned Interceptor to CAP, the director may specify a Strategic Orbit Point/Recovery (STOPR) to which the Interceptor is to be directed. This is done by using the light sensor on the displayed STOPR instead of by pushing the Activate button. The program treats the STOPR as a target, computes a direct course to the point, and provides guidance instructions for the Interceptor. If a STOPR is not designated in the Commit action, the assigned director must manually provide directions to the pilot for vectoring the Interceptor to the desired position. The designation of a STOPR for guidance assistance may be added to or deleted from a CAP mission at a later time through a Recommit action.

When manned Interceptors are maintained on CAP, it is the responsibility of the SD to order additional commitments for CAP to replace those Interceptors which must return to base because of low fuel supply. Normally a manned Interceptor is replaced in its CAP area before its fuel supply will no longer allow it to complete an Intercept mission and be recovered routinely.

Only the SD may authorize the use of BOMARCs and any attempt by a director to commit a BOMARC when BOMARCs are not authorized results in a Not Actionable TD, and commitment will not occur. Before the SD takes the BOMARC Authorized action, a BOMARC Safety Interlock switch, located on the wall in front of the SD console, must be set to the ON position. This is a wiring limitation as opposed to a program limitation in that the information for the BOMARC Authorized action never reaches the computer if the BOMARC Safety Interlock is in the OFF position. The SD may countermand the use of BOMARCs at any time by taking a No BOMARC Authorized action. The BOMARC Safety Interlock switch does not affect this action. If BOMARC simulation and/or BOMARC Prelaunch Status Test (BPST) are in effect, simulated BOMARCs may be launched without the BOMARC Authorized action being taken. In fact, BOMARC Authorized action in this case will turn off all simulation activity and only live launchings are possible.

Normally, low-altitude BOMARC intercepts are not permitted. If an intercept is calculated to occur below the Safe Altitude Fusing Option (SAFO) altitude, the program forces a SAFO Conflict Attention display in the BOMARC track symbology to the assigned WD. The SD decides if the SAFO Off action is to be taken to authorize low-altitude BOMARC intercepts or if to recommit the BOMARC to CAP or another target and use another weapon to intercept the target. The BOMARC Authorized and SAFO conditions in effect are displayed in the Operational Conditions SID.

BOMARCs can only be committed for the purpose of intercepting Hostile tracks*. The BOMARC Commit action causes the program to calculate the intercept and determine if the intercept is possible. For possible intercepts, the program selects the missile to be launched, transmits launch commands to the missile by ground-to-ground data link and displays a BOMARC track symbology at the missile base location on the SID. Since the committing director does not transmit any voice commands in launching a missile, the Scramble Track TD, as provided for manned Interceptors, is not displayed. Guidance calculations begin automatically when the BOMARCs launch is predicted.

The program may determine that the point of interception will be beyond the range of a BOMARC squadron but that the target is heading toward the BOMARC coverage area. Therefore, by delaying the launch for a period of time, the intercept will occur within range of the BOMARC. In this case, the time-to-wait before launching is calculated and the BOMARC Precommit display is forced adjacent to the target track symbology. The time-to-wait is counted down in the display. At zero, a missile is selected from the squadron and launch commands are transmitted. If the target heading changes during the wait period such that the target will not penetrate the BOMARC coverage area, the commitment will be automatically cancelled.

In Figure 10-3, a BOMARC from LM squadron has been committed against Hostile track M334 (the arc denotes BOMARC range). If the BOMARC were to be launched at the time of the Commit action, the intercept point would occur at point A but by delaying the launch ten minutes (10M), the intercept will occur at point B which is within range of the BOMARC

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*Simulated BOMARCs may be committed against tracks whose identity is other than Hostile, BOMARC, or manned Interceptor. During BOMARC simulation, Prelaunch messages are not transmitted to the squadron; the program determines the abort probabilities and provides the appropriate simulated status messages for the missile.

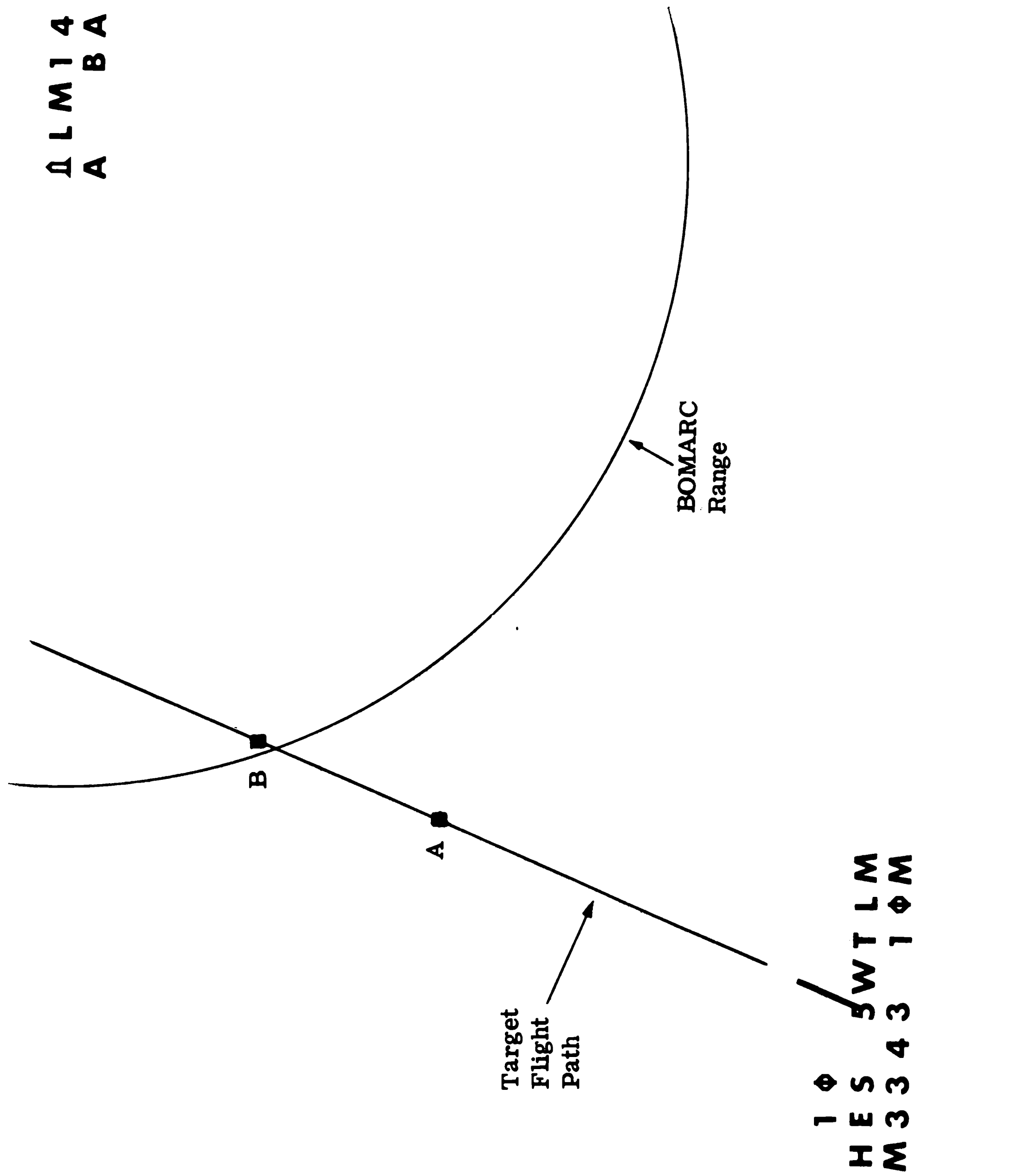

Figure 10-3. BOMARC Precommit Illustration

squadron. The wait (WT) condition for the LM squadron (LM) is indicated by the WTLM to the right of the target track symbology. The wait time (10M) will be counted down in minutes until two minutes remains. At this time the M is replaced by an S and countdown will be in seconds. The BOMARC range arc, target flight path, and intercept points are not displayed, but are used for clarification.

If the intercept is calculated to be impossible because of speed or insufficient fuel, the commitment is automatically cancelled by the program. A BOMARC Cancel Commitment display is presented to the left of the BOMARC Base display at the console of the director taking the Commit action.

CNCLΩLM13
M323A   BA

Figure 10-4. BOMARC Cancel Commitment Display

Figure 10-4 shows cancellation (CNCL) of the commitment of a BOMARC from the LM squadron against a target track M323. The BOMARC Cancel Commitment display is cleared from the scope after about thirty seconds.

BOMARC commitments are also automatically cancelled during a delayed launch when the target track is dropped or reidentified to a non-Hostile class.

The SD may take an Unconditional BOMARC Commit action if he wishes to override the cancellation of the commitment by the program. This action, however, will not override a cancellation due to a calculated speed impossible intercept. If the action results in a delayed launch and the target heading subsequently changes so that it will not enter the BOMARC coverage area, the commitment will not be cancelled.

The only time that a BOMARC commitment can be cancelled by a director is during a delayed launch. The director takes the Cancel BOMARC Commitment action and specifies either the target track number or the target track number and the BOMARC squadron. The first sequence cancels all BOMARCs in a delayed launch condition against the specified track, and the second cancels BOMARCs from the designated squadron in a delayed launch condition against the target track.

WEAPONS RECOMMITMENT

Weapons recommitment is the means of changing manned Interceptor and BOMARC missions and/or targets. Recommitment is required when an Interceptor completes its mission or when another mission is more critical. Recommitment is accomplished either automatically by the program or manually by directors through switch action.

A recommitment decision is usually based on considerations of the manned Interceptor's fuel, oxygen, and armament state; recovery base proximity; and availability of other weapons for interception. The CAD may be requested to predict the success of a recommitment. The Recommit action may be taken to intercept a more threatening track first. The possibility of obtaining an earlier intercept through the use of a ground scramble, BOMARC, or ADA weapon may also make recommitment desirable. In certain cases, only a portion of the manned Interceptor flight may be recommitted as when a multi-flight target splits.

If all weapons are recommitted from one target to another before completion of the original mission, a new commitment against the first target will normally be made by the director. The assigned director receives a forced Track Assignment TD upon a recommitment of his assigned manned Interceptor by the SD. As in the Commit action, manned Interceptors will be recommitted even though the intercept is calculated to be impossible. If a WD recommits, he will usually be required to notify the SD verbally of the action unless he has had prior approval of the SD for the recommitment. Directors are required to keep the pilot informed of all changes in target and/or mission by voice radio since this information is not available through data link equipment.

BOMARCs may be recommitted against a Hostile track only if sufficient flight time remains to reach the new intercept point. A BOMARC may be recommitted when the original Hostile track against which the missile is committed is less threatening than the Hostile track being considered as the new target by virtue of the number of weapons committed against the track, the type of weapons, or the time-to-go to intercept. The recommitment might be made in the case of a split in the Hostile track or the appearance of a new Hostile track closer to the bomb release point than the original target. The recommitment will not be accomplished until the program has checked and established that an intercept is possible. If the intercept is not possible, a BOMARC Recommit Impossible display (Figure 10-5) is forced to the console taking the Recommit action, and the prior commitment is retained.

FUEL
A359
A356
LM12

Figure 10-5. BOMARC Recommit Impossible Display

In Figure 10-5, it can be seen that a Recommit action was taken on BOMARC track LM12 to intercept target track A356 while on an intercept mission against A359. The program determined that A356 was out of the BOMARC range (FUEL) and, therefore, cancelled the recommitment and retained the interception of A359. The display remains for about 15 seconds at which time the original BOMARC track symbology is replaced.

If a BOMARC's target track is either dropped or reidentified as non-Hostile, the BOMARC is automatically placed on CAP by the program and an attention display is forced to the assigned director notifying him of the change in mission. This will not occur in the final stages of an intercept mission when, instead, the BOMARC will be placed on a depaired intercept mission. The characters FROZ will appear in place of the target track number.

FORWARDTELL

The SD is responsible for the forwardtell function. Forwardtell is the process of transmitting track and summary data to the Region Combat Center (CC) to facilitate the coordination of air surveillance and weapons functions within the Region. Forwardtell is normally conducted by digital data link but, in an emergency situation, can be accomplished by voice telephone. The voice telephone is also used to pass additional data not automatically transmitted.

In a Division containing multiple NCCs, only one of the NCCs will forwardtell directly to the CC (direct forwardtell). The other NCCs will lateraltell their data (indirect forwardtell) to the direct forwardtell NCC which combines all the data for transmission to the CC. The direct forwardtelling NCC is determined by Division directive and is designated to the program by a manual input card. The insertion of a manual input card starts forwardtell to the CC, sends a direct forwardtell indicator to other control facilities, and forces a Forwardtell Change Attention TD to the SD. When the other NCCs receive the direct forwardtell indicator, indirect forwardtell begins automatically and the SD is informed by the Forwardtell Change Attention TD. If two NCCs attempt to direct forwardtell simultaneously, the Forwardtell Change Attention TD is forced to all SDs in the Division to indicate the conflict. One of the NCCs must then cease direct forwardtell.

TRACK DATA

Once direct forwardtelling starts at one of the NCCs, all NCCs in the Division begin automatically selecting tracks to forwardtell. All Hostile, Unknown, Faker, Special, and Airborne Radar Platform (ARP) tracks with an Established or Manual Input status are automatically selected as well as manned Interceptors and BOMARCs on intercept missions. Using either the Send to CC or High Priority actions, the SD can select any non-told-in track for passing to the CC. The High Priority action, which can also be taken on tracks already being forwardtold, causes an indicator to be included with the track data to ensure special attention to this particular track at the CC. Once initiated, forwardtell information is sent periodically until the track is no longer the responsibility of the NCC, until it no longer qualifies for automatic passing, or until the SD takes a Stop Sending to CC action on the track. Forwardtell of tracks that qualify for automatic passing cannot be terminated by the SD switch action. The reason for termination is sent to the CC in a Termination message.

SUMMARY DATA

Summary data are collected and maintained at the NCC and periodically forwardtold to the CC when forwardtell is in effect at one of the Division NCCs. The data includes a summary of the air situation within the Division, and the status of manned Interceptor and BOMARC squadrons and AADCPs. The Air Situation Summary data for the entire Division are available for display at the NCC performing direct forwardtell in the Air Situation Summary TD. However, a direct forwardtelling NCC can not display track or weapons summary data received from an associate NCC for forwardtell only. The CC may request that the kill count (the cumulative number of kills entered against all Faker and Hostile tracks) be cleared for the Division. The SD at the direct forwardtelling NCC takes the Reset Kills action which clears the count for this NCC and sends a Reset Kills indicator to associate NCCs. Kill counts at associate NCCs are automatically cleared in response to the indicator.

SUMMARY

The output of the air surveillance and identification functions is a picture of the air situation which is used to evaluate a threat. The BUIC III programs associated with the complementary functions of track assignment and weapons commitment are designed to ensure that at least one person is aware of and responsible for every (HUKID) track in the NCC system, and that at least one weapon is paired against each (HUK) track.

WEAPONS DIRECTION

Weapons direction is the ground control of manned Interceptors and BOMARC missiles in the performance of air defense missions. It is the prime responsibility of the Weapons Director (WD). Weapons direction begins when a manned Interceptor or BOMARC becomes airborne. To assist the WD in his duties, the Air Defense Computer Program (ADP - hereafter referred to as "the program") generates guidance commands required for interception and transmits these commands to data link-equipped Interceptors. Guidance commands are displayed to the WD for monitoring the progress of intercepts and for relaying to manned Interceptors with malfunctioning or no data link equipment. Switch actions are provided to override guidance commands and to initiate the transfer of control of Interceptors to directors in the same or an adjacent facility.

INTERCEPTOR MISSIONS

In the course of his duties, the WD will be required to conduct several types of air defense missions with manned Interceptors and BOMARCs. These include intercept, combat-air-patrol (CAP), return-to-base (RTB), and depaired intercept missions.

An intercept mission consists of an Interceptor (manned or BOMARC) paired with a target for the purpose of identification (manned Interceptor only) and/or destruction. Intercept calculations, performed by the program each cycle, consider the required attack geometry and yield the commands necessary to achieve interception. Interceptors may be either committed or recommitted to an intercept mission.

A CAP mission consists of an Interceptor patrolling an area or being vectored toward a patrol area while awaiting an assignment to a target. A manned Interceptor can be committed or recommitted to CAP and is automatically placed on CAP when its target is dropped or at the completion of an intercept mission. When a manned Interceptor on CAP is paired with a Strategic Orbit Point/Recovery (STOPR), guidance commands are calculated to direct the aircraft to the designated patrol point.

A manned interceptor on an RTB mission is enroute to an airbase or recovery point and, by SOP, is not considered a weapons source. If it is paired with a STOPR, guidance commands are calculated and sent to direct the aircraft to the specified point. Guidance commands are also calculated and sent if a manual heading is inserted. Other than in these two cases, there are no data link communications with a manned Interceptor on an RTB mission.

A BOMARC cannot be committed to CAP (launched for CAP) nor can it be paired with a STOPR. A BOMARC can, however, be recommitted to CAP and is automatically placed on CAP when its target is dropped or reidentified to other than Hostile. An exception to the foregoing occurs in the final stages of an intercept mission when a BOMARC is automatically placed on a depaired intercept mission if its target is dropped or reidentified non-Hostile. Maximum time remaining until transition (TRUT) is sent to the missile in an effort to prevent transition. Transition is the time when a BOMARC prepares for final attack. The director may also insert a manual heading to try to divert the missile. A BOMARC cannot be recommitted by switch action to or from a depaired intercept mission. For simulated BOMARCs, reidentification of the target does not change the BOMARC mission, i.e., it continues with its present intercept mission.

INTERCEPT CALCULATIONS

From the target location and heading and the interceptor's location the program computes a point of interception and provides the required guidance information to the Interceptor. If the target changes speed, heading, or altitude the intercept point will change and so will the instructions to the Interceptor.

In performing intercept calculations, the program uses a double-turn guidance logic which takes into consideration the Interceptor's ability to turn. The solution includes the turn from the Interceptor's present heading to a command heading which places the Interceptor in the vicinity of the target where a turn to an attack heading is made. The determination of a new solution consists of examining all necessary turn combinations and headings yielding interception. The heading and turn combination providing the minimum time to interception is used.

The term "double-turn" is used to describe the type of guidance, but does not mean that there are only two turns in the entire mission. In the course of an intercept mission, the Interceptor will be required to make whatever heading changes are required to compensate for target maneuvering. Each change in heading, of course, requires a turn, and all but the change to the attack heading are called initial turns. The turn to the attack heading is referred to as the final turn.

The basic tool of the double-turn guidance is the miss-distance criterion. For each heading and turn combination attempted, the program also determines how close the Interceptor will come to the target. The ideal miss distance is zero but if that value were used, small fluctuations in target heading or speed would cause the Interceptor to make heading changes continually and produce a zig-zag course. Since the Interceptor takes over in the final phases of an intercept and can acquire the target with its radar even though it is not exactly positioned, a miss distance within variable limits is allowed. The greater the separation between the Interceptor and its target, the wider the limits. As the Interceptor nears its destination the limits decrease to a minimum. When the separation is great, it is not so critical to define the exact point as it may be anticipated to change several times before the Interceptor reaches it.

Wind velocity must be considered in the intercept calculations. The azimuth and speed of the wind at various locations and altitudes is entered into the computer by the Manual Inputs Section. The target velocity is corrected to the Interceptor air mass by using the wind velocity components at the Interceptor's present position and command altitude.

In performing intercept calculations, the program uses a profile and a tactic. The profile defines the type of initial climb, the cruise speed, and the cruise altitude used in getting the Interceptor to the target area. The tactic defines the combat speed, the combat altitude, and the type of attack to be used in intercepting the target.

PROFILES

A profile is a combination of speed and altitude variables, including initial climb rate, cruise speed, cruise altitude and transition period. The transition period for a manned Interceptor is the time required to change to combat speed and altitude, and for a BOMARC, it is the time required to change to combat altitude and activate the target seeker (a radar homing device). Selection of the profile parameters is made by the program upon a Commit or Recommit action. A director can change profile parameters for manned Interceptors by switch actions when he deems it necessary. An example might be when he needs to complete an intercept before the target penetrates ADA coverage, he may increase the cruise speed and/or cruise altitude. For BOMARCs, he may cause a profile reselection through switch action, e.g., Target Altitude action.

For a manned Interceptor, a standard profile is used which consists of a Buster climb to optimum cruise altitude and optimum cruise speed to the point in space where transition begins. Optimun cruise speed at optimum altitude is the speed and altitude which provides the greatest fuel economy for each manned Interceptor type. A minimum transition time of one minute is programmed to ensure that the required changes are received by the pilot before the attack phase begins.

Three BOMARC profiles are available for automatic selection: Profile I - Low-Altitude Short Range; Profile II - Low-Altitude Long Range; Profile III - High-Altitude. The current profile is displayed in the BOMARC Interception Mission TD.

TACTICS

The initial selection of a tactic is made by the program based upon the Interceptor and armament characteristics and the target altitude and speed. A tactic includes an attack option, a combat speed, and a combat altitude. The attack option is displayed in the Offset/Intercept Point display and the Mission TD. The selection and monitoring of tactics for manned Interceptors are significantly different than for BOMARCs and are discussed separately.

MANNED INTERCEPTOR TACTICS. Four attack options are available in BUIC III for manned Interceptors-stern, front, beam, and cutoff. When the WD receives assignment for a manned Interceptor, he evaluates the attack option and may change it if he deems another one more desirable. During the course of an intercept, target maneuvers may cause the program to recommend a change in the type of attack. An Interceptor Attention display is forced to the WD indicating the recommended attack option while the current option is maintained. (In certain cases the cutoff attack is automatically selected and used by the program.)

FRNT
J323
CE2
JP12

Figure 10-6. Manned Interceptor Attention Display Recommending a Front Attack Option

The display in Figure 10-6 indicates that the program is recommending a front attack (FRNT) for manned Interceptor JP12 intercepting target J323. The director may switch insert the recommended attack, select another, or continue with the present one.

With some exceptions, combat speed and altitude are automatically changed by the program to account for target tactics. If a new type of attack is recommended, combat altitude and speed are not changed. If the WD overrides the combat speed or altitude, the overridden value is not changed by the program. Automatic changes are displayed to the WD and transmitted to data link-equipped manned Interceptors.

A single-Offset STERN ATTACK is used by manned Interceptors unless the magnitude of the final turn is calculated greater than a maximum acceptable value, in which case, the double-offset stern attack is selected. A director cannot select the type of stern attack for a manned Interceptor by switch action.

In considering the logic to select between the two stern attacks, the relative merits of each must be considered by the program. The single-offset stern has very little geometry associated with it while the double-offset geometry is extensive but with the capability to sacrifice some of that geometry when faced with a target maneuver. However, both have the identical terminal phase geometry. The single-offset stern does provide a quicker intercept when the Interceptor is paired in the rear hemisphere of the target. The time to intercept is nearly the same for both stern attacks when the Interceptor is paired in the target front hemisphere. An undesirable characteristic of the single-offset stern is that if the target turns into an Interceptor near the offset point, the attack will develop into a front attack which may not be the most suitable for the Interceptor and its weapons.

The single-offset stern attack consists of a collision course to offset, a turn at offset to a rear-hemisphere position, and a pursuit course (tail chase) to interception. (See Figure 10-7.) A zero-degree track-crossing angle and antenna-train angle are employed. The track-crossing angle is the smallest angle formed by the Interceptor command heading and the target flight path measured from the target tail. The antenna train angle is the smallest angle between the Interceptor heading and a line joining the Interceptor and target positions and is measured from the Interceptor heading. Thus, in the stern tactic, the Interceptor will be directly behind and headed toward the target at rollout (when the Interceptor completes the final turn).

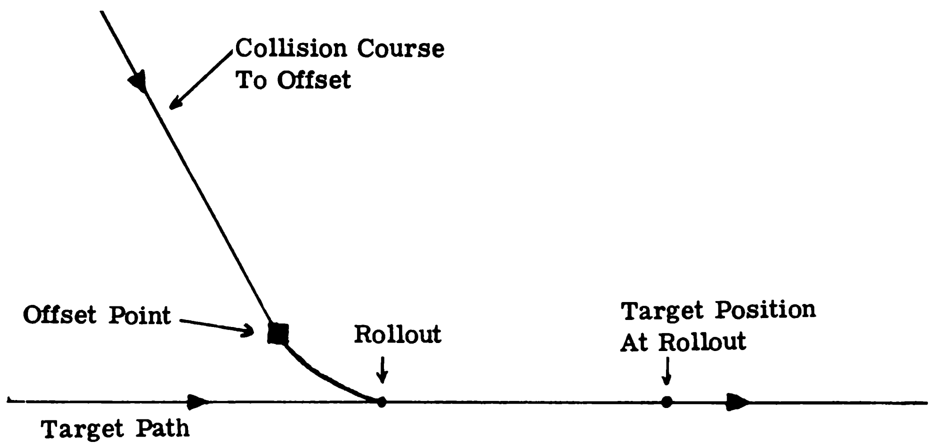

Figure 10-7. Single-Offset Stern Attack

In monitoring the single-offset stern attack, the magnitude of the final turn is compared with a maximum acceptable value. If the magnitude is greater than the value, a new solution using the double-offset stern attack is computed and used.

The double-offset stern attack consists of a collision course to first offset, a turn at first offset on a course perpendicular to the target to second offset, a turn at second offset to a rear-hemisphere position, and a pursuit course to interception. (See Figure 10-8.)

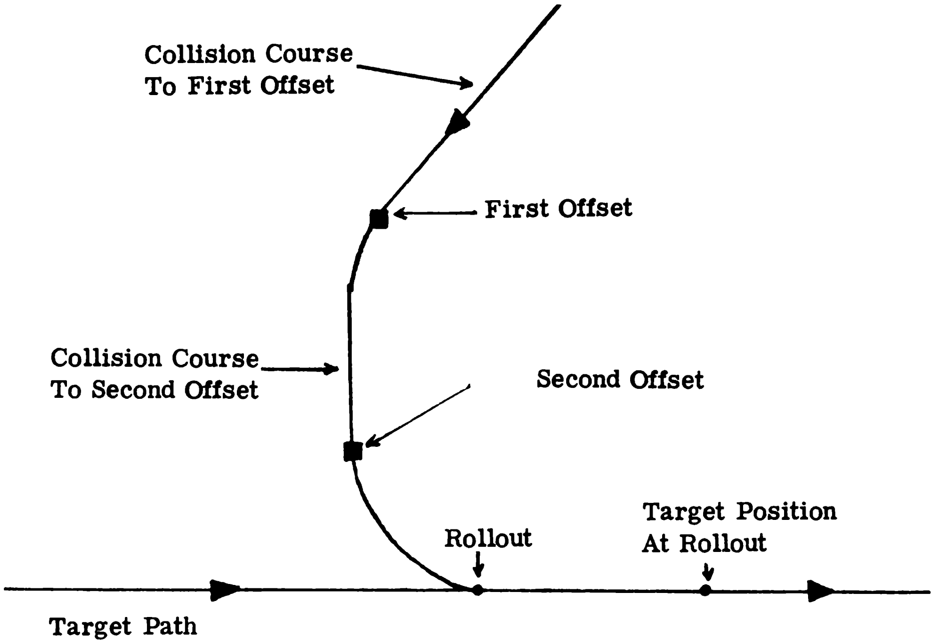

Figure 10-8. Double-Offset Stern Attack

In monitoring the double-offset stern attack, as long as the command heading is toward the rear hemisphere of the target path, the solution is accepted. In Figure 10-9, Interceptor path A with target path D comprises an acceptable solution. However, when the target heading changes to path E, the double-offset solution yields Interceptor path B which is not toward the rear hemisphere of the new target path. In this case, a single-offset stern attack (path C) is calculated and, if the turn at offset is not excessive, it is used.

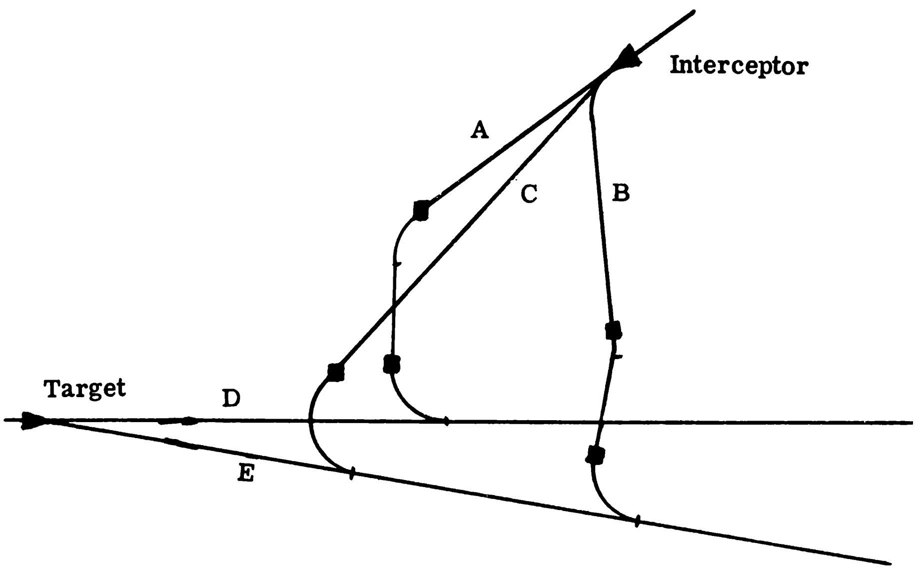

Figure 10-9. Monitoring the Double-Offset Attack

As first offset in a double-offset stern attack is approached, the amount of turn to a new command heading due to target maneuvers is tested. If it exceeds a maximum acceptable value, the perpendicular leg is decremented by 15-second segments until a solution which satisifes the turn criterion is found. In Figure 10-11, the first and second solutions yield offset points A and B, respectively, in which the change in command heading is excessive. The third solution to offset point C, results in an acceptable command heading change. In succeeding cycles, the program will attempt to use the maximum length of the perpendicular leg. Should the perpendicular leg be eliminated and no solution be found, both first and second offsets are eliminated, combat phase is entered, and a pursuit course is computed.

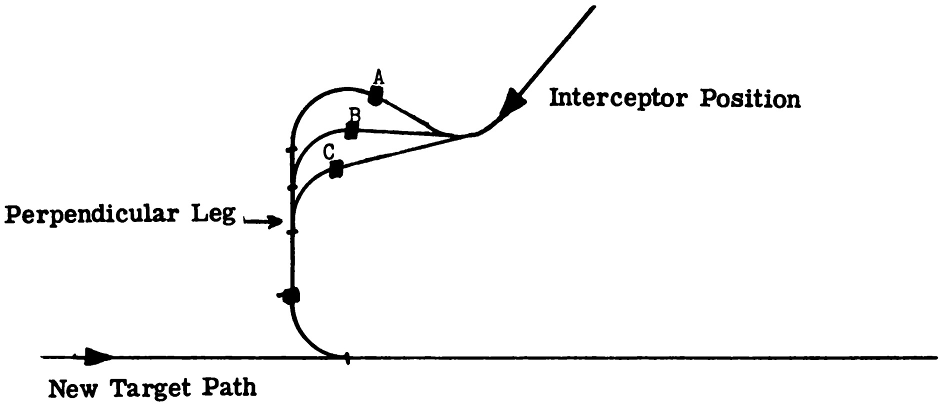

Figure 10-11. Turn Restriction for the Double-Offset Attack

Excessive changes to command heading after first offset will also cause combat phase to be entered with a pursuit course to interception.

The FRONT ATTACK requires vectoring such that the Interceptor will intercept the target from the front. The attack consists of either a lead collision course to interception (similar to cutoff attack - see Figure 10-12) or a final turn course which requires a collision course to an offset point, a turn to an attack heading, and a lead collision course to interception (see Figure 10-13). A lead collision course is the flight path an Interceptor must fly in order to reach a point along the target path at the same time the target does.

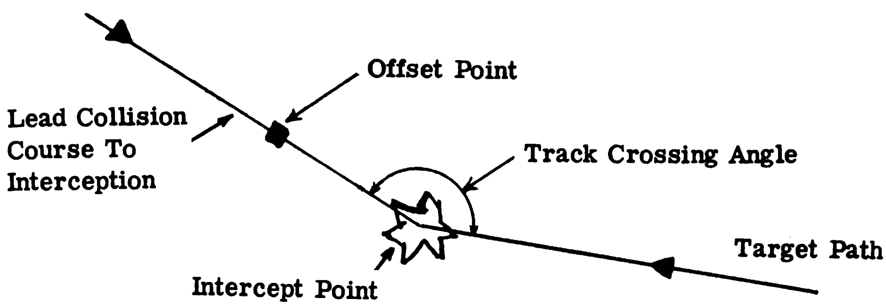

Figure 10-12. Front Lead Collision and Cutoff Attacks

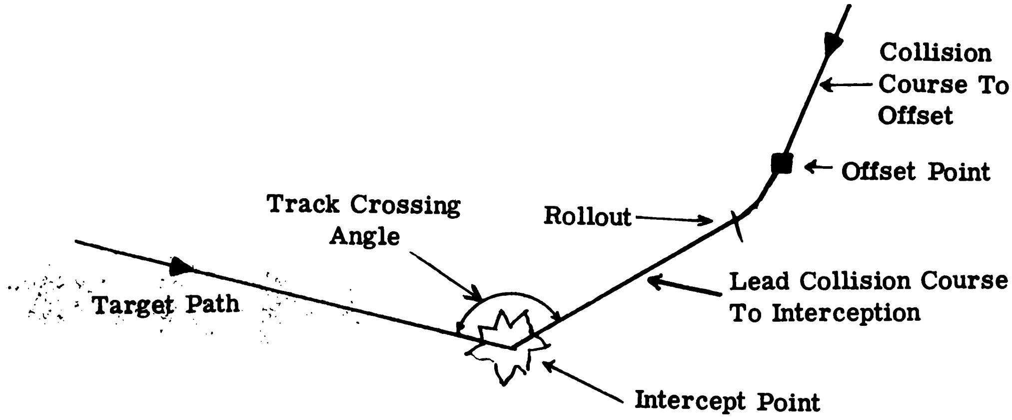

Figure 10-13. Front and Beam Final Turn Attacks

The lead collision attack is used when a designated minimum track-crossing angle is satisfied. When the TCA is less than the acceptable value in a lead collision attack, the final turn attack is used to position the Interceptor for a front attack. The lead collision attack is used whenever possible to eliminate unnecessary turns. Selection of the type of front attack is a program function which is influenced by director switch action, such as manual heading, altitude and speed overrides. The cruise speed of the Interceptor is automatically altered to achieve the most desirable geometry under the existing conditions. If both the lead collision and the final turn attacks are impossible, the cutoff attack is automatically selected and used. When the director takes a Command Speed action, the program will not alter the inserted speed if an impossible intercept condition arises. In this case the director receives the Impossible Intercept attention display and the tactic will remain the front attack. It will be up to the director to take a switch action either to insert a higher Interceptor speed or to cancel the speed override.

A BEAM ATTACK consists of a collision course to an offset point, a turn to an attack heading, and a lead collision course to interception (see Figure 10-13). The beam attack is similar to the front attack employing a final turn. The only difference is that the TCA for the beam attack is smaller to allow a side attack. The TCA of the front attack employing a final turn may vary with target track maneuvers as long as it meets the minimum TCA. The TCA for the beam attack is not variable, i.e., the offset point will move to account for target heading changes to maintain the required TCA.

The CUTOFF ATTACK is a lead collision course to interception (see Figure 10-12). An offset point is displayed on the manned Interceptor's flight path where the transmitted time-to-go (TTG) will be zero. The cutoff attack is not selected initially by the program, but will be used under certain conditions when other attacks yield impossible conditions. This option is normally selected by director switch action to overcome difficulties encountered in track positional errors. The front lead collision and cutoff tracks are similar in many respects, the major difference is that the cutoff attack is not restricted by a minimum TCA but the antenna train angle (ATA) is monitored to determine if it exceeds a maximum desirable angle.

BOMARC TACTICS. Two attack options are available for BOMARC Interceptors--cutoff and final turn. Selection of the attack option for an intercept is a program function based upon the BOMARC position relative to the target heading. The Attack Option action is not available to the WD for BOMARCs.

A CUTOFF ATTACK is a collision path to interception, which allows for a minimum intercept time (see Figure 10-14). It is initially selected upon commitment or recommitment and will be retained through the intercept as long as the minimum track-crossing angle can be maintained.

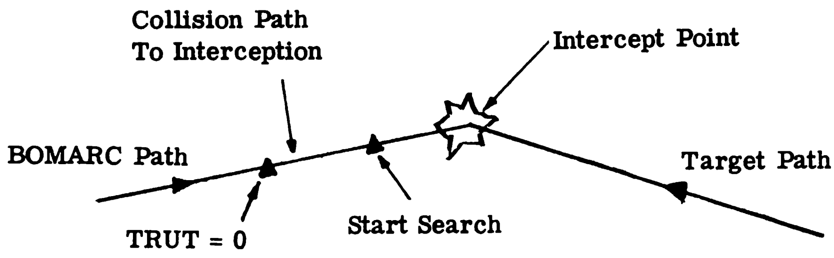

Figure 10-14. BOMARC Cutoff Attack

A FINAL TURN ATTACK consists of a collision path to an offset point, a turn to an attack heading, and a collision path to interception (see Figure 10-15). A final turn attack will be selected by the program when a minimum track-crossing angle cannot be achieved with a cutoff attack.

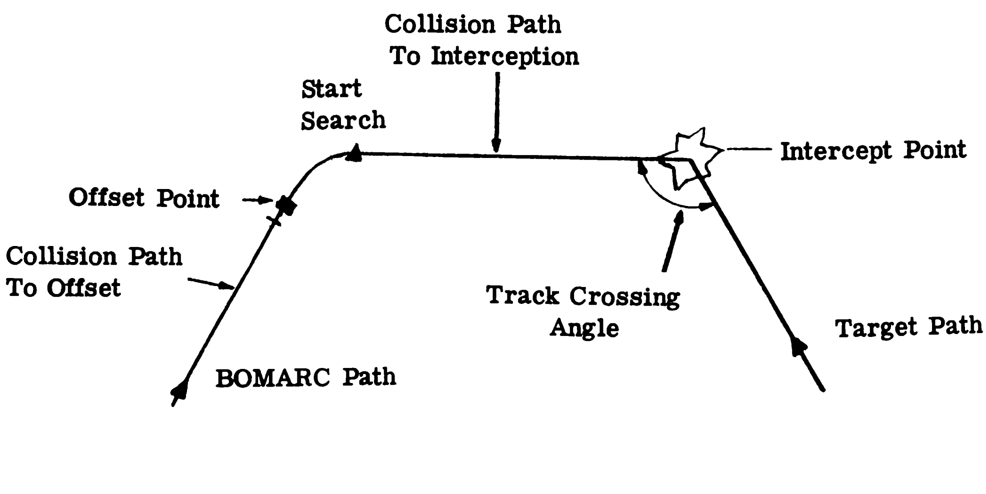

Figure 10-15. BOMARC Final Turn Attack

The BUIC computer and the program are merely aids to the director in conducting Interceptor missions. Under ideal conditions, an intercept could be successfully completed by the program. However, target maneuvering, tracking difficulties, safety hazards, etc., could develop into major problems which could cause missed intercepts. Thus, the director, who can anticipate situations more readily than a computer, must at times take actions to override commands or actions of the program. In effect, the program repeatedly performs the calculations a director is required to perform in a manual NCC and displays the results of the calculations for director consideration, if required.

For a manned Interceptor Commit action, the committing director's technician calls in the scramble information to the Combat Alert Center (CAC) of the departure base. Either the CAC informs the assigned director of the manned Interceptor takeoff time or the pilot contacts the director as soon as possible after he is airborne. The director takes the Airborne action which sets the track status of the manned Interceptor to Airborne and starts guidance calculations. Since BOMARC launching is automatic in response to a Commit action, the BOMARC track status is changed to Airborne either upon receipt of a takeoff message from the BOMARC squadron or at the predicted time of launch. Guidance calculations are started but command transmissions do not begin until the BOMARC has reached cruise altitude.

To aid in the identification and tracking of Interceptors, Mode 2 Selective Identification Feature (SIF) transponder equipment is available on most Interceptors controlled by the NCC. SIF radar returns are received from an Interceptor through a radar site and are used by the air surveillance function to track the Interceptor with the associated SIF code.

A Mode 2 SIF code number, consisting of four octal digits, is ordinarily available to the program for each Interceptor initiated at the NCC. For manned Interceptors, the first two digits are identical for each aircraft within a squadron. These squadron codes stored in the program are subsequently assigned to scrambled manned Interceptors. Either the CAC, at takeoff, or the pilot, at initial radio check in, will inform the WD of the SIF code for the aircraft. The WD inserts the last two digits into the computer by the Assign SIF or Airborne with SIF action. For a BOMARC, the SIF code associated with each missile within a squadron is stored in the program. In response to a Commit action, the program selects a missile from the designated squadron and assigns the related SIF code to the track.

When radar data appear near the departure base, the WD must determine if these data belong to his assigned Interceptor. This can be determined by the flight pattern, or the WD may request the program to locate any radar data with the same SIF code of the Interceptor by taking a Request SIF Display action.

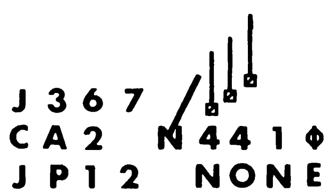

Figure 10-16. Track SIF Display

In Figure 10-16, the Mode 2 SIF code assigned to manned Interceptor JP12 is 4410 and the data with the same SIF code are marked by the one-half inch vertical vectors. The NONE indicates that other Mode 2 SIF data are not being used to track the manned Interceptor. The WD now knows where the Interceptor's data are, so he takes the Reinitiate action to reposition the Interceptor symbology over the latest data. This action also sets the track status to Established and the track merit to Reliable.

An Automatic Initiation feature is incorporated in the program to relieve the WD of the task of reinitiation under certain conditions. When radar data with the same SIF code as that of an Interceptor appear near the track symbology, the program automatically repositions the Interceptor symbology onto the data and sets the track status to Established. Automatic initiation is attempted for a manned Interceptor at the time its SIF code is inserted if the track status is either Airborne or Scramble, or for a BOMARC at the predicted time of launch. Automatic initiation attempts continue until the track status of either the Interceptor type is other than Scramble or Airborne.

At locations where facilities are available, Federal Aviation Agency (FAA) controllers may assume control of manned Interceptors in certain phases of the mission. In the interest of safety the AF/FAA agreement was made to reduce the occasions of two agencies controlling aircraft simultaneously in the same airspace. When the NCC orders a scramble, FAA controllers direct the manned Interceptor from takeoff until the WD requests handoff (acceptance of control). Handoff will normally occur when the Interceptor approaches the airspace reserved for practice intercepts or in time to accomplish the tactical phase of the mission. At the completion of the mission, control of the Interceptor will be transferred back to FAA for directing the Interceptor back to home base. At this time, the Interceptor track may be dropped from the system or carried as a surveillance track, i.e., guidance commands are not transmitted to the Interceptor by the computer. A more detailed description of AF/FAA procedures can be found in ADCM 55-14, Air Traffic Control Procedures or Fighter-Interceptor Operations.

Most of the information required in conducting a mission is contained in a Mission TD. Since a director will be frequently referring to this display, it should be requested as soon as possible after he receives assignment of an Interceptor.

Figure 10-18 is the Mission TD for the intercept problem shown in Figure 10-17. From Figure 10-17, it can be seen that manned Interceptor JP12 is in the process of intercepting Hostile track J323 using a single-offset stern attack with about four minutes remaining to offset.

The Mission TD in Figure 10-18 is interpreted as follows:

line 4 - Manned Interceptor JP12 has a clean configuration (C - no tanks) and is receiving data link instructions through transmitter site B.

line 5 - A single-offset stern (S) is being employed and four minutes (4M) remain to offset. Present fuel on board is 4700 pounds.

line 6 - The attack heading will be 135° (A135). Present target range is 11 miles.

line 7 - The command heading requires a port turn to 195 degrees (P195). Target bearing is starboard at 20 degrees (S020).

line 8 - Interceptor command speed is 1.13 mach and target speed is .92 mach.

line 9 - Interceptor command altitude is 40,000 feet (400) and target altitude is 40,500 feet (405).

The program provides a fuel monitoring and prediction function which estimates the amount of fuel on board and determines whether it is sufficient to complete a mission. Standard fuel consumption rates for each type of aircraft, based upon speed, altitude, climbs, and descents, are used.

The normal fuel load for each manned Interceptor type (including tanked and clean) is stored in the program. Thus, at takeoff, the amount of fuel on board is known by the program and, each cycle, the amount of fuel used since the last cycle is subtracted from the fuel on board. The calculation of fuel used is based upon the guidance information transmitted to the aircraft and the results are displayed in the Mission TD. The WD may insert a new value for the fuel on board by switch action when the pilot report is significantly different from that displayed.

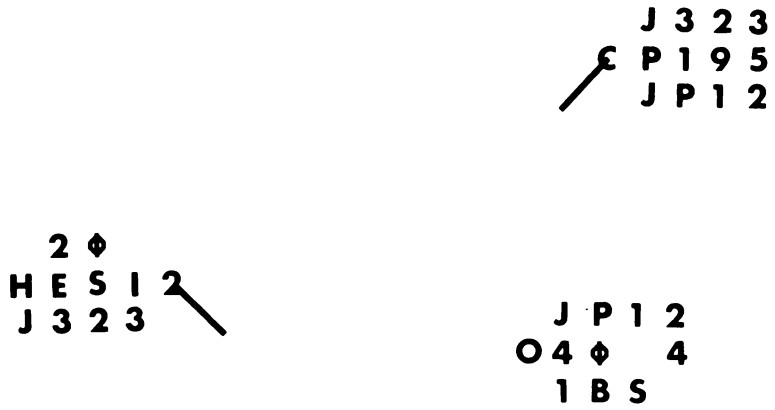

Figure 10-17. Sample SID of an Intercept Problem

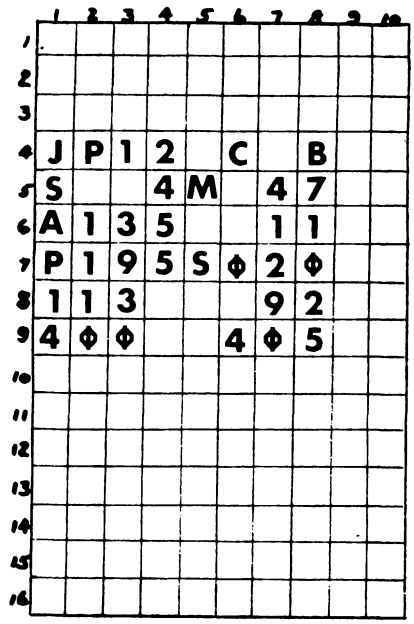

Figure 10-18. Sample Intercept Mission TD - Manned Interceptor

Since the flight time, speed, and altitude of the manned Interceptor is calculated by the program each cycle, the amount of fuel required to complete the intercept can be determined. Fuel predictions are only made when a change in command heading is required. If the fuel required for interception exceeds the fuel on board, a flashing Fuel Impossible attention display in the top row of the Interceptor symbology is forced to the WD and guidance computations continue (see Figure 10-19). The WD should confirm the displayed fuel on board with the pilot and, if correct, he may change the command speed and/or altitude or the tactics, or he may decide to use another weapon to intercept the target. If displayed fuel is incorrect, the insertion of the correct value may eliminate the impossible intercept condition.

FUEL
V3ΦΦ
CE2
JP14

Figure 10-19. Manned Interceptor Attention Display Fuel Impossible

When fuel predictions are made and sufficient fuel is available for the intercept, the amount of fuel that is calculated to remain after intercept is forced to the WD in a flashing Fuel Reserve attention display in the top row of the Interceptor symbology (see Figure 10-20). The WD can cause the Fuel Reserve attention display to appear by inserting a new value for fuel on board. If he takes the Insert Fuel action without indicating any fuel (no buttons pushed in the general inputs modules), the display is forced but the fuel on board is not changed.

FR37
V1Φ9
TE4
JP12

Figure 10-20. Manned Interceptor Attention Display

Fuel predictions for BOMARCs are made by comparing the maximum intercept time with the elapsed time since launch plus the time remaining to interception. If greater, the intercept is possible and the intercept continues. If less, interception is impossible and a Fuel Impossible display (identical to manned Interceptor display) is forced to the WD. Guidance calculations and data link command transmission continue and the WD may need to take corrective action. He may determine that certain information, such as target altitude or heading or BOMARC position, is in error. Switch insertion of the correct data may make the intercept possible. If the information appears to be correct, the WD may recommit the BOMARC and use another weapon on the target, or continue with the commitment.

FOLDBACK

Foldback is an intercept condition in which the time-to-interception does not allow a manned Interceptor or BOMARC to reach command altitude and speed by following the shortest path to interception. In other words, an Interceptor will not be able to complete its scheduled profile by the time it arrives at the target position.

For a manned Interceptor, if foldback occurs before a cruise altitude is reached and the WD has not overridden the cruise altitude, the profile is automatically modified by setting cruise altitude to combat altitude. This will remove the foldback only if the target altitude is below cruise altitude and time would not be taken up in climbing to an altitude above the target and then diving to combat altitude. Should foldback occur after cruise altitude is reached, command speed and altitude are set to combat speed and altitude and the intercept recalculated. This eliminates the remainder of the cruise leg and gets the Interceptor at combat altitude and speed as soon as possible.

FOLD
V467
TE1
JP15

Figure 10-21. Manned Interceptor Foldback Attention Display

Should foldback still exist after the program attempts to overcome the condition, a flashing Foldback attention display is forced to the WD (Figure 10-21) and guidance calculations continue using the newly selected values, if any. The probability of a successful intercept with a foldback condition is very low. The WD should, therefore, attempt to remove the foldback by momentarily vectoring the manned Interceptor away from the target to allow time to reach altitude or by cancelling any overrides he may have taken. The possibility of intercepting the target with another weapon should also be considered at this time.

For a BOMARC, if foldback occurs in Prelaunch, the missile is launched on a heading that will increase lateral separation between the BOMARC and its target so that time to interception will not exceed profile time. A Foldback attention display is forced to the assigned and committing directors until foldback no longer exists. If foldback occurs on a recommitment, the recommitment is cancelled and the current commitment and calculations continue. An Interceptor attention display is forced to the WD indicating the cancellation.

FOLD
M423
M445
AM11

Figure 10-22. Interceptor Attention Display

In Figure 10-22, BOMARC AM11 was recommitted against target M445 and a foldback (FOLD) condition was determined. The recommitment was cancelled and AM11 pairing with target M423 remains. Both the FOLD and M445 symbologies will flash to attract the WD's attention to the condition.

IMPOSSIBLE-INTERCEPT CONDITIONS

Target maneuvers can at any time cause an intercept to become impossible under the current conditions for conducting the intercept. Within certain limitations, the program attempts to overcome the impossible situation. When it cannot do so, the WD is informed through appropriate displays. Intercepts are monitored for impossible conditions due to Interceptor speed disadvantage (no solution), insufficient fuel and excessive ATA.

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IMP
V423
DE1
AL14
```

Figure 10-23. Manned Interceptor Speed Impossible Attention Display

The speed impossible situation arises when the speed of the target is such that the miss distance calculations cannot yield an acceptable solution. The Speed Impossible attention display (Figure 10-23) is forced to the WD and the Interceptor (manned or BOMARC) is vectored on its last command heading.

The Fuel Impossible attention display is forced to the WD when the program predicts that insufficient fuel remains to complete the intercept. Intercept calculations continue as if the intercept were possible.

Monitoring of the ATA is only done for a manned Interceptor on a cutoff attack. When the ATA exceeds a specified angle, the assigned director receives an ATA Impossible Intercept attention display (Figure 10-24) which indicates that the target will probably be outside the coverage area of the airborne radar in the final stages of the intercept. Guidance computations and command transmissions continue as in a possible intercept condition.

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ATA
U456
TE1
JP15
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Figure 10-24. Manned Interceptor ATA Impossible Attention Display

To overcome the impossible conditions, the director may cancel or change overridden values or make corrections to the target headings, speed, and/or altitude, if in error.

For an ATA impossible, an insertion of a height command speed, if possible will usually result in a smaller ATA. Using Figure 10-25 as an example, the Interceptor's present heading is toward point A with the resulting ATA A' which is, in this case, excessive. When the director inserts a higher speed, the intercept is accomplished much sooner (intercept point moves toward target) and yields a command heading toward point B with an acceptable ATA B'.

If, after taking corrective action, the intercept is still impossible, the director may determine that the intercept may be marginal and will continue with it by vectoring the Interceptor as close as possible for an attack. The director should also consider using another weapon and recommitting the presently employed Interceptor to a more likely mission.

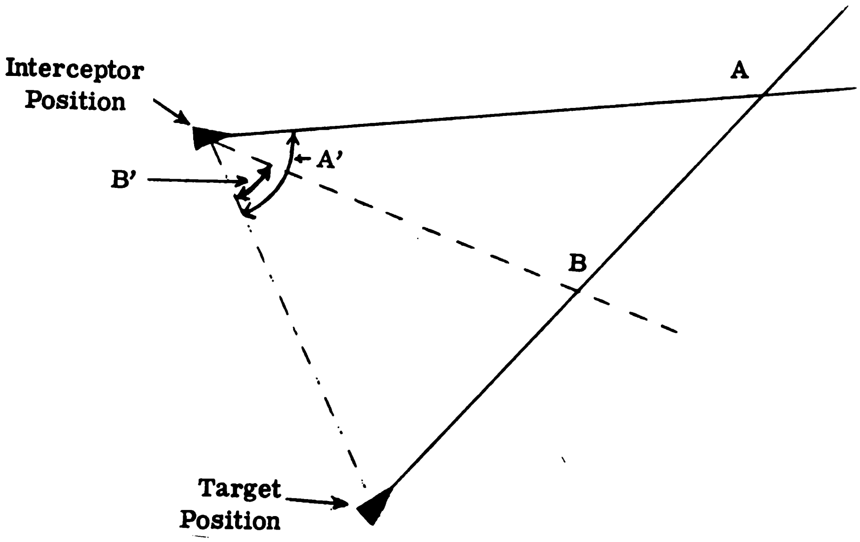


Figure 10-25. Excessive ATA Problem

COMMAND TRANSFORMATION

Command headings are transmitted in the reference system of the Interceptor receiving data link instructions. Data link command headings for manned Interceptors are referenced to magnetic north except for the F-106 which receives its commands referenced to true north. Attention displays for voice transmission to manned Interceptors are all referenced to magnetic north. BOMARC data link command headings are transformed into the coordinate system used in BOMARC navigation.

In order to avoid an obstacle, to steer away from a populated area, or to maintain control under adverse tracking conditions, the WD may manually override the computed command heading of an Interceptor. The inserted heading for the Manual Heading action is interpreted by the program as the magnetic heading for all manned Interceptors and true heading for BOMARCs. It should be noted the SID scopes are referenced to true north, and therefore the magnetic variation should be applied to the desired true heading for manned Interceptors.

HANDOVER

Control of manned Interceptors or BOMARCs may need to be transferred to another director within the NCC or to an adjacent control facility. This can be caused by a WD being overloaded with assignments or having an intercept occurring in an adjacent facility's area.

An internal transfer or handover is effected by the SD or controlling WD through the Reassign action after coordination between the two directors. For manned Interceptors, the pilot may be required to change his voice control frequency to the receiving WD's frequency. A Track Assignment TD is forced to the newly assigned WD, who then assumes control.

DIFFERENTIAL ALTITUDE REQUESTS

A director may request the program to measure the difference in altitude between a manned Interceptor and its target if sufficient time remains until transition. The altitudes of both tracks are measured consecutively by the same height finder and the difference in altitudes is displayed to the director in the manned Interceptor track display. The display will be positive if the manned Interceptor is above the target and negative if below. The program will also indicate any Aborted or Negative reply conditions in the manned Interceptor symbology.

An external handover is initiated by the Start Lateraltell for Tracking action of the SD or WD. To be eligible for handover, manned Interceptors may be on any mission while a BOMARC can only be on an intercept mission. Interceptor and target information is lateraltold by the program over digital data link lines to the specified facility. When a director is assigned in the receiving facility, a message is returned to the controlling facility and a Handover Imminent attention display is forced to the responsible director (Figure 10-26). If a manned Interceptor is being handed over, the voice frequency of the receiving director must be relayed to the pilot. When the receiving director establishes radio contact with the pilot of a manned Interceptor, or when SIF tracking is established for a BOMARC, the receiving director takes the Accept Handover action. The two computer programs automatically accomplish the transfer of control and the losing WD receives the Handover Completed attention display (Figure 10-27).

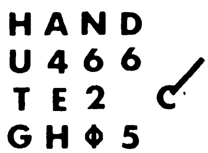


Figure 10-26. Handover Imminent Attention Display

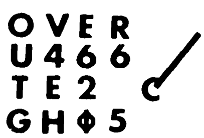


Figure 10-27. Handover Completed Attention Display

COMMAND TRACKING

At the discretion of the assigned director, a manned Interceptor may be placed on command tracking. The tracking function then uses command heading and command speed for prediction of the track position. Since the manned Interceptor will be following these commands, the track position can be more accurately predicted and tracking will be more reliable. BOMARCs will always use command tracking. When a manned Interceptor is off command tracking, track prediction is based on radar returns.

Voice radio and ground-to-air (G/A) time division data link (TDDL) are used for communicating with manned Interceptors. TDDL is the prime means. Voice radio is used to relay to the pilot certain data not transmitted over TDDL, or to voice control a manned Interceptor if data link communications fail or if the aircraft is not equipped with data link. Ground-to-ground (G/G) data link is used to initiate the launch of BOMARCs and to receive BOMARC status information from the Interceptor Missile Squadron Operation's Center (IMSOC). TDDL is the only means of transmitting guidance information to airborne BOMARCs. Telephone communications are provided to manned Interceptor bases for scrambling and status reporting, and to IMSOCs as an alternate means of status reporting.

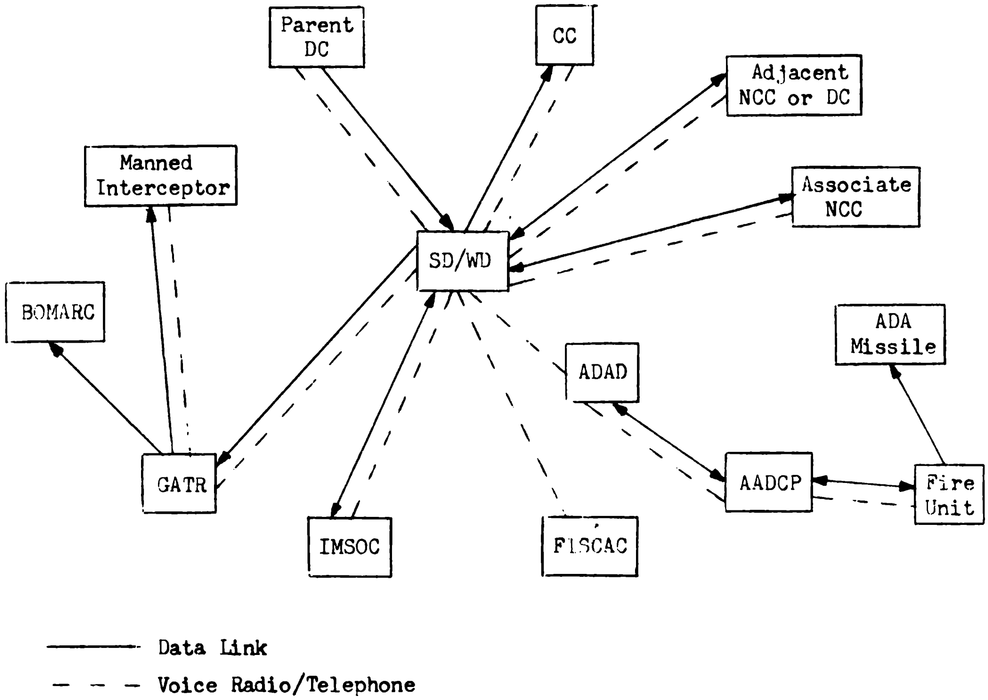


Figure 10-28. Weapons Communication Interface Diagram

TIME DIVISION DATA LINK (TDDL)

TDDL messages are automatically sent to Interceptors through the use of ground-to-air transmitter (GAT) sites. All GAT sites within a BUIC-controlled Division form a network connected to a single controlling NCC, which is designated on the Ground-to-Air Transmitter (GAT) Site Status manual input card at each NCC. All commands generated at other Division NCCs are sent to the controlling NCC over lateraltell data link lines. The controlling NCC combines the lateraltold messages with its own and relays the messages to the GAT sites. An Interceptor receives all data link messages but accepts only those addressed to it. In manned Interceptors, the airborne equipment interprets and displays the guidance data. In BOMARCs, the data are used automatically to guide the missile.

To ensure receipt of messages, two GAT sites are always selected for message transmissions to BOMARCs. Initially, two GAT sites are selected for manned Interceptors, but the SD may cause the program to use only one site for each manned Interceptor by taking the GAT Option action. The GAT Option in effect is displayed in the Operational Conditions SID.

GAT sites selection is based upon a site index and an altitude coverage check. The site index is a measure of the radio frequency power that can be delivered to an Interceptor from a particular GAT site. The altitude coverage check ensures that the GAT site can "see" the Interceptor, i.e., there are no ground obstructions, such as mountains, between the GAT site and the Interceptor. If all GAT sites have been turned off by the GAT site status card, messages are sent using the all status address in the event one or more of the sites are still operating. Reselection of GAT sites is made each program cycle and prime consideration is given to the previously selected site.

TDDL test messages are generated and transmitted by the controlling NCC to each GAT site every cycle provided sufficient time exists between command message transmissions. Pilots may check the TDDL system by switch selecting the test address and observing the standard displays presented. If the displays of the test messages are in error or missing, the pilot will inform the WD who will then voice control the Interceptor since data link information will not be reliable.

When a BOMARC is to be handed over to an adjacent facility, the receiving facility lateraltells its TDDL channel number to the losing facility. The losing facility, in turn, transmits the new channel number to the BOMARC, which changes its receivers to be compatible with the new controlling facility. When the change is completed the losing facility informs the new facility, which then assumes control of the BOMARC.

GROUND-TO-GROUND DATA LINK

Two-way G/G data link communications between the NCC and tied BOMARC sites are provided for the NCC to transmit fire-up commands to the BOMARC site and receive BOMARC Launcher Status reports from the site.

PRELAUNCH MESSAGES. Prelaunch commands are automatically transmitted when a BOMARC Commit action is taken and the intercept is possible. Essentially the information in the G/G messages is the same as contained in the G/A TDDL messages; the format is different. The prelaunch translator receives the messages, converts the missile information to G/A format, and transmits information to the missile for initial flight commands and to the launcher to initiate the fire-up sequence.

When the NCC is in the Active mode, BOMARC authorization is not in effect, and BOMARC squadron's Sim/Live indicator is Sim, the BOMARC Prelaunch Status Test (BPST) feature can be initiated by manual input card. BPST provides a capability for live interaction between the NCC and a BOMARC IMSOC for prelaunch status testing. A BOMARC Commit action, when BPST is in effect, causes BOMARC symbology to be displayed and simulated prelaunch messages to be generated and transmitted to the IMSOC. These simulated messages do not cause the actual firing of a BOMARC. In response to simulated prelaunch messages, a Prelaunch Status Simulator (PLSS) at the IMSOC generates simulated results (Fire-up, Take-Off, Malfunction) and transmits these as simulated status messages to the controlling NCC. BPST is terminated by manual input card, SD BOMARC Authorized action, or a change to Monitor mode. The BPST indicator is displayed in the top row of the Operational Conditions SID.

In the Active mode, test messages can be sent to BOMARC squadrons to check the G/G lines. Test messages are started by a BOMARC Line Test manual input card which specifies the squadron (or all) to be tested and the duration of the test. The test may be terminated or the squadron changed by another manual input message. Transmission of test messages to an IMSOC receiving prelaunch messages is delayed until the prelaunch message transmission is completed. A Line Test indicator is displayed in the BOMARC Missile Base SID for each squadron.

A BOMARC selected for launching must successfully pass checks for SIF overlap, successive missile launching time, and seeker frequency interference.

LAUNCHER STATUS REPORTING. BOMARC launcher status is reported either by an automatic status reporting system or manually by telephone plus manual input. In the automatic mode, the program makes periodic time checks to determine if a reporting failure exists. If timely reports are not being received, a Missile Status Report Failure TD is forced to the SD. Manual status reporting must be initiated. The program continues to monitor the automatic reporting system and when it determines that a malfunction no longer exists, a display is forced to the SD indicating the resumption of automatic reporting. The reporting method is always displayed in the BOMARC Missile Base SID. A BOMARC missile may have a reported status of: 1) Not Available, 2) Ready (available for commitment), 3) Fire-up (being launched), 4) Take-off (launched), or 5) Malfunction (missile trouble has developed). The number of BOMARCs in a Ready status for a squadron is displayed in the BOMARC Missile SID.

The track status of a scrambled BOMARC is set to Airborne at the predicted time of launch and to Establish when it is automatically initiated or manually reinitiated. If a Fire-up status report is not received at the NCC by the predicted launch time, a No Fire-up attention display is forced to the WD. If a Take-Off status report is not received within 30 seconds after predicted time of launch, a No Take-off attention display is forced to the WD. Should a malfunction status report be received at any time, the Malfunction attention display is forced to WD and no reselection of missiles is made. The WD must drop the BOMARC track symbology when it is determined that the missile has not launched. The program stops looking for status reports, for a launched missile, 30 seconds after the predicted time of launch.

VOICE COMMUNICATIONS

If a manned Interceptor is not equipped with TDDL or if a data link malfunction exists, the manned Interceptor must receive all guidance data by voice. Guidance information is available to the WD for transmission in the Mission TD and Interceptor Attention SIDs.

The program selects and displays, in the Mission TD, a voice-transmitter site for manned Interceptors in a Scramble status and for manned Interceptors in the process of being handed over from an adjacent facility. The selection of the site determines the frequency to be used by the WD in communicating with the pilot. This frequency must be relayed to the pilot via the CAC on a scramble and is lateraltold by the gaining facility on a handover for relaying to the pilot by the losing WD. The selection of the voice transmitter site is based upon the nearest site to the manned Interceptor with an ON status and does not take into consideration the altitude of the manned Interceptor. When an aircraft transmits and a radio site is receiving, a CODAN (Carrier-Operated Device Anti-Noise) lamp indication will be shown next to the appropriate radio site button on the Radio Site Selection Panel. WDs will normally use this site for voice transmissions.

SUMMARY

The computer program generates, transmits, and displays guidance instructions for each manned Interceptor and BOMARC based upon the type of mission selected. Commands are automatically transmitted to BOMARCs by data link and to those manned Interceptors equipped with data link receivers. Commands and instructions can also be transmitted to manned Interceptors by voice radio.

Weapons personnel monitor assigned tracks and, by switch actions, may change, correct, or override computer-selected parameters for the mission, as required. Conditions requiring operator attention cause the program to force appropriate displays to the assigned operator's console.

AIR DEFENSE ARTILLERY COORDINATION

The Air Defense Artillery (ADA) system is an Army ground-to-air weapons system consisting of Army Air Defense Command Posts (AADCPs) and their fire units. This is a point-defense system in that elements are located strategically within the United States for the defense of large cities, industrial complexes, airbases, and other prime targets. The NCC is responsible for monitoring ADA operations and for coordinating ADA surface-to-air missile employment within the NCC's area of responsibility. Specifically, the NCC ADA function:

1. Selects tracks for transmission to AADCPs controlled by the NCC.

2. Selects tracks for ADA-purpose lateraltell to other control facilities.

3. Places ADA fire control restrictions on tracks as directed by the SD.

4. Processes results of ADA tactical action and fire unit status data received from AADCPs.

5. Maintains information relative to ADA activity on tracks and fire unit alert status for display and forwardtell.

The Air Defense Artillery Director (ADAD) is responsible for maintaining the operational efficiency of the ADA function in the NCC. He is required to coordinate track-information flow between the NCC, the adjacent control facility, the AADCP, and the ADA fire units. To do this, the ADAD, assisted by a technician, monitors the ADA program operation and controls or overrides the program by switch actions and/or by telephone communications with the AADCP and the adjacent control facility. The ADAD must know the location and characteristics of each type of ADA weapon within the Division and adjacent Divisions, as well as all directives, rules, and policies governing the use of these weapons.

The AADCP is the nerve center of the ADA defense system. The AADCP receives and correlates information from its controlling SAGE DC or BUIC NCC, from its own surveillance radars, and from its associated fire units. These inputs are used to maintain a complete air picture of the AADCP surveillance area, and to control and monitor fire unit operations. Fire unit status is periodically reported to the controlling facility.

The fire unit is an ADA missile complex consisting of missiles and tracking, launching, control, and guidance equipment. Fire units operate in either a centralized or decentralized control mode. A special condition, termed Pop-Up or Low Sweep operations, may exist for either mode. In the centralized mode, fire units engage only targets assigned to them by the AADCP, while in the decentralized mode, fire units may engage Hostile tracks without direction from the AADCP. When Pop-Up operations are authorized, fire units may engage any airborne objects that are initially detected by ADA radars and that meet Pop-Up criteria. Pop-Ups are reported to the BUIC NCC by data link through a switch activation at the fire unit.

NCCs operate with AADCPs in one of two basic operating options--automatic and lateraltell. An Off option is also available but technically is not considered an operating option. When more than one AADCP is associated with an NCC, the AADCPs may be placed in any combination of Automatic, Lateraltell, or Off options. NCCs are capable of interfacing with Missile Mentor (AN/TSQ-51) and BIRDIE-5 (AN/GSG-5) types of AADCPs.

An AADCP located within a control facility's area of responsibility is termed an internal AADCP. If the AADCP is outside a facility's area but is adapted for the facility, it is termed an external AADCP. Normally, internal AADCPs operate in the Automatic option while external AADCPs operate in the Lateraltell option. An external AADCP may also qualify for the Automatic option provided data link lines are available between the control facility and the AADCP.

When an NCC changes to the Active mode, internal AADCPs are automatically placed in the Automatic option, while a change to Monitor mode places all AADCPs in the Off option. It is the ADAD's responsibility to select the appropriate operating option for each AADCP adapted for the NCC. He must coordinate with the AADCP at the time Active mode is entered and before any subsequent changes in mode. When changing to the lateraltell option, he must also coordinate with the ADAD in the adjacent facility responsible for the AADCP.

In the Automatic option, tracks at the NCC are selected either automatically by the program or manually by ADAD switch action. Selected tracks that qualify are passed (transmitted) to the AADCP. The ADAD may also pass other information on a track to the AADCP, such as a Hold Fire or Cease Fire Command. Replyback messages, containing fire unit status and tactical action information, are relayed to the NCC by the AADCP. The information is made available to the ADAD via displays; some requested and some forced.

An external AADCP in an adjacent facility whose radar surveillance area overlaps into the NCC's area, will normally operate in the Lateraltell option. Tracking information is selected in the same manner as in the Automatic option, but it is lateraltold to the adjacent facility where it is screened before passing to the AADCP. Screening is performed to maintain control over the information being sent to the AADCP and to prevent an overload situation at the AADCP.

Should communications be broken between an external AADCP and its controlling facility and data link lines are available between the NCC and the AADCP, the NCC may change the operating option to Automatic. Under these conditions, the adjacent control facility may change to the Lateraltell option. At the NCC, an AADCP operating in the Lateraltell option is handled much as an AADCP operating in the Automatic option: information to and from the AADCP is merely routed through an adjacent facility. Replyback messages received directly from a Lateraltell AADCP are rejected by the program but lateraltold-in feedback messages from the adjacent control facility are accepted and used.

For an AADCP in the Off option, neither automatic nor manual track selection is performed. Replyback and feedback messages, if received, are rejected by the program.

TRACK CLASSIFICATION AND SELECTION

The computer program performs track classification and selection calculations to determine whether a given track should be considered for further processing for an AADCP. Each track is processed and classified on an individual AADCP basis. Track selection considers the track position, speed, and heading. Two circular areas are used in classifying tracks for an AADCP.

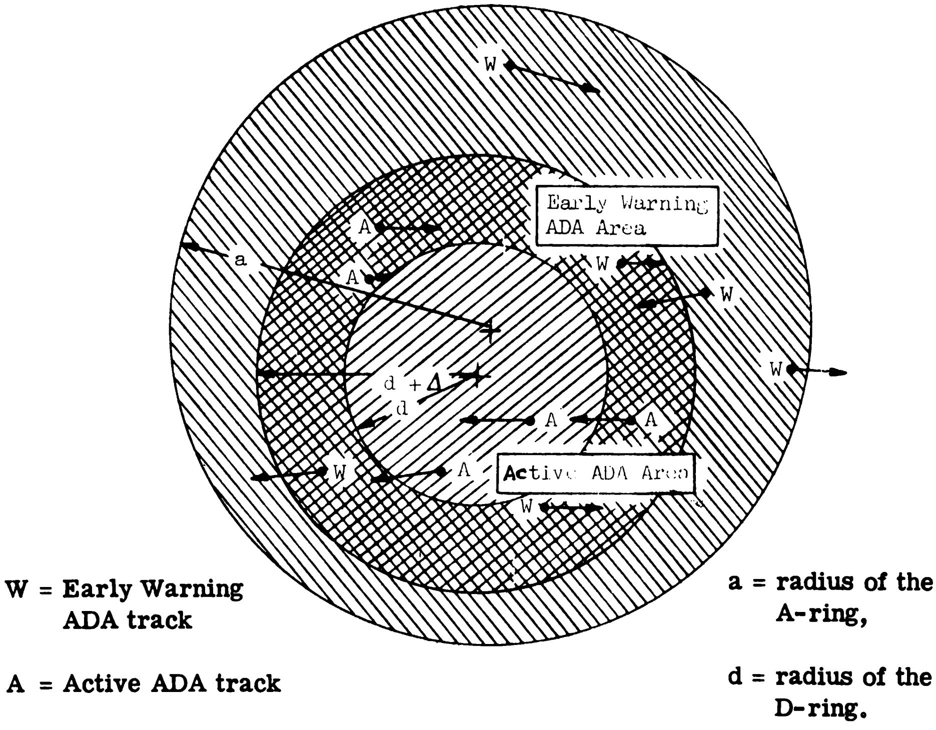


Figure 10-29. Examples of Early Warning ADA and Active ADA Tracks

The letters A and W indicate the present track positions and vectors indicate heading. The double-cross-hatching marks the area in which a track's category may be either Active ADA or Early Warning ADA. Since the Active ADA area is unique for each track, the middle ring ($d + \Delta$) is used for illustrative purposes only.

The A-ring is the circumference of the area in which tracks can be passed to an AADCP. The center of the ring is usually located at the position of the AADCP's surveillance radar and has a radius approximating the range of the data display console at the AADCP. Since the AADCP cannot "see" beyond this display range, tracks outside the A-ring are not considered for passing to the AADCP.

The D-ring is the circumference of the area that can be defended by an AADCP. It is the smallest circle that circumscribes the area in which an intercept can be made by any missiles from the fire units controlled by the AADCP. The radius of the D-ring is a unique-to-site constant and is dependent upon the positioning of the individual fire units. Because the circle is used to approximate the defended area, there may be areas within the circle that cannot be reached by any fire unit in the AADCP complex.

The program also uses a Reaction Time (adaptation value) to compare with a track's time-to-go to penetration of the AADCP's D-ring. Use of a reaction time ensures that tracks are passed at a distance such that ADA intercepts can be made at maximum missile range.

Tracks at the NCC are classified into one of three categories with respect to a given AADCP: Non-ADA, Early Warning ADA, or Active ADA tracks.

Non-ADA tracks are those tracks not within the AADCP A-ring. They are not considered for further processing during the present cycle.

Early Warning ADA tracks are those tracks within the A-ring which are not expected to penetrate the D-ring within the AADCP's Reaction Time.

Active ADA tracks are those tracks within the AADCP D-ring and those that could penetrate the D-ring within the Reaction Time adapted for the AADCP.

After a track has been given an ADA category, the program determines if the track should be passed to an AADCP. Active ADA tracks, and Early Warning Hostile and Faker tracks are automatically passed except when the track: is being dropped; is a BOMARC; has a zero velocity; was not told-in for ADA purposes; or has a track status of Scramble, Manual Input, Lost or Extrapolated. An ADAD may manually select any track within the A-ring for passing to an AADCP except when the track: is being dropped; is a BOMARC; has a zero velocity; was not told-in for ADA purposes; or has a track status of Scramble.

If the number of tracks selected for passing exceeds the maximum number that can be passed to that AADCP, the program uses a priority system for passing tracks. This system ensures that the more critical tracks continue to be passed. Track priorities are listed below in descending order.

1. Active or Early Warning ADA tracks with a Priority 1 action in effect. (ADAD action)

2. Active ADA tracks with a Hold Fire or Cease Fire action in effect. (ADAD action)

3. Active ADA tracks with an identity of Hostile or Faker. (Program selected)

4. Early Warning ADA tracks with an identity of Hostile or Faker and with a Pass Track action in effect. (ADAD action)

5. Active ADA tracks with a friendly-class identity. (Program selected)

6. Early Warning ADA tracks with an identity of Hostile or Faker. (Program selected)

7. Early Warning ADA tracks with a friendly-class identity and with a Pass Track action in effect. (ADAD action)

MONITORING ADA OPERATIONS

The ADAD takes certain actions either to control or to override ADA track selection procedures. For example, an action may change a track's passing precedence or may remove a restriction that is prohibiting the track's automatic selection. However, only the Pass Track and Priority 1 actions can, by themselves cause a track to be passed to an AADCP. Other actions only modify existing conditions, such as displays, selection criteria, and message content. ADAD actions are often in response to special alarms and displays. In some cases, the ADAD coordinates with the SD prior to taking actions.

PRIORITY 1 and PASS TRACK ACTIONS

When the ADAD is aware of a track with special significance to an AADCP, he may take a Priority 1 or Pass Track action. Both actions cause the track to be passed if it is within the A-ring or immediately upon entering the A-ring. The Priority 1 action gives the track the highest ADA passing precedence.

SIMULTANEOUS COMMITMENT AND ENGAGEMENT

Special alarms and displays are generated to indicate the possibility of simultaneous commitments or engagements of tracks by ADA weapons and manned Interceptors or BOMARCs. A Possible Simultaneous Commitment display is forced to the ADADs, the SD, and the assigned WD when a target has an Interceptor paired with it and is being passed to an AADCP. A Possible Simultaneous Engagement display is forced when a target has an Interceptor paired with it and a fire unit indicates that it has launched a missile against the target. A decision must be made whether to break the Interceptor pairing by SD or WD Recommit action, to continue with present conditions if the Interceptor can complete its intercept before ADA interception, or to continue with the Interceptor pairing and issue a Cease Fire command to the AADCP's fire units on the target.

HOLD FIRE/CEASE FIRE COMMANDS

The Cease Fire command is not digitally transmitted to an AADCP, but must be transmitted by the ADAD over the voice telephone. Fire units will refrain from firing additional missiles at the target but will continue interception with missiles in flight and will continue tracking the target.

When a Hostile track is reidentified to a friendly class or when a friendly-class track is inadvertently locked on by a fire unit, the ADAD takes a Hold Fire action. This command is transmitted over data link lines to the AADCP. Fire units will cease firing and tracking the specified track and, if possible, will destroy missiles in flight against the track. The ADAD should verbally confirm the Hold Fire condition with the AADCP.

DUMP TRACK

To dump a track is to stop transmission of track data to an AADCP or exclude a track from future selection processing for that AADCP. A track may be dumped by ADAD switch action or by the program. The ADAD takes the Dump Track action when a track is no longer a potential threat or when AADCP track channels are filling up (thus, providing room for more important tracks). The ADAD can monitor the remaining channels available in the ADA AADCP SID and is notified when three channels are remaining for an AADCP by a forced Approaching Channel Capacity TD. The program automatically dumps a track when it no longer qualifies for passing, the ADA channel being used for passing a track is needed for a higher priority track, or a Request for Dump or an Effective (total kill) replyback message is received from a AADCP. Transmission of track information ceases after two dump messages are sent to the AADCP.

CANCELLATION OF ADAD ACTIONS

The ADAD may return a track to normal automatic selection procedures for an AADCP operating in the Automatic option by taking a Reselect Track action. This action releases a Priority 1, a Pass Track, or a Dump Track action on a track or nullifies an Effective or

Dumped Track status received from the AADCP. This action is used in the event the tactical situation changes or a button is pushed in error by the ADAD or the AADCP personnel.

When a Cease Fire or Hold Fire condition is no longer applicable, the ADAD takes a Release action. The AADCP should also be informed verbally of this action.

REPLYBACK MESSAGES

Fire units periodically transmit status messages to the AADCP, which are then routed to the NCC. These replyback messages trigger program responses which affect displays at the NCC and messages being sent to the AADCP. If an NCC fails to receive replyback messages from an AADCP, an ADA Input Status Attention TD is forced to the ADAD. When this occurs, the ADAD contact the AADCP by telephone and switch inserts information normally received over data link lines until replyback messages are again being received. Three types of messages may be received from an AADCP--Request for Dump, Periodic Status, and Pop-Up.

REQUEST FOR DUMP

This message is sent from an AADCP to request the NCC to terminate transmission of a specified track that is of no further interest to the AADCP. Two Dump messages are sent by the NCC to ensure termination of the AADCP. Displays are updated to indicate the Dump condition provided a higher priority display from another AADCP is not in effect. The track will no longer be considered for transmission to that particular AADCP until the ADAD takes the Reselect or Pass Track action.

PERIODIC STATUS

The Periodic Status messages provide weapons personnel with current fire unit engagement or readiness condition. The information is available in the ADA AADCP SID, the ADA Track TD, and associated track symbology. If a Periodic Status message indicates that a fire unit is preparing to engage or has already engaged a track, the ADAD is alerted by a forced Tactical Action TD.

POP-UP

The Pop-Up message is actually a Periodic Status message with a Pop-Up indicator set. Airborne objects that are initially detected by ADA radars and meet certain criteria are termed Pop-Up targets. Pop-Up messages are generated at a fire unit by activation of a switch after the Target Tracking Radar (TTR) locks on the target. The first Pop-Up report causes a First Pop-Up Attention TD to be forced to the SD and ADADs. A Pop-Up Attention Track SID is generated at the positional coordinates supplied by the AADCP. If the ADAD visually determines that the Pop-Up correlates with a non-Hostile BUIC track, he takes a Hold Fire action and verbally informs the AADCP of the Hold Fire condition.

Figure 10-30. Pop-Up Attention Track Display

In Figure 10-30, a Pop-Up (POP) with an Altitude of 2000 (20) feet and a flight size of 2 is being tracked (T) by AADCP AG. If the fire unit status changes to Ineffective (not all objects killed or destroyed) or Out of Action (fire unit not able to fire), the Pop-Up Attention Track SID is automatically replaced by a Manual Track SID with an ADA source. The track is then processed in the same manner as other Manual Input tracks. If the Manual Input track can be correlated with a BUIC Hostile track or with radar data, the Manual Input track may be dropped by weapons or air surveillance personnel. If the fire unit status changes to Effective (total kill) or Ready (no longer tracking the Pop-Up), the Pop-Up Attention Track SID is removed.

ALERT STATUS

AADCPs verbally report fire unit alert status information to the controlling NCC. The ADAD inserts and updates these data by taking the Update ADA Alert Status action. The alert status information contains the number of fire units on 5-minute and 15-minute alert, the number of fire units on 3-hour alert, and the number of fire units available. Alert status for all AADCPs in the Division is available to the ADAD in the ADA Alert Summary TD which is requested by switch action. Through the Cancel ADA Alert Status action, the ADAD can inhibit the display and forwardtell of ADA alert status summary data for a specified AADCP. This action is usually taken to clear the status counts when changing the simulation status of an AADCP and thus preventing mixed simulated and live status from being forwardtold.

SUMMARY

The ADAD is responsible for maintaining the operational efficiency of the ADA air picture in the NCC. To do this, the ADAD, assisted by the program, coordinates and monitors the information flow between the NCC and AADCPs. The efficient coordination of track information between the NCC and AADCPs is one of the most important factors in the NCC ADA function. The ADAD keeps the SD informed of current ADA activities so that the SD can use his Interceptors in the most effective manner.

POSITIVE TARGET CONTROL

Positive target control (PTC) is the process of controlling Exercise aircraft and of ensuring the safety of all aircraft during a live air defense exercise. During such exercises, live intercepts are conducted against aircraft simulating enemy invaders. The targets, called Exercise aircraft, are frequently SAC bombers participating in joint ADC/SAC training missions. The value of PTC is that it allows live training and testing missions in a realistic environment (often with ECM), while still enabling compliance with safety criteria set forth in SAC and NORAD regulations.

PTC routes unique SIF code data on all Exercise target aircraft to a specially designated console. The data are not presented to operators at other console positions. Using the data, personnel forming a Target Monitoring Team are able to monitor an air picture which has little degradation caused by ECM or by operator error. Thus, the Target Monitoring Team can ensure safety of flight for exercise participants, while leaving the air picture displayed at other consoles unchanged.

PTC is especially critical when Exercise target aircraft employ ECM against the system. Under ECM conditions, the BUIC air picture tends to be degraded and accurate tracking is sometimes difficult to maintain. Exercise tracks correlate with MK X data and thus provide greater tracking accuracy than tracks correlating with search or strobe data. In addition, MK X data tend to be much less subject to degradation in an ECM environment than search data.

PTC can be performed in the Active and Monitor modes, however, track initiation and lateral-tell for tracking can take place only in the Active mode.

A Target Monitoring Team at a BUIC NCC consists of an Exercise Director and a Target Monitor (TM). The Exercise Director is a qualified Weapons Director Staff Officer who is familiar with BUIC NCC procedures and with the weapons direction function. He supervises the Target Monitoring Team, coordinates with the Combat Center, maintains cognizance of target route information and, and is responsible for the exercise. The TM is a qualified, combat-ready, Weapons Controller who has a situation display (SID) console and ground-to-air radio communications. He uses this equipment to monitor the progress of, and action against, all Exercise target aircraft in his area of responsibility. His primary concern is aircraft safety. Personnel designated by the Exercise Director to have access to exercise information in order to assist in its preparation and conduct are called trusted agents. In the strict sense of the word, all personnel associated with the Target Monitoring Team are trusted agents in that they have access to sensitive information concerning the exercise plan, aircraft call signs, and penetration routes and times. None is considered an operations crew member in the ordinary sense during the exercise.

By using the information supplied only to his console, the TM is able to keep a more accurate display of Exercise target aircraft positions than is normally possible at operational consoles. This knowledge, augmented by target route and timing information, enables him to detect unsafe situations before they can develop into serious incidents or accidents. Rules and procedures to be used by all elements of ADC for the conduct of safe intercept activity during training missions and air defense exercises are defined in ADCR 51-6, MISSION EMPLOYMENT PROCEDURES. When the TM determines that an unsafe situation exists, as defined in this and other directives, he notifies appropriate personnel or takes other action until it is determined that the situation is again safe. He does this by verbal communication and by taking an Aircraft Unsafe switch action on the aircraft involved. This action forces the Aircraft Unsafe attention display to the SD, WD, TM, and RICMO/ASO consoles for each track designated. The Aircraft Unsafe attention display is forced until the TM takes an Aircraft Safe action, at which time the track displays resume their normal routing.

THE TARGET MONITORING POSITION

Prior to a live exercise the Target Monitoring Team is provided with pre-mission information concerning Exercise target aircraft routes, timing, altitudes, callsigns, and all other data necessary for the PTC function to operate. Some information is entered into the computer program prior to the exercise, while other data are manually organized into strike route maps, charts, tables, etc. All are designed to assist the TM in his primary responsibility of maintaining safety of flight.

Two of the TM's important tasks before the mission are to provide manual inputs personnel with Exercise target aircraft flight plan information and program air movement data (AMD) correlation limits. Flight plan data consists of at least the following items: call sign, sortie number, SIF code, aircraft type, flight size, altitude, speed, activation time, and position of activation. Even though Exercise tracks have a Bee identification, their flight plans are entered as a Faker (K) category. The TM console must be assigned by a manual inputs action before the flight plans are accepted by the program. Correlation limits are entered only if they differ from those normally used by the program for flight plan monitoring. The computer program uses these criteria in determining whether or not a given track is correlating with its flight plan.

If the mission begins with the NCC in Monitor mode, the TM's preparations for transition to active mode include: (1) TM console assigned, (2) PTC On switch action taken, (3) Exercise flight plans and correlation limits entered, and (4) Accept actions on backtold Exercise tracks.

During the exercise, the TM performs all air surveillance tasks associated with Exercise track initiation, monitoring and control. These tracks are performed for Exercise tracks in a manner similar to the way they are performed by ASOpers for non-Exercise tracks during Active mode operation. An important exception to the foregoing is that automatic height requests are bypassed for Exercise tracks, and manual height requests are illegal. When an Exercise track is paired with ADM, the program obtains height information from the flight plan. In all other cases, the TM obtains this information directly from the aircraft crew and enters it by taking an Insert Height and/or Flight Size action. In either situation, the TM verifies target height by radio communication with the Exercise aircraft because accurate height information is essential for safety monitoring.

The insertion of present height not only aids the computer tracking program but is essential for the operation of the automatic umpiring program. In the event that the TM is unable to obtain accurate height information temporarily, an altitude of 5,000 feet can be inserted for known low profiles and 35,000 feet for high. Although an approximate figure should be used as a last resort, the important thing to remember is to insert an altitude.

Exercise tracks are unique in several other respects. For example, the TM must initiate them with a manually inserted track number and the track number prefix is always T. For multifacility exercises, the TM coordinates with the other facilities to ensure that no two Exercise tracks have the same track number at the same time. This coordination is done in advance of the exercise. Other ways in which Exercise tracks differ from non-Exercise tracks are that they are automatically identified as Bee and cannot be reidentified; they can only be treated as Exercise tracks when PTC is On; and except for those designated Unsafe, Exercise tracks and data are displayed at the TM console only.

The Exercise SIF code contained in the flight plan is a MK X Mode 3 code which the program uses as basic tracking information for Exercise target aircraft. In providing automatic tracking of these aircraft, the program compares all incoming MK X returns with Exercise SIF codes. Returns that bear one of the Mode 3 codes for target aircraft are termed Exercise Matched data. Any correlating MK X beacon data detected within a certain distance of Exercise tracks are called Exercise Unmatched data. Mode 3 SIF data that match a special Unsafe code are known as Exercise Unsafe data. This special code is used by Exercise Pilots to indicate an unsafe/emergency situation to the TM and, at the TM's request, in identifying an aircraft's position. It is important for the TM to understand the distinction between the three types of MK X data which can be associated with Exercise target aircraft, because only Exercise data can be correlated with and used for tracking Exercise target aircraft. Each type is displayed with a unique symbol at his console and the TM controls their display through the Stop (or Start) Exercise Data Display switch action. Search and strobe data from target aircraft are subject to normal processing and are available for display at all NCC consoles, including that of the TM. Exercise data are not displayed at any console other than that of the TM. The three types of Exercise data are displayed as follows:

EXERCISE DATA

Type	Correlated	Uncorrelated
Exercise Matched Data	////	\\\\
Exercise Unmatched Data	――――	| | | |
Exercise Unsafe Data	TTTT	⊥⊥⊥⊥

When the TM takes the Start PTC switch action to begin the target monitoring activity, all the Exercise data within these three types are forced to his console. This action also forces the AMD SID for all Exercise flight plans to the TM console. (AMD displays for non-Exercise aircraft are available through the appropriate category selection switch.) Using a combination of AMD SIDs, Exercise data and radio communications with the target aircraft crew members, the TM confirms the identity of targets and takes an Initiate or Accept switch action to establish Exercise tracks. A newly initiated Exercise track has a flight size and altitude of Unknown. Once an Exercise track is established, the TM examines the AMD SIDs to determine whether or not a flight plan is stored for the track. (In some instances, such as a last minute change in target aircraft support, a flight plan may not have been filed.) When the matching flight plan is located, he takes a Pair Track with Flight switch action in order to obtain program correlation monitoring of the track with its AMD. This action also causes the program to accept the flight size and altitude from the flight plan. For Exercise tracks without flight plan, the TM must switch-insert this information.

The TM can easily determine exactly which flight plan is paired with a given track by referring to his AMD TD display. The Exercise track SID D2 character indicates whether or not the track is within correlation limits or not paired. The Air Movement Data SID contains the AMD number with which a track is correlating plus call sign and sortie number. The AMD TD contains all this information plus a great deal more which is of interest to the TM. Rather than try to describe these displays in detail, an example of each is presented at the end of the section as it might look when displaying information about the same Exercise track.

By using these displays and others, such as the AMD Correlation Box, AMD Route, and SIF codes data, the TM initiates Exercise tracks and monitors their progress. The primary switch actions which he employs for this purpose are Initiate, Reinitiate, Exchange, Insert Height and/or Flight Size, and Drop. In use, the switch actions are nearly identical to their counterparts at the ASOper positions.

Should SID display symbologies overlap and cause illegible overprint, the TM can remove the intefering symbology by use of the category selection switches and/or by switch actions. Non-Exercise track data can be turned off with the category selection switches; Exercise Information may be turned off by using the following actions, as needed:

Request Stop Exercise Track SID switch action

Request Stop Exercise Data SID switch action

Request Stop Exercise AMD SID switch action

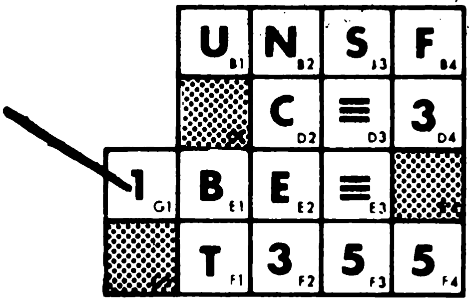
After reading the previously illegible symbology the TM can resume the original display by restoring the category switches and/or by taking these additional actions:

Request Exercise Tracks SID switch action

Request Exercise Data SID switch action

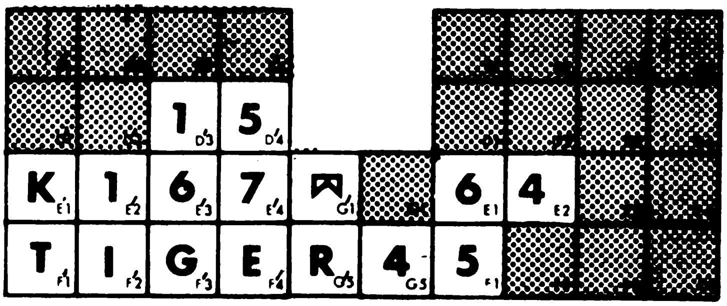
Request Exercise AMD switch action

Information necessary for safe monitoring should be turned off no longer than necessary. The Exercise Track SID, AMD, SID, and AMD TD examples are shown below:



Exercise Track SID

Aircraft is Unsafe (B1-B4), it is correlated with AMD (D2), the track is emitting Mode 3 SIF (D3), Altitude is 30,000 ft. (D4), flight size of one (G1), identity Bee (E1). It is an Established track (E2), tracking on computer Mode 3 SIF data (E3). Exercise track number is T355.



AMD SID

AMD number is 15 (D'3, D'4), Exercise flight plan category is Faker (E'1), sortie number 167 (E'2-E'4), flight plan is correlated (G'1), SIF code is 64 (E1-E3), call sign is TIGER 45.

	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4	A	M	D		1	5				
5	S	I	F		6	4				
6	A	L	T		3	Φ	Φ			
7	S	P	D			5	8			
8	S	I	Z		1					
9	L	O	C		A	B	C	L		
10	L	I	V		2	1	3	3		
11	I	D			B	E	E			
12	T	Y	P		B	5	2			
13	C	O	R		T	3	5	5		
14	C	A	P		2	5				
15	C	A	L	L		S	G	N		
16	T	I	G	E	R	4	5			

AMD TD

Line	
9, 10	Georef ABCL 2133, Live track
12	B-52 aircraft type
13	AMD correlated with track T355
14	Remaining capacity 25 flight plans

SAFETY MONITORING

The TM continuously monitors Exercise tracks for any deviation from safety criteria. Among the many possible examples of unsafe track behavior, those most likely to be encountered by the TM are:

1. Loss of Exercise track radar data.

2. Failure to maintain minimum separation distances.

   a. Non ECM/chaff environment - 3 n.m.

   b. ECM/chaff environment - 5 n.m.

3. Presence of aircraft without tracks in intercept area.

4. Loss of radio contact between Interceptor and control facility.

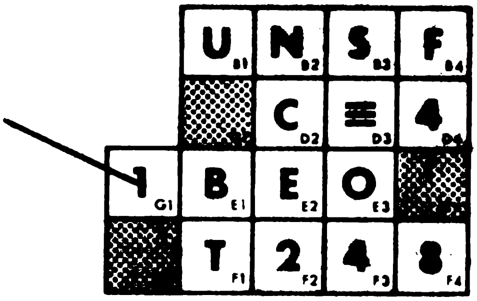
5. Conflicting flight paths.

6. Aircraft transponding the Unsafe SIF code.

The computer program helps the TM detect unsafe or potentially unsafe situations through Out of Correlation attention displays and Exercise Unsafe SIF data trails. Some situations which the TM determines to be potentially unsafe can be remedied through coordination with the SD, RICMO/ASO, WD, or the Exercise target aircraft pilot. When either an Exercise track or non-Exercise track is exhibiting unsafe behavior, however, the TM takes the Aircraft Unsafe switch action on the track. Interceptors committed against Unsafe target tracks are made indirectly Unsafe by the program when an Unsafe action is taken on the target. The Aircraft Unsafe action forces an attention display adjacent to the track symbology of the Unsafe track and to the symbology of any Interceptor committed against the track. The attention displays are forced to the SD, WD, RICMO/ASO and TM consoles. The Aircraft Unsafe display preempts all other surveillance and attention displays and is accompanied by an alarm. The attention display consists of the letters UNSF appearing in the top row of characters in the associated track SID.

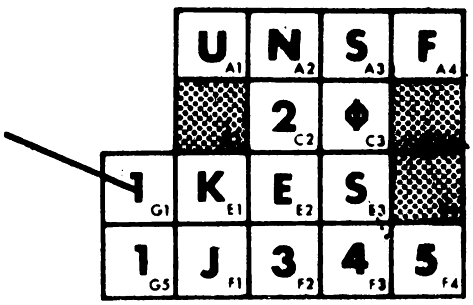
There is an important distinction between the kinds of tracks representing a target aircraft at the NCC. One is a Faker track and the other an Exercise track. The TM can designate either of these, or any other kind of track, as Unsafe. Whenever possible, however, he takes this action on non-Exercise tracks in order to avoid disclosing a target aircraft's true location to operations personnel. Needless to say, aircraft safety is the first consideration in any such decision.

The illustrations below show two different track SIDs for the same unsafe target aircraft. The first example is of the Unsafe Exercise track SID (as it would appear with B and D characters selected). The second example represents the Faker track for the same aircraft as it might be displayed at a weapons console (A and C characters selected).



Unsafe Exercise Track SID

Exercise track T248 (F1-F4) is Unsafe (B1-B4). It is correlated with AMD (D2), emitting a Mode 3 SIF code (D3), flying at 40,000 ft. (D4), and has a flight size of 1 (G1). Its identity is Bee (E1), status is Established (E2), and is tracking on Assigned SIF data only (E3).



Unsafe Faker Track SID

Faker track J345 is Unsafe. It has 2 Interceptors committed (C2), no kills recorded (C3), and has a flight size of 1. Its status is Established, it is tracking on search data (E3), and is assigned to WD 1.

When the unsafe condition is rectified to the TM's satisfaction, he takes an Aircraft Safe action which removes the forced displays and alarms. Exercise tracks are again displayed at the TM console only. Interceptors made Unsafe by the program, as a result of their association with unsafe targets, require individual Aircraft Safe actions.

The monitoring for unsafe situations continues throughout the mission and the designation of aircraft as Unsafe is repeated as often as deemed necessary by the TM. At the conclusion of the exercise, the TM takes a Drop switch action on each Exercise track and terminates special processing by taking the Stop PTC switch action.

1. Weapons and Armament:

RELATED MANUAL INPUTS

a) BOMARC CHANNEL CHANGE message

b) BOMARC LINE TEST message

c) BOMARC PRELAUNCH STATUS TEST Message

d) BOMARC STATUS Message

e) WEAPONS STATUS Message

RELATED SWITCH ACTIONS

a) ARMANENT

b) BOMARC/NO BOMARC AUTHORIZED

c) CHANGE CONFIGURATION

d) SAFO ON/OFF

e) SQUADRON TRACK NUMBERS

RELATED DISPLAYS

a) BOMARC MISSILE BASE SID

b) MANNED INTERCEPTOR AIRBASE SID

c) STOP/RECOVERY POINTS

d) BOMARC STATUS REPORTING FAILURE TD

e) MANNED INT WEAPONS AVAIL TD

f) MISSILE WEAPONS AVAIL TD

g) SQUADRON TRACK NUMBER TD

RELATED DATA LINK MESSAGES

a) BOMARC LINE TEST

b) BOMARC MISSILE LAUNCHER STATUS

2. Track Assignment/Weapons Commitment/Mission Evaluation:

RELATED MANUAL INPUTS

a) VOICE FREQUENCY CHANNEL ASSIGNMENT message

RELATED SWITCH ACTIONS

a) ASSIGN/REASSIGN

b) CANCEL BOMARC COMMITMENT

c) COMMIT-BOMARC FOR INT

-MAN. INT FOR CAP

-MAN. INT FOR INTERCEPTION

d) DEFER

e) FLIGHT SIZE

f) KILL

g) MA ACTION

h) RECOMMIT BOMARC FOR INT/CAP

i) RECOMMIT MANNED INT FOR INT/CAP/RTB

j) UNCONDITIONAL BOMARC COMMIT

RELATED DISPLAYS

a) INTERCEPTOR TRACK (GENERAL DISPLAY) SID

b) BOMARC COMMITMENT CANCELLED SID

c) BOMARC PRECOMMIT SID

d) CAD - IMPOSSIBLE INTERCEPT/POSSIBLE INTERCEPT SID

e) INTERCEPTION LOCATION SID

f) SCRAMBLE TRACK SID

g) INTERCEPTOR ATTENTION DISPLAYS SID

h) INTERCEPTOR TRACK (ASSIGNED WD) SID

i) INTERCEPTOR TRACK TD

j) MA ACTION RESULTS TD

k) SCRAMBLE TD

l) TRACK ASSIGNMENT TD

m) UNASSIGNED TRACK TD

n) WD ASSIGNMENT SUMMARY TD

RELATED DATA LINK MESSAGES

a) NOTIFY ASSIGNMENT

b) BOMARC PRELAUNCH

3. Weapons Guidance and Communication:

RELATED MANUAL INPUTS

a) GAT SITE STATUS message

b) WINDS ALOFT DATA message

RELATED SWITCH ACTIONS

a) ATTACK OPTION

b) MANUAL HEADING/CANCEL

c) CANCEL SPEED/ALT OVERRIDE

d) CLOSE CONTROL

e) COMBAT ALTITUDE

f) COMBAT SPEED

g) COMMAND ALTITUDE

h) COMMAND SPEED

i) DATA LINK ON/OFF

j) GAT OPTION

k) GATE CLIMB

l) INSERT FUEL

m) MODIFIED CLOSE CONTROL

n) PRESENT ALTITUDE

o) TACAN ON/OFF

p) TARGET ALTITUDE/RETURN

q) CHANGE CONFIGURATION

RELATED DISPLAYS

a) BOMARC INTERCEPT-NUCLEAR BURST POINT SID

b) INTERCEPTOR ATTN DISPLAYS TD

c) MANNED INTERCEPTOR OFFSET-INTERCEPT-NUCLEAR BURST POINT SID

d) BOMARC ON INT OR CAP MISSION TD

e) MANNED INTERCEPTOR INTERCEPT MISSION TD

f) MANNED INTERCEPTOR ON CAP OR RTB MISSION TD

RELATED DATA LINK MESSAGES

a) INTERCEPTOR DATA LINK RELAY

b) MANNED INTERCEPTOR GUIDANCE

c) BOMARC GUIDANCE

Air Defense Artillery:

RELATED SWITCH ACTIONS

a) ADA ALERT STATUS/CANCEL

b) CEASE FIRE

c) DISENGAGE

d) DUMP TRACK

e) ENGAGE

f) HOLD FIRE

g) PASS TRACK

h) PRIORITY 1

i) RELEASE

j) RESELECT TRACK

k) UPDATE LIVE ADA ALERT STATUS

l) UPDATE SIM ADA ALERT STATUS

RELATED DISPLAYS

a) ADA AADCP SID

b) POP-UP ATTENTION TRACK

c) ADA ALERT SUMM TD

d) ADA CHANNEL ASSIGNMENT TD

e) ADA INPUT STATUS ATTN TD

f) ADA TACTICAL ACTION TD

g) ADA TRACK TD

h) FIRST POP-UP ATTN TD

i) HOLD FIRE - CEASE FIRE ATTN TD

RELATED DATA LINK MESSAGES

a) TACTICAL DATA CHANGE ADA

b) REQUEST FOR DUMP

c) PERIODIC STATUS

d) POP-UP

e) TRACK INFORMATION

Positive Target Control

RELATED MANUAL INPUTS

a) EXERCISE SIF CODE message

b) EXERCISE TRACK CORRELATION BOX message

c) FLIGHT PLAN DATA message

RELATED SWITCH ACTIONS

a) AIRCRAFT SAFE/UNSAFE

b) PAIR TRACK WITH FLIGHT

c) START STOP PTC

RELATED DISPLAYS

a) AIRCRAFT UNSAFE ATTN SID

b) EXERCISE TRACK SID

c) EXERCISE SIF CODE TD

d) POSITIVE TARGET CONTROL STATUS TD

RELATED DATA LINK MESSAGES

None

NOTES

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CHAPTER 11

REAL-TIME SIMULATION

The BUIC III real-time simulation portion of the Air Defense Program (ADP) is designed to serve a dual purpose. First, it provides the capability for program and system checkout through the use of an environment of simulated inputs which the system reacts to essentially as it would to the live environment, but which can be precisely specified and controlled and which is not dependent upon coordination, functioning and reliability of inputs from live external sources. This process, known as Assembly Testing, is generally accomplished under conditions where live inputs are not possible or have not been incorporated. When using the simulation program for system checkout purposes, a mode of startup known as the "Test Mode" is employed, and some special capabilities designed specifically for checkout purposes are incorporated.

The second purpose of real-time simulation is to provide the capability of simulating a broad spectrum of computer-based events adequate to support positional, functional, full-site and milti-site training and evaluation exercise requirements. This may involve the use of only simulated inputs to the system, or may be a combination of simulated and live external inputs. Exercises conducted for training and/or operational evaluation purposes are limited to those conditions that can be computer-based when ADP operations start via the "Initiate" mode of startup.

CAPABILITIES

In order to adequately accomplish real-time simulation, two different capabilities are required of the program. One is the capability to dynamically generate and manipulate simulated information on a real-time basis to keep pace with operational conditions. The other is to incorporate into the system diverse types of information prepared on a preplanned basis which are adequate in form and content for simulating the environmental conditions of the BUIC III NCC. In addition to these simulation capabilities, ADP also can perform certain exercise monitoring, umpiring, evaluation and feedback functions in support of training and evaluation.

SETE

The overall training and exercising function for BUIC III is known as SETE (System Exercising for Training and Evaluation). Although here we are primarily concerned with those aspects of SETE supported by the real-time simulation portions of ADP, it should be pointed out that there are the elements of SETE not contained in ADP but which contribute to the training and evaluation process. Among these is the support system known as BEPS (BUIC Exercise Preparation System) which has the capability of producing and/or modifying many of the personnel, non-dynamic inputs for an exercise, particularly the exercise tapes which can be used to simulate, among other things, all or part of the radar environment of a BUIC III NCC.

In addition to tapes and associated training aids produced by BEPS, SETE may also use training problems produced in other production facilities, but which must be compatible. These problems are produced in such a manner that they correspond in content with problems produced for adjacent air defense units (BUIC or SAGE) and are designed for the purpose of providing coordinated training for multiple units of the air defense system - usually all of NORAD. Tapes from this source may require modification by BEPS before they are suitable for use at a BUIC III NCC.

BARS

Another utility and support system which is part of SETE, but not contained in ADP, is BARS (BUIC Analysis and Reductions System). BARS is designed to process the information contained on the BUIC Operational Recording Tapes (BORTs) which may be produced by the Operational recording function of ADP. BARS consists of five processors, only two of which are used by SETE, the remaining three being designed for program, system and subsystem test, checkout and evaluation. When used in proper coordination with the recording functions of ADP, the information available with BARS is considerably more versatile, detailed and specific than that available through the use of the debriefing printout option of the real-time simulation portion of ADP, although not as readily available.

PERSONNEL

Simulation, training and evaluation activities are the fulltime responsibility of the Training Technician (TT). During the course of an exercise he is assisted in these activities by supplementary operational administration personnel to make up the Simulation (SIM) Team and the Training Observation Report (TOR) Team.

The SIM Team consists of individuals directly involved in the generation and/or implementation of simulated system inputs during an exercise. Among the functions performed by the SIM Team are the dynamic internal generation of both Interceptor and non-Interceptor aircraft; the simulation of non-participating external agencies such as airbases, personnel at radar squadrons, etc; the implementation of appropriate information from simulated manual input sources and providing specific inputs concerning such things as pre-planned or contingent battle damage reports in the correct format to the appropriate sources; and the operation of communications jamming equipment, etc.

In exercises involving more than a single NCC (i.e., Region-wide, ADC-wide, or NORAD-wide exercises) the SIM Team is also responsible for coordination with other air defense units in the implementation and control of simulated inputs. These tasks do not require individual manning, that is one member of the SIM Team may perform more than one task.

During an exercise the supervision and coordination activities of the SIM Team are the responsibilities of the Simulation Supervisor (SIM SUP). The SIM SUP tasks may be fulfilled by the TT. In addition to supervisory and coordination responsibilities, the SIM SUP has a number of other functions which cannot be performed by other members of the SIM Team. He is responsible for assigning simulation/weapons console pairings; controls the changing, starting, stopping or forward-spacing of exercise input tapes; implements the operation of the real-time simulation program of ADP; and shares with the Senior Director the capability to stop simulation either because of the termination of an exercise or because of a change in the live external environment, such as the occurrence of an air defense emergency, a failure of the parent SAGE DC, or a degrading of the live air picture.

CONSOLES

To conduct a simulation exercise, a maximum of four of the consoles in a BUIC III NCC can be designated as Simulation Consoles, one of which must be designated a SIM SUP console. The remaining three function as Flight Path Simulator consoles. These consoles may be used for the dynamic internal generation and control of both simulated manned Interceptors and non-Interceptor flights. A SIM SUP console is capable of performing all of the functions of an FPS console, but the converse is not true.

In addition to the simulation capabilities available through the use of specially designated data display consoles, there is also a special unit known as the Simulation Message Composer Set (SMCS). This consists of two keyboards situated on either side of a data display console. There is only one data display console location at each facility where keyboards are plugged in. In order for the SMCS to be used, this data display console should be designated to be used for simulation purposes. The keyboards of the SMCS are structured for the sole purpose of performing the task of an Interceptor Pilot Simulator (IPS) and allow for the generation and control of simulated manned interceptors. Forced simulation displays concerning Interceptors generated and/or controlled through the use of the SMCS are displayed at the associated data display console. A Simulator Group Controller (SGC), located in the Data Processing Area allows switch actions to be taken at each SMCS keyboard and the keyboard of the associated data display console independently without conflict.

One ten-site G/A (Ground-Air) communication channel is multiplexed from the data display console associated with the SMCS and from the SMCS keyboards to each of six selected operational consoles. This data display console is provided with the key equipment to allow for dynamic assignment of the SMCS keyboards and the console itself to one or more of the selected operational consoles. Telephone equipment at the console and at the SMCS Keyboards enables the simulation of G/A Communication between the operational WDs and the simulated aircraft (usually manned Interceptors) which they control. This equipment operates on a time-sharing basis.

CONDITION FOR OPERATION

Simulation capabilities are designed to be available at any time during the BUIC III NCC operation. The following conditions must prevail in order for these capabilities to be utilized:

1. Live BOMARCs must not be authorized

2. The SIM SUP must be assigned a data display console

3. The SIM SUP must initiate the simulation function (Start Simulation switch action).

The availability of simulation capabilities in a live environment is not affected by a change in the Air Defense program operational mode (active/monitor). Neither does the deassigning of the SIM SUP console, nor the act of going through a startover, have any effect on current simulated information. However, termination of simulation functions will take place if a startup should occur, or may be caused by switch action to stop simulation at either the SIM SUP's or SD's console, or if the BOMARC authorized switch action is taken at the SD's console. Should simulation terminate, all simulated information and operational conditions will be cleared from ADP.

CAPACITY

When real-time simulation is operative, ADP has the capacity to handle up to 180 simulated airborne objects simultaneously. Of these, not more than 100 may be externally generated (come from an exercise tape). Each simulated airborne object from a given exercise tape is assigned a unique four-digit number with the range 0001-3999. This is known as a Simulation Reference Number (SRN). For versatility purposes, a given exercise tape may contain more than 100 SRNs. In order to stay within legal system limits, and also to facilitate meeting the needs of a particular exercise, it is possible, through the use of manual input cards, to specify which SRNs from a problem tape are to be set as "active", or potentially "active" - that is, to allow ADP to display them at the time when they occur on tape. All other SRNs on the tape are set to "inactive" and will not be displayed at any time during the exercise and, therefore, do not affect the legal system limits. An alternate method is to specify certain SRNs as inactive, leaving the remainder as either active or potentially active depending upon when they occur on the tape. Using either option, SRNs may be specified either individually or in sequential blocks. It is possible to have a total of more than 100 active and potentially active SRNs in an exercise as long as the number of simultaneous active SRNs does not exceed 100. When the external simulation capacity is saturated (i.e., 100 external channels utilized) any new simulated airborne objects that are processed from the exercise tape are set inactive.

The capacity for handling internally generated airborne objects (those objects originated by SIM SUP, FPS, or IPS switch actions or by the commitment of a simulated BOMARC) is not to exceed 80. Each internally generated airborne object is also assigned a unique SRN, which consists of a three digit number ranging from 001 to 699, preceded by one of the letters U, V, X or Y, depending upon local site adaptation. As is the case with externally generated SRNs, internally generated SRNs which are made inactive are not included in the maximum allowable total of internally generated SRNs. When the remaining capacity to handle internally generated airborne objects falls to 7, the APPROACHING CHANNEL CAPACITY TD is forced to the SIM SUP. The remaining capacity is available only to those internally generated airborne objects stemming from the commitment of simulated Interceptors at the NCC. When the internal simulation capacity (73 for non-Interceptors, 80 for Interceptors) is reached, all further SIM SUP, FPS and IPS switch actions that would result in additional simulated airborne objects being started are illegal.

FUNCTIONS

In the live NCC environment it is possible for aircraft to fly in such a configuration that information received from search radar causes them to be displayed as a single airborne object. Supplementary information received from other sources, such as height finders or manned Interceptors, may contain the actual number of aircraft in the indicated location. In this case the track symbology associated with the data will indicate the track as having a "multiple flight size". For simulation purposes, it is possible for both internally and externally generated data, to simulate a given piece of radar data representing a flight size greater than one. In this case, the information as to actual flight size is contained on the exercise tape for external data, and is known to simulator personnel and to the real-time simulation program for both internally and externally generated data. This data is assigned a single SRN and a single simulation channel. The SRN is not made inactive until it has terminated, or until the flight size is reduced to zero. When the Start Simulation action is taken from the SIM SUP console, a number of features become automatically available. Among these are the ability to generate and control internally simulated radar, height and ECM information, the availability of an automatic umpiring function, and control over the input of information from exercise tapes. These features may be supplemented and/or modified by a group of manual input messages known as Operational Conditions for Simulation (OCS) messages. There are eight types of these messages. They are employed to control the features to be used during the exercise and to temporarily modify certain of the parameters used by the simulation program. While simulation is in effect, the information in these messages is superimposed over the conditions established by Normal Operational Procedures (NOP), and any variance between these imposed simulated conditions and those established by NOP, is resolved in favor of the simulated conditions. When simulation is terminated the information from these messages is no longer recognized and the NOP conditions are immediately available to guide the ADP without the need to resort to a startup.

Features made available for simulation activities through the use of OCS messages may be for either mode (active or monitor) of operation of the Air Defense program. Included in these features are BOMARC simulation, ADA simulation, ID response simulation, automatic crosstalk, deletion or modification of the automatic umpiring capability, and debriefing printouts. With the exception of debriefing printouts, all of these features can be modified by inputting new OCS messages during the simulation activity.

INPUT STATUS

A simulation exercise may employ only simulated source radar data (internally or externally generated) or may employ a combination of simulated and live radar inputs. An OCS: Sensor Activity Status Manual Input message will determine the conditions for each tied radar set. A Regular (R) status is applied when all radar data is retrieved from the message processor channel associated with that site. A Simulated (SIM) status means that only simulated information representing radar data from this site will be accepted. A Mixed status interrogates both sources, giving preference to regular radar data. A non-Existent (NE) status means that neither REG nor SIM data will be obtained from this site.

SIMULATION POSITIONS

The generation and control of internally generated simulated manned Interceptors equipped with data link are normally accomplished through a combination of interactions between the simulator (SIM SUP, FPS or IPS), the real-time simulation program and the weapons guidance portion of ADP. The simulator initiates the generation of the simulated MK X data by specifying the track number of the interceptor and its command heading. The simulation program generates data at the appropriate airbase and then proceeds to control the movement of the data according to guidance commands originating from the ADP weapons guidance program.

If a simulated manned Interceptor is not data-link equipped the generation of its MK X data is accomplished in the same way, but the subsequent control of the movement of the Interceptor remains under the control of the simulator who is in voice communication with the WD or SD controlling the intercept. The simulator maneuvers the Interceptor data in heading, speed and altitude according to verbal directions from the controlling WD or SD, who is getting his information from his display console. For both data-link and non data-link controlled simulated intercepts there is a certain amount of voice communication between the controlling WD or SD and the simulator who has generated the simulated Interceptor data, and in this communication the simulator acts the part of the pilot of a manned Interceptor, responding to and initiating the same types of verbal exchange of information in form and content as would occur between a WD or SD and the pilot of a live Interceptor. There is considerably more of this communication for non data-link or ''voice'' Intercepts than there is for those in which the Interceptor is simulated as being data-link equipped. Whether or not a simulated Interceptor is considered by the simulation program as being data-link equipped is initially determined by prestored interceptor parameters, but an Interceptor may be taken off data-link by a switch action or by any guidance control switch action for that Interceptor taken by the simulator. A non data-link Interceptor originally designated as being data-link equipped may be put back on data-link by a switch action on the part of the simulator.

BOMARC

Internally generated BOMARC data are started automatically by the program, when a BOMARC is committed, provided that the proper prerequisites have been met. The simulated BOMARC responds only to guidance instructions from the weapons program, and simulation personnel have no control in the maneuvering of these data, although they can cause the data to be suppressed through the use of the Flight Size switch action.

TARGETS

Internally generated non-Interceptor data may be started by simulator switch action from the SIM SUP or FPS consoles. In order to accomplish this, an initial location and heading must be specified. The initial speed, altitude flight size and blip scan ratio* are set by the simulation program but can, along with the heading, be changed by subsequent simulator switch actions. Non-Interceptor data may also be started automatically if a track is told in with the data generation indicator set in the tell message.

EXERCISE TAPES

Exercise tape inputs may be provided any time during the operation of the air defense program provided the proper procedures have been employed and simulation is in effect. The reading of the exercise tape can be initiated either manually by a Start Tape switch action taken by the SIM SUP, or by an OCS: Exercise Tape Control manual input message which specifies tape start time. A given exercise problem tape may exist on more than one physical reel of tape. In this case, the sequential number of each reel is contained in the information on the tape. The simulation program checks this number and reads the tapes sequentially until it reads an end of test record indicating that this is the end of the problem, or until simulation is turned off.

A "back-to-back" capability also exists which permits two separate exercise problems to be run sequentially, either or both of which may consist of one or more physical tapes. When this option is to be employed it must be so specified on the OCS: Exercise Tape Control manual input message. The time that the second problem tape is to be read may be specified in this message, and may be prior to, concurrent with, or later than the termination of the first problem tape. The time that is specified for a problem tape to be read is known as the "pass start time". When the pass start time specified for a second problem tape equals the current Zulu time, or when the first pass has ended, all tables containing information for exercise tape SRNs from the first pass are cleared. All non-tape data are unaffected by the transition to the new exercise tape problem. If a pass start time is not specified for the second problem, it begins immediately after the completion of the first pass.

The specification of SRNs that are to be displayed from an exercise problem tape is accomplished through the use of an OCS: Allow/Disallow SRNs manual input message. For a back-to-back exercise, SRNs to be allowed or disallowed must be specified for each pass.

In addition to information indicating the problem number, the beginning and the end of physical reels and the end of the problem, an exercise problem tape may contain the following types of records: Radar, Flight Characteristics, ECM, Keyboard, Manned Input, Tell, ADA Replyback, Height Reply, and BOMARC Replyback. With the exception of Radar and Flight Characteristic records, any or all of these record types can be bypassed during the reading of the tape, as specified by information contained on the OCS: Exercise Tape Control manual input message. Also, all data in the Radar records with an SRN of zero (representing background "noise" and not airborne objects) may be bypassed.

*Blip scan ratio is the ratio of the number of detections of an airborne object to the total number of radar scans of that object.

The inclusion of various types of records from the problem exercise tape will depend primarily upon the purpose and configuration of the exercise. A simulation exercise at a BUIC III NCC may utilize telling inputs from live participating facilities (facilities which are physically and logically connected to the BUIC III NCC) and control facilities simulated from the exercise tape. All of the participants can be live, as in a NORAD-wide exercise; they can all be simulated as in an in-house, single-site exercise; or they can be mixed as in a joint exercise with some, but not all, adjacent air defense facilities participating. The particular configuration used during an exercise is controlled by OSC manual input messages and operator switch action.

It may also be desirable to provide the capability to exercise only certain individuals or functions within the NCC. This is accomplished through the use of a problem type with Keyboard records which contain the information necessary to simulate switch actions taken from consoles which are not actually manned. If proper conditions are met, ADP will interrogate and interpret this information in place of live switch actions taken from the actual consoles.

DATA ASSOCIATION

A data association function exists in simulation which is utilized in order to distinguish live flights from simulated flights in a mixed environment. This distinction can be beneficial in determining legitimate threats and unsafe flying conditions. Indications that live tracks are smoothing on simulated data, and vice versa, will be displayed to the Simulation operator for possible change of status. By switch action this change of status will set an indicator making the track live if previously simulated, and simulated if previously live. The data association function is also employed in establishing SRN/TRN association - that is, which SRN, if any, best represents a TRN.

AUTOMATIC UMPIRING

One of the features available when the SIM SUP takes the Simulation control: Start Simulation switch action is automatic umpiring for manned Interceptors. This feature includes abort logic, fuel and armament monitoring, and a determination of the probability of armament kill being less than one. Automatic umpiring is utilized to assist simulation in the determination of intercept success. It also provides a means of automatically reducing the flight size for simulated radar data representing aircraft for which the simulation function has determined a kill. (When the flight size is reduced to zero the data is suppressed and the SRN is made inactive.) The outcome of a simulated intercept is dependent upon the relative positions of the Interceptor and its target and several probability factors which represent the frequency with which a live Interceptor would achieve the same outcome under the circumstances. Based upon armament kill probabilities, interceptor type, intercept geometry, and the use of a random number generator, the automatic umpiring routine will determine the success of an attempted intercept. Automatic umpiring for BOMARCs also become available whenever BOMARC simulation is specified by the OSC: Internal Simulation Operational Conditions manual input message. This message can also be used to make a number of modifications to the automatic umpiring function, or to delete it entirely.

1. Simulation:

RELATED MANUAL INPUTS

a) OPERATIONAL CONDITIONS FOR SIMULATION MESSAGE Message

RELATED SWITCH ACTIONS

a) BEACON DATA CONTROL (+IPS)

b) BLIP SCAN CONTROL (+IPS)

c) BREAK PAIRING

d) CHANGE ALTITUDE (+IPS)

e) CHANGE HEADING (+IPS)

f) CHANGE SPEED (+IPS)

g) CHANGE STATUS

h) CLEAR (IPS)

i) DATA LINK ON/OFF (IPS)

j) ECM CONTROL

k) EXERCISE COMMUNICATIONS CONTROL

l) FLIGHT SIZE (+IPS)

m) LOCATION REQUEST

n) PAIR CONSOLES

o) SIMULATION CONTROL

p) SPECIFY CODE NAME/ID REPLY/SIF

q) START MISSILE DATA

r) START NON INT DATA

s) TABULAR DISPLAY REQUEST (IPS)

t) TAPE CONTROL

RELATED DISPLAYS

a) CHANGE OF DATA CORRELATION SID

b) DEAD SRN SID

c) HANDOVER IN FOR SIMULATION SID

d) INITIATION OF NON-INT DATA SID

e) LOCATION REQUEST DATA/TRACK SID

f) SIMULATED SIF CODE SID

g) SIMULATION EVENT DISPLAY SID

h) DEAD SRN SUMMARY TD

i) EXERCISE TAPE STATUS TD

j) SIMULATED HANDOVER TIME TD

k) SIMULATION CONDITIONS TD

l) SIMULATION MANUAL HT REQUEST TD

m) SIMULATION MISSION TD

n) SIMULATION RADAR SITE STATUS TD

o) TAPE SRN STATUS TD

RELATED DATA LINK MESSAGES

a) SUPPRESS TAPE SRN

NOTES

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229	Foldout in Back of Book
231	Foldout in Back of Book
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CHAPTER 12

RECORDING

PURPOSE

The purpose of the recording function is to save specified data on magnetic tape during the cycling of the BUIC III Air Defense Computer Program. Data are recorded for the following reasons:

1. To perform equipment, program and system testing

2. To describe and analyze system operations

3. To describe, evaluate and analyze training exercises.

The data saved by the recording function during the cycling of the BUIC III Air Defense Computer Program are determined by a Recording Specification Table. This table informs the recording function which data to record, when to record the data, and for how long to record the data. The type of data collected by the recording function includes compool-defined tables and portions of working core being utilized at that time.

PERSONNEL

The Senior Director (SD) and Air Surveillance Operator (ASOper), and the Facility Maintenance Monitor (FMM) perform the following tasks when the recording function is used during air defense operations:

1. The SD directs the FMM to load tapes for recording and directs the ASOper to begin operational recording.

2. The ASOper responsible for recording takes a RECORD ON or RECORD OFF switch action, which initiates or terminates operational recording. (The RICMO/ASO coordinates with the SD before either of these switch actions is taken).

3. The FMM informs the responsible ASOper that recording tapes have been loaded. While recording is on, the FMM monitors the teleprinter and makes appropriate responses to the recording messages. The FMM may use the RECORD control card, the RECORD OFF control card, or the RECORD CHANGE control card to initiate, terminate, or change operational recording. When using the manual input card the FMM coordinates with the SD.

RECORDING SPECIFICATION TABLE

After the operation of the recording function is initiated by a switch action or a control card, the recording function collects and saves data that have been specified in a Recording Specification Table. Data are recorded from core memory either before, during, or after the operation of an operational program. A Recording Specification Table must be available in core memory for the recording function to operate. The Recording Specification Table was produced by the prerecording function of the Utility Computer Program and is read in from tape or drums to core by the startover function, which also assigns absolute core memory addresses to the RST entries. The recording function requires that the following information be provided in each RST entry for the data specified in the entry to be recorded:

1. The identification of the program around which or during which the specified data is to be recorded

2. An indicator that specifies whether the data is to be recorded before, during, or after the program's operation

3. The absolute address in core memory of the data to be recorded

4. The number of words to be recorded

5. The period of time during which the data is to be recorded.

The Air Defense Program master tape contains a Recording Specification Table which specifies the data required by operations personnel. Since this Recording Specification Table is on the master tape, it is automatically read in at startup and is available to the recording function when recording is requested.

For those situations, such as testing, in which the Recording Specification Table contained on the master tape does not meet the necessary data requirements, the prerecording function of the Utility Program may be used to modify or generate a new Recording Specification Table.

RECORDED OUTPUT

The recording function outputs the recorded information on the BUIC Operational Recording Tape (BORT). Five types of records are output on the recording tape. They are the RST record, the Time record, the Data record, the End record, and the End of File record. The maximum length of any of these records is 4095 words. The RST record contains the image of the Recording Specification Table. The RST record is written on the recording tape (BORT) when one of the following conditions exists:

1. A RECORD ON switch is taken

2. A RECORD card is read

3. A startover occurs before which the recording function was operating

4. A new recording tape is being written.

The Time period provides a time orientation for the Data records that follow it. It is output every cycle in which there are one or more Data records. Both the Zulu time and the cycle number are written.

The Data records contain the data or a portion of the data specified in a RST recording request entry. Data records follow and are referenced to a time cycle. The number of complete Data records that are output for a given cycle depends upon the number and types of requests in the RST for the cycle and the presence of the requested area of core.

The End record is written on tape when one of the following conditions occurs:

1. A RECORD OFF switch action is taken

2. A RECORD OFF control card is read

3. The time to stop recording, specified in the RST, has been reached

4. The end of tape mark has been reached

5. The RECORD CHANGE CONTROL card has been received.

The End of File record provides an indication to data reduction programs that the end of the test has been reached.

Recording:

<u>RELATED MANUAL INPUTS</u>

None

<u>RELATED SWITCH ACTIONS</u>

a) RECORD OFF

b) RECORD ON

c) RECORD TRACK/STOP

<u>RELATED DISPLAYS</u>

a) RECORDED TRACK LIST TD

b) STARTOVER ATTN TD

<u>RELATED DATA LINK MESSAGES</u>

None

SAVE A LIFE

If you observe an accident involving electrical shock,
DON'T JUST STAND THERE - DO SOMETHING!

RESCUE OF SHOCK VICTIM

The victim of electrical shock is dependent upon you to give him prompt first aid. Observe these precautions:

1. Shut off the high voltage.
2. If the high voltage cannot be turned off without delay, free the victim from the live conductor. REMEMBER:
   a. Protect yourself with dry insulating material.
   b. Use a dry board, your belt, dry clothing, or other non-conducting material to free the victim. When possible PUSH - DO NOT PULL the victim free of the high voltage source.
   c. DO NOT touch the victim with your bare hands until the high voltage circuit is broken.

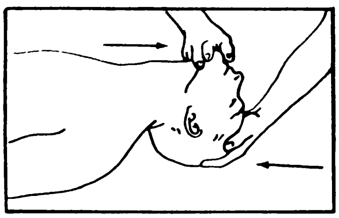
FIRST AID

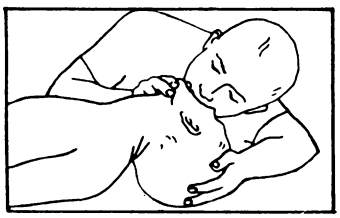
The two most likely results of electrical shock are: bodily injury from falling, and cessation of breathing. While doctors and pulmotors are being sent for, DO THESE THINGS:

1. Control bleeding by use of pressure or a tourniquet.
2. Begin IMMEDIATELY to use artificial respiration if the victim is not breathing or is breathing poorly:

   a. Turn the victim on his back.

   b. Clean the mouth, nose, and throat. (If they appear clean, start artificial respiration immediately. If foreign matter is present, wipe it away quickly with a cloth or your fingers).





   c. Place the victim's head in the "sword-swallowing" position. (Place the head as far back as possible so that the front of the neck is stretched).

   d. Hold the lower jaw up. (Insert your thumb between the victim's teeth at the midline - pull the lower jaw forcefully outward so that the lower teeth are further forward than the upper teeth. Hold the jaw in this position as long as the victim is unconscious).

   e. Close the victim's nose. (Compress the nose between your thumb and forefinger).

   f. Blow air into the victim's lungs. (Take a deep breath and cover the victim's open mouth with your open mouth, making the contact air-tight. Blow until the chest rises. If the chest does not rise when you blow, improve the position of the victim's air passageway, and blow more forcefully. Blow forcefully into adults, and gently into children.

   g. Let air out of the victim's lungs. (After the chest rises, quickly separate lip contact with the victim allowing him to exhale).

   h. Repeat steps f. and g. at the rate of 12 to 20 times per minute. Continue rhythmically without interruption until the victim starts breathing or is pronounced dead. (A smooth rhythm is desirable, but split-second timing is not essential).

DON'T JUST STAND THERE - DO SOMETHING!