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AUGMENTED RADAR BEACON TRACKING LEVEL SYSTEM DESIGN SPECIFICATION

L. Huff, et al

Sperry Univac

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16. Abstract

This document is a system specification for the Augmented Radar Beacon Tracking Level (RBTL) system. The Augmented RBTL expands the Beacon Tracking Level (BTL) ARTS III system by providing the capability of automatically tracking and displaying information on both non-beacon and beacon-equipped aircraft. In addition, this system provides improved tracking techniques together with new techniques for improving the controller-computer interface.

The Augmented RBTL system expands the ARTS III system, but retains the ARTS III features. Primary radar processing is accomplished through the addition of an Radar Data Acquisition Subsystem (RDAS) together with radar processing software. The RDAS accepts basic timing and radar video information from a search radar. It provides quantized video hits to the ARTS computer (IOP) in the form of 30 bit words. The computer uses these hits to perform radar target detection and position estimation.

Included as an appendix to this document is a stand alone specification for an RDAS. Another appendix provides an approach to dual Augmented RBTL implementation.

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1. SCOPE

This specification sets forth the requirements for the expansion of the ARTS III Beacon Tracking Level (BTL) system to a fully integrated radar and beacon tracking level system. The expanded system is designated the Augmented Radar Beacon Tracking Level (RBTL) system. The system retains the modularity and expandability features of the ARTS III system. All other ARTS III features, such as the processing and display of beacon-derived data, are also retained. In addition, the following features are provided:

a) Automatic reporting and tracking of all beacon and non-beacon equipped aircraft
b) Improved techniques for radar and beacon tracking
c) Improved controller-computer interface.

Contained within this specification are the system requirements for the addition of the above features to the ARTS III single beacon system. These requirements include hardware, software, installation, testing, reliability, and maintainability. An approach to the expansion of the dual beacon ARTS III to a dual Augmented RBTL is provided as an appendix.

The additional hardware items required for the Augmented RBTL system are the following: one Input Output Processor (IOP), 16K core memory, and a Radar Data Acquisition Subsystem (RDAS). The IOP and core memory are additions to the Data Processing Subsystem (DPS) of the ARTS III.

The RDAS produces quantized target video in serial binary form, accumulates it into 30-bit words, and parallel transfers these words to the DPS memory via IOP control. In addition, the RDAS transfers clutter information to the DPS in 30-bit words and receives command and zone control words from the DPS.

Software requirements for the expanded system include modifications and additions to the ARTS III operational program, utility programs, maintenance and diagnostic programs, and system test program. Modifications to the operational program are required in the tracking and display areas. The principal addition to the operational program is a radar processing module.

The modifications in the tracking area of the operational program are required to incorporate several improved radar and beacon tracking techniques. Among these are the following: automatic initiation, tracking and termination of all aircraft; enhanced cross-referencing; and track-oriented smoothing.

Modifications in the display area bring about a more efficient and convenient controller-computer interface. Two specific modifications in this area are the incorporation of "prime" functions which eliminate redundant keyboard entries and the incorporation of automatic handoff capability.

The add-on radar processing module performs radar target detection, combines radar and beacon reports received from the same aircraft, and dynamically controls the RDAS to enhance its performance.

1. (continued)

The radar processing, beacon processing and radar/beacon correlation functions are performed in one IOP, whereas the tracking and display functions are performed in a second IOP.

A detailed hardware specification for the RDAS is included as an appendix to this document.

This specification is submitted to fulfill the requirements of 3.3.2.1.5 of the ARTS Enhancement Statement of Work, dated 1 April 1971, Modification 19. FAA-TD/S-120-801 is applicable to the extent that compliance with this document accomplishes the purpose of the ARTS enhancement contract. Where FAA-TD/S-120-801 is not applicable, the designers of equipment are guided by the contract for ARTS III Equipment (DOT FA-69WA-2071).

2. APPLICABLE DOCUMENTS

2.1 FAA Documents.-

The following FAA specifications and standards of the issues specified in the invitation for bids or request for proposals form a part of this specification, and are applicable to the extent specified herein.

2.1.1 FAA Specifications.-

FAA-D-638	Instruction Books, Electronic Equipment
FAA-G-2100/1	Electronic Equipment, General Requirements; Part 1, General Requirements for All Equipments
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-TD/S-120-801A	System Technical Description and Specification for a Modularly Expandable ARTS III (Tracon"C") Beacon Tracking Level System

2.2 Military Publication.-

The following Military publication of the issue in effect on the date of the invitation for bids or request for proposals forms a part of this specification and is applicable to the extent specified herein.

MIL-E-17555	Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of

2.3 Other Publications.-

The following publications, of the issue in effect on the date of the invitation for bids or request for proposal, form a part of this specification and are applicable to the extent specified herein.

2.3.1 Sperry Univac Documents.-

PX 6213	General System Manual for ARTS III Beacon Tracking Level System
PX 5895	Technical Manual for ARTS III Data Processing Subsystem
PX 5896	Technical Manual for ARTS III Data Processing Subsystem Input/Output Processor

2.3.1 (continued)

PX 5897	Technical Manual for ARTS III Data Processing Subsystem Memory
PX 5898	Technical Manual for ARTS III Data Processing Subsystem, Power Supply
PX 5899	Technical Manual for ARTS III Data Processing Subsystem, Peripheral Adapter Module
PX 6047	ARTS III Coding Specifications for the Modular Automated Terminal Air Traffic Control System
PX 6185	ARTS III IOP Diagnostic Manual
PX 6196	User's Manual for ARTS III Support Software

2.3.2 Texas Instrument Documents.-

Instruction Book for ARTS III Data Entry Display Subsystem
(Volumes 1, 2, 3)

2.3.3 Burroughs Documents.-

Technical Manual for ARTS III Data Acquisition Subsystem
(Volumes 1, 2, 3 and 4)

(Copies of this specification and other applicable FAA specifications, standards, and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved, or other use to be made of the requested material).

(Single copies of Military specifications and standards may be obtained from Federal Aviation Administration, Washington, D.C., 20590, attention: Contracting Officer. Requests should cite the invitation for bids, request for proposals, or contract for which the material is needed. Mail requests, if found acceptable, will be forwarded to a military supply depot for filling; hence, ample time should be allowed.)

(Industrial publications listed are available at Federal Aviation Administration headquarters.)

3. REQUIREMENTS

3.1 Extent of Work.-

3.1.1 Equipment and Services to be Furnished by the Contractor.- The contractor shall provide all necessary services and materials to design, fabricate, test, deliver, install, and integrate the add-on hardware and software required by this specification to expand the ARTS III system to the Augmented RBTL system. The equipment and services shall be provided in the quantities and at the time required by the contract. Also included shall be equipment unit and subsystem interconnections, testing, and demonstration of the ability of the expanded system to meet specified system performance requirements. In addition, the contractor shall provide all necessary services and material to prepare, reproduce, and provide reports, computer programs, and documentation as specified herein.

The expanded system shall retain all features of the ARTS III system. In addition, it shall provide for the tracking and display of primary radar targets, the enhancement of beacon tracking through the use of the radar data, improved tracking techniques, and improved controller-computer interface.

3.1.2 Summary of Contractor-Furnished Equipment and Services.- All equipment shall be delivered and installed by the contractor at the locations specified by the Government. All necessary facilities, parts, and hardware, including system/subsystem grounding plates, receptacles, connectors, cabling, wiring adapters, and outlets, except the GFE (Government Furnished Equipment) items identified in 3.1.3, shall be incorporated to enable the components of the add-on subsystem to be properly assembled, interconnected, and installed as required herein. The following is a summary of equipment and services to be provided by the contractor:

a) Expansion of DPS by one IOP and 16K core memory (3.3.2.1)
b) RDAS hardware (3.3.4.1.12 and Appendix A)
c) Radar processing software (3.3.4.2.4 and 3.3.4.2.6)
d) Modifications to operational software (3.3.4.2.3, 3.3.4.2.5, 3.3.4.2.7, 3.3.4.2.9, 3.3.4.2.10, 3.3.4.2.13, 3.3.4.2.14)
e) System Acceptance Testing (3.6)
f) Quality Assurance Testing (4.)
g) Interconnecting cables and wiring (see paragraph below).

All cables and bridging equipment connecting radar video, radar trigger, Azimuth Change Pulse (ACP) and Azimuth Reference Pulse (ARP) signals from the GFE common equipment to the Radar Video Digitizer (RVD) will be furnished and installed by the contractor. All wiring shall meet the requirements of Specification FAA-E-1217C.

3.1.3 Government-Furnished Equipment (GFE) and Services.- The Government will provide or install, or both, where applicable:

a) GFE ARTS III system including data processing, data entry, and display and beacon data acquisition subsystems, together with interconnecting cables
b) GFE common equipment
c) All modifications required to Government buildings
d) Any additional air conditioning capability that may be required to maintain the environment conditions specified in FAA-TD/S-120-801A
e) Space for the RDAS in the ARTS III equipment cabinet room
f) AC power outlet in the equipment cabinet room with size of circuit breaker to be specified by the contractor
g) Any additional cable support or ducting required between GFE common equipment and RDAS
h) All modifications to Government-furnished radar equipment required to provide non-integrated normal and MTI video signals for the RDAS. This includes conduit and cabling between radar site and GFE demarcation junction box, and between junction box and common equipment
i) Any additional AC power duct, conduit, or other appropriate cable support and power cable between CFE power panel and RDAS
j) Furnish and install all grounding wires from signal reference plates to RDAS. The contractor will be responsible for any changes required to the ARTS III grounding system necessitated by the addition of the RDAS to the ARTS system
k) All necessary AC power connectors and receptacles necessary to interface the contractor-furnished RDAS and the GFE AC power cable. The contractor shall furnish mating connectors and receptacles necessary to connect power cable to RDAS.

Within 60 days after contract award, contractor shall advise the recommended size of circuit breaker, primary power requirements, and additional duct work to be furnished and installed by the Government.

The proposal shall contain estimates of space, power, and additional air conditioning requirements for the addition of the RDAS to the ARTS III system.

3.2 Definitions.-

Air Route Traffic Control Center (ARTCC).- An air traffic control facility which provides air traffic control services to all aircraft operating under Instrument Flight Rules (IFR) within controlled airspace, principally during the enroute phase of flight

Automated Radar Terminal System (ARTS).- A computerized air traffic control system which provides terminal area controllers with PPI (Planned Position Indicator) displayed alphanumeric data for use in controlling transponder-equipped aircraft

3.2 (continued)

Airport Surveillance Radar (ASR).- A short range (60nm) radar system used to maintain control of air traffic within a 30 mile radius of an airport

Augmented Radar Beacon Tracking Level System (RBTL).- An automated air traffic control system which retains the ARTS features but in addition provides improved tracking and display of alphanumeric data on non-beacon equipped aircraft

Beacon Data Acquisition Subsystem (BDAS).- The subsystem of the Augmented Radar Beacon Tracking Level system which receives broadband beacon video and transmits target replies, range, azimuth, and mode data to the data processing subsystem in the form of digital messages

Data Acquisition Subsystem (DAS).- The term used in the ARTS system for what is called the BDAS in the Augmented RBTL system

Data Entry and Display Subsystem (DEDS).- The subsystem in the Augmented RBTL system which provides the capability of manually entering data inputs to the system and of receiving display information from the data processing subsystem

Data Processing Subsystem (DPS).- The computer, memory, and peripheral modules of the Augmented RBTL system

Radar Data Acquisition Subsystem (RDAS).- The hardware subsystem which receives broadband radar video, digitizes it, and transfers the hits to the DPS. The RDAS receives control information from the DPS.

3.3 Equipment Makeup and Functional Requirements.-

3.3.1 General System Description.- The Augmented RBTL system expands the ARTS III system to provide the capability of reporting and tracking non-beacon equipped aircraft. To accomplish this, radar processing hardware and software are added and the ARTS III tracking program is upgraded to make appropriate use of the radar data available. In addition, the keyboard and display programs are modified to improve and simplify controller-computer interface. A block diagram of the Augmented RBTL system is contained in figure 3-1. A broken line encloses those hardware and software modules which are add-ons to the ARTS III system. A dotted line encloses the ARTS III software modules which undergo modification. A general description of the way in which the ARTS III system is upgraded to the Augmented RBTL system is contained in the following paragraphs.

3.3.1.1 ARTS III System Description.- The ARTS III single beacon system consists of the three hardware modules: the BDAS, the DPS, and the DEDS. The ARTS III system contains the following software modules: Beacon Processing, Tracking, and Display Processing.

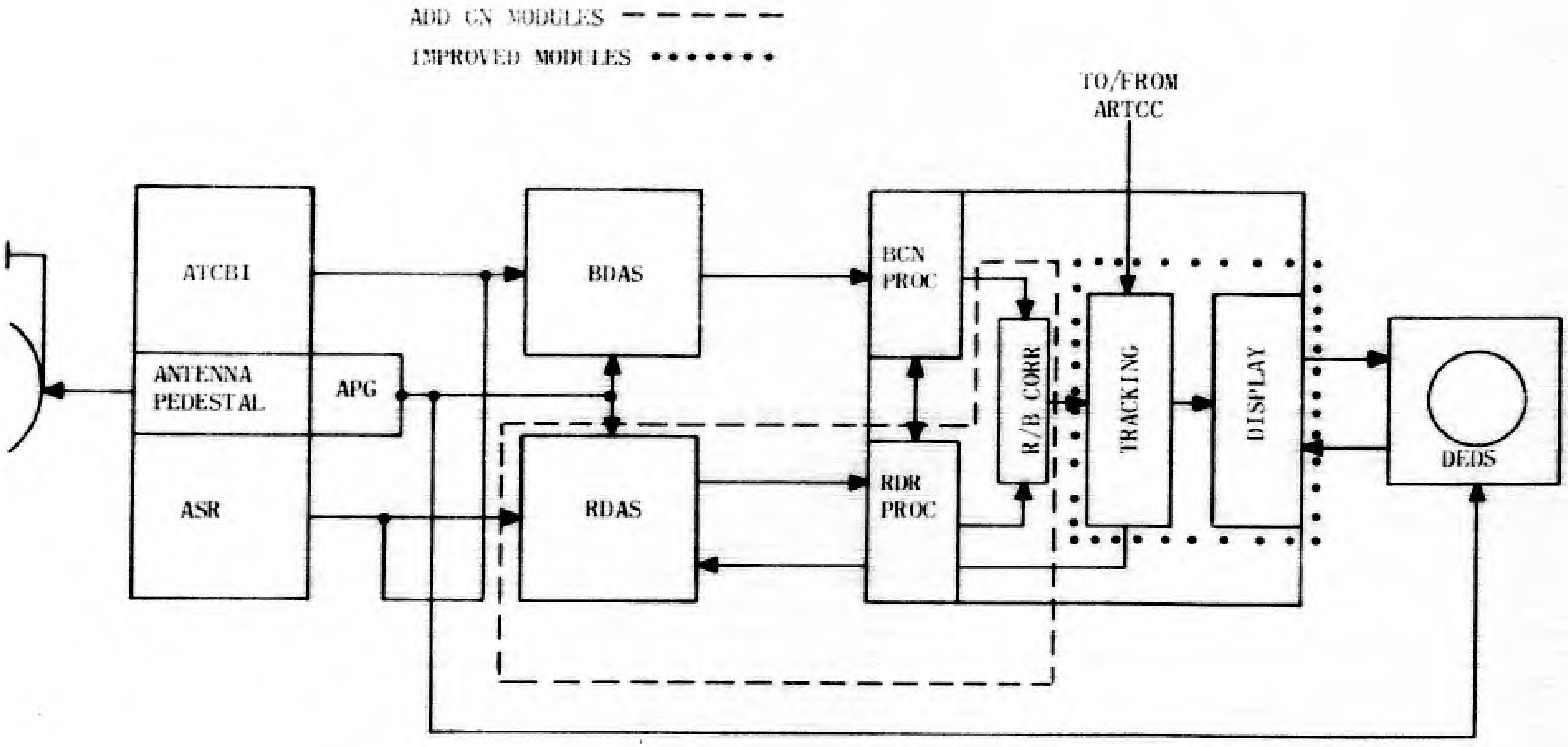


Figure 3-1. Simplified Block Diagram of Augmented RBTL System

3.3.1.1 (continued)

The BDAS (usually called the DAS in the ARTS III documentation) receives beacon video and triggers from the Air Traffic Control Beacon Interrogator (ATCBI) and azimuth information from the Azimuth Pulse Generator (APG). The beacon signals are digitized and decoded and beacon replies are sent to the DPS together with the range, azimuth, and reply code.

In the ARTS III system, the DPS consists of one computer called an IOP, 16-24K memory, and several input/output devices and controllers.

The DEDS provides for the display of analog beacon and radar video together with computer derived alphanumeric information. In addition, the DEDS provides a means for manual input of information to the DPS via keyboard or trackball entry.

The beacon processing software within the ARTS III system performs sweep-to-sweep correlation of beacon replies in order to declare beacon targets. The beacon processing software also performs reliability checks on beacon code information.

Beacon reports declared by the ARTS beacon processing software become input for tracking. The function of tracking is to create and maintain files containing report information on controlled aircraft. The tracking software uses the report data to compute velocity and to associate aircraft identity tags with the appropriate aircraft.

The display software interfaces with the DEDS, making available for display the aircraft information being generated by the tracking software. The display software also interprets and processes the keyboard and trackball information which is entered from the DEDS.

3.3.1.2 Additions to the ARTS III System.- The hardware additions to the ARTS III system which are required to upgrade it to the Augmented RBTL system are an RDAS, one additional IOP, and 16K additional core memory. The software add-ons are a radar processing module and a beacon radar correlation module.

The RDAS receives broadband radar video and triggers from the ASR and azimuth information from the APG. The RDAS converts the analog signal to digital and transmits the hit data to the DPS together with azimuth information.

The additional IOP and memory is added to the ARTS III DPS in order to perform the radar processing and beacon/radar correlation function. The beacon processing function is also assigned to the add-on IOP in order to make more efficient use of processing capability.

The radar processing software detects radar targets by performing sweep-to-sweep integration of the binary bit data received from the RDAS. This module also contains the software which dynamically controls the performance of the RDAS by feeding back command and control words.

3.3.1.2 (continued)

The radar targets declared by radar processing are correlated with beacon targets by the beacon/radar correlation software. The beacon radar correlation routine is designed to insure that only beacon and radar returns from the same aircraft are correlated.

<u>3.3.1.3 Modifications to the ARTS III Software</u>.- Software modifications are required to the tracking and display modules to upgrade the ARTS III system to the Augmented RBTL system.

The ARTS III tracking logic is modified to introduce improved tracking techniques. The augmented RBTL system has available both radar and beacon reports. Much of the redesign of the ARTS tracker is based on the desire to use radar and beacon data in an appropriate fashion. To the existing cross-referencing scheme is added a qualifying scoring to reflect the relationship of all tracks to their associated radar/beacon reports. Automatic initiation and tracking of all targets is performed. The resolution of ambiguous situations by the correlation algorithm is enhanced through the use of the qualifying score which exists for all track-target combinations. When an ambiguous situation cannot be resolved by qualifying score alone, deviation scoring is attempted in some cases to determine which target or targets (radar/beacon combination) is the correct one for correlation. After a target has been selected by correlation, track-oriented smoothing is performed on the track's velocity and position. Track-oriented smoothing basically involves smoothing in a rotated system, along the track's estimated direction, while preserving the use of ordinary X, Y coordinates for its implementation. After correlation and smoothing have been performed, the track is predicted to its next scan position. If this position is in a predesignated handoff area and is eligible for handoff, it is automatically handed off to a specific controller. All targets not used by tracking are eligible for automatic initiation. When an unused target has passed the required criteria, an unused track slot is created; and positional tracking of the target commences.

The keyboard input area of display processing is changed to incorporate the addition of "prime" functions. These prime functions allow the controller to make certain keyboard entries without having to first depress the specific function key on his keyboard. The elimination of this requirement, together with the fact that identity data-primarily trackball coordinates-would be the only required controller entry, reduces the data entry load on the controller and allows him to better perform his primary task of monitoring traffic.

The display output portion of display processing is changed to incorporate the display of both controlled targets (those tracks that have specific flight plan or controller-entered identity data) and uncontrolled targets (those unused targets that were automatically initiated by tracking). The controlled tracks are displayed in the usual format, i.e., ACID*, altitude, and speed. Uncontrolled tracks are filtered for each display based on the particular filter selection for that display.

* (Aircraft Identification)

3.3.2 System Organization.- The Augmented RBTL system is designed as a single beacon/single radar configuration. It is comprised of the following four hardware subsystems:

a) DPS
b) BDAS
c) RDAS
d) DEDS

The design takes into account the future possibility of upgrading to a Level 1 Redundant system. This particularly applies with respect to the RDAS computer interface.

The following paragraphs describe the Augmented RBTL hardware subsystems.

3.3.2.1 Data Processing Subsystem.- The DPS consists of the following major modules (see figure 3-2):

a) IOPs
b) Memory modules
c) Peripheral adapter module
d) Magnetic tape handler
e) Two console typewriters.

The DPS configuration for the Augmented RBTL system includes at least two IOPs, two 16,384 word memory modules, and one 8,192 word memory module.

The IOP combines the functions of an I/O multiplexer and a data processing unit. The number of I/O channels varies from 8 to 16, depending on the site complement of display consoles. One group of four channels is configured for intra-cabinet application to accommodate the magnetic tape, console typewriter, interfacility adapter, and BDAS, with word lengths to match the requirements of each device. The remainder of the channels have a 30-bit word length and are capable of operation with external cables. These are used for the display consoles, RDAS, and, other external equipment. The characteristics of the IOP are described in "Technical Manual for the ARTS III Data Processing Subsystem, Input/Output Processor."

A memory module has either 8,192 words or 16,384 words. Word length is 30 data bits plus two parity bits. Memory cycle time (with one access port) is 750 nanoseconds (nsec). A memory module can be equipped with 1, 2, or 4 access ports and the associated access priority circuitry. Systems requiring further access port expansion utilize a centralized memory access module. The characteristics of the memory module are described in detail in "Technical Manual for ARTS III Data Processing System, Memory."

The DPS peripheral equipment consists of a magnetic tape handler, a console typewriter, and a Peripheral Adapter Module (PAM) which contains: 1) a magnetic tape control unit; 2) a console typewriter adapter; and 3) an interfacility communication adapter (if required) for communication with an ARTCC. This

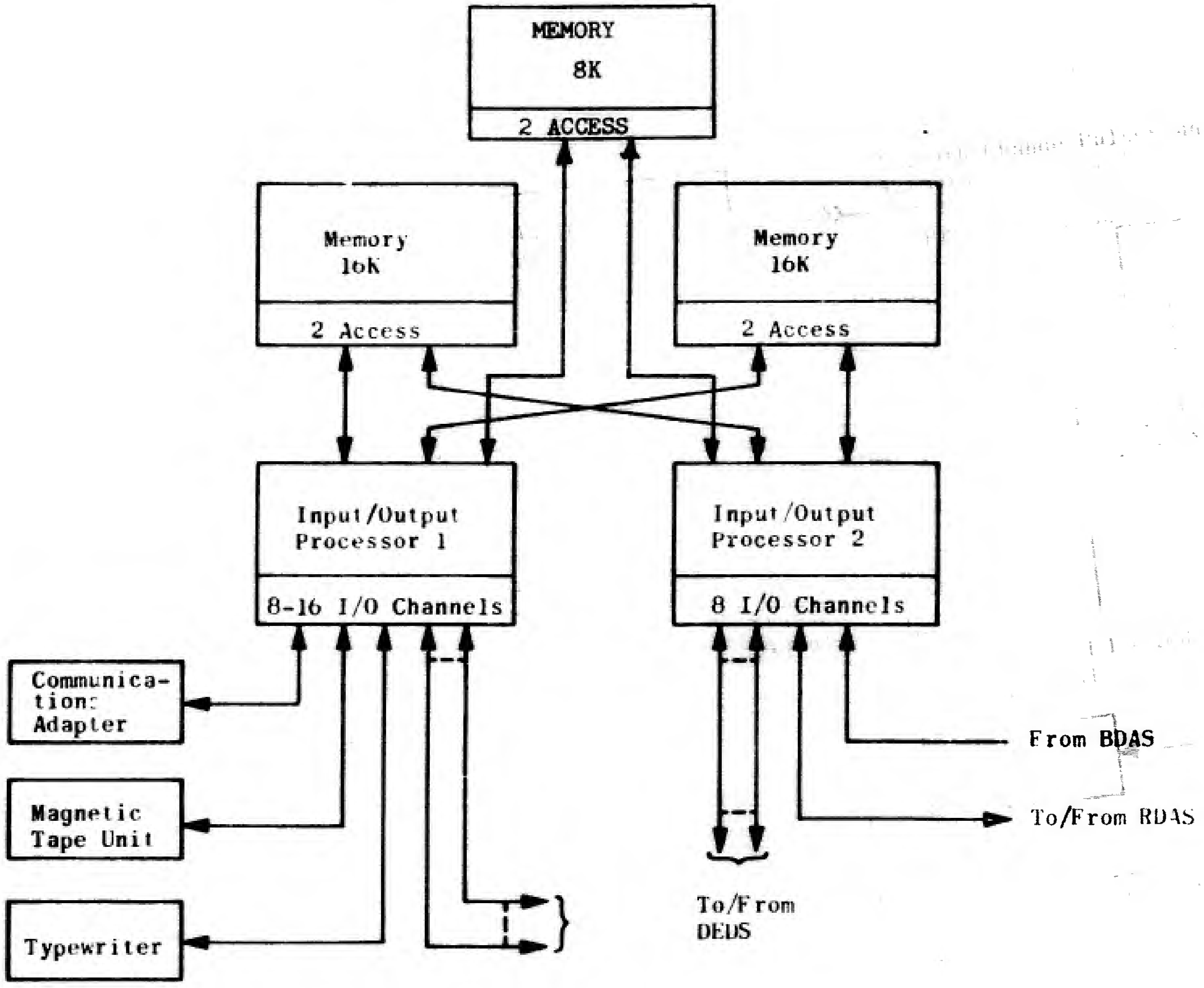


Figure 3-2. Basic ARBTL Data Processing System Configuration

3.3.2.1 (continued)

equipment is described in detail in "Technical Manual for ARTS III Data Processing Subsystem, Peripheral Adapter Module."

For the Augmented RBTL system, the data processing and input/output requirements are satisfied by configuring the DPS with two IOPs and two 16,384 and one 8,192 word memory banks. Figure 3-2 illustrates this DPS configuration.

The standard functional modules (Central Processor Unit (CPU), IOP, memory) are designed with a common physical size and form factor for system packaging convenience. For the Augmented ARTS III, the DPS is packaged in two cabinet sections. One section, (processor cabinet) is capable of housing four standard modules; two of these can be IOP modules. The second section (peripheral equipment cabinet) houses the PAM, the magnetic tape handler, and BDAS card assembly.

If additional data processing capabilities are required, the DPS described above is supplemented with UNISERVO VIC magnetic tape units and a UNIVAC 9300 card processor.

3.3.2.2 Beacon Data Acquisition Subsystem.- The BDAS accepts broadband beacon replies and converts them into digital form suitable for further processing by the DPS. Refer to figures 3-2 and 3-3. It should be noted that the BDAS does not provide a target detection function (sweep-to-sweep correlation of replies) but that this function is performed by software within the DPS.

An electronics unit (BDAS card rack assembly) comprising the Beacon Reply Group (BRG) and the Azimuth, Range, and Timing Group (ARTG) is located in the ARTS III equipment room, where it is mounted in the DPS peripheral equipment cabinet. A separate beacon control unit (control box) is located in the ARTS III operations area. An APG is located at the radar site where it is mounted on the radar antenna pedestal.

The ARTG receives antenna rotation signals from the APG and beacon pretriggers and mode triggers from the Air Traffic Control Radar Beacon System (ATCRBS) equipment. These signals are used to control range and azimuth counters within the ARTG which then provide range, azimuth, and mode information to the BRG.

The BRG receives the beacon video signal, quantizes it, and feeds it into a high-speed shift register which detects bracket pulses and samples the data pulses in a serial manner. Each reply is tested for the presence of garble conditions. Overlapped, interleaved, and closely-spaced replies are resolved by the BRG logic.

The BDAS includes a line compensator and trigger separator which permits the BDAS to interface directly with the beacon interrogator site equipment; an analog channel, which provides partially-decoded video outputs to the DEDS; and a control box for remote control of the beacon interrogator. These features permit ARTS III to operate independently of the existing beacon interrogator site equipment.

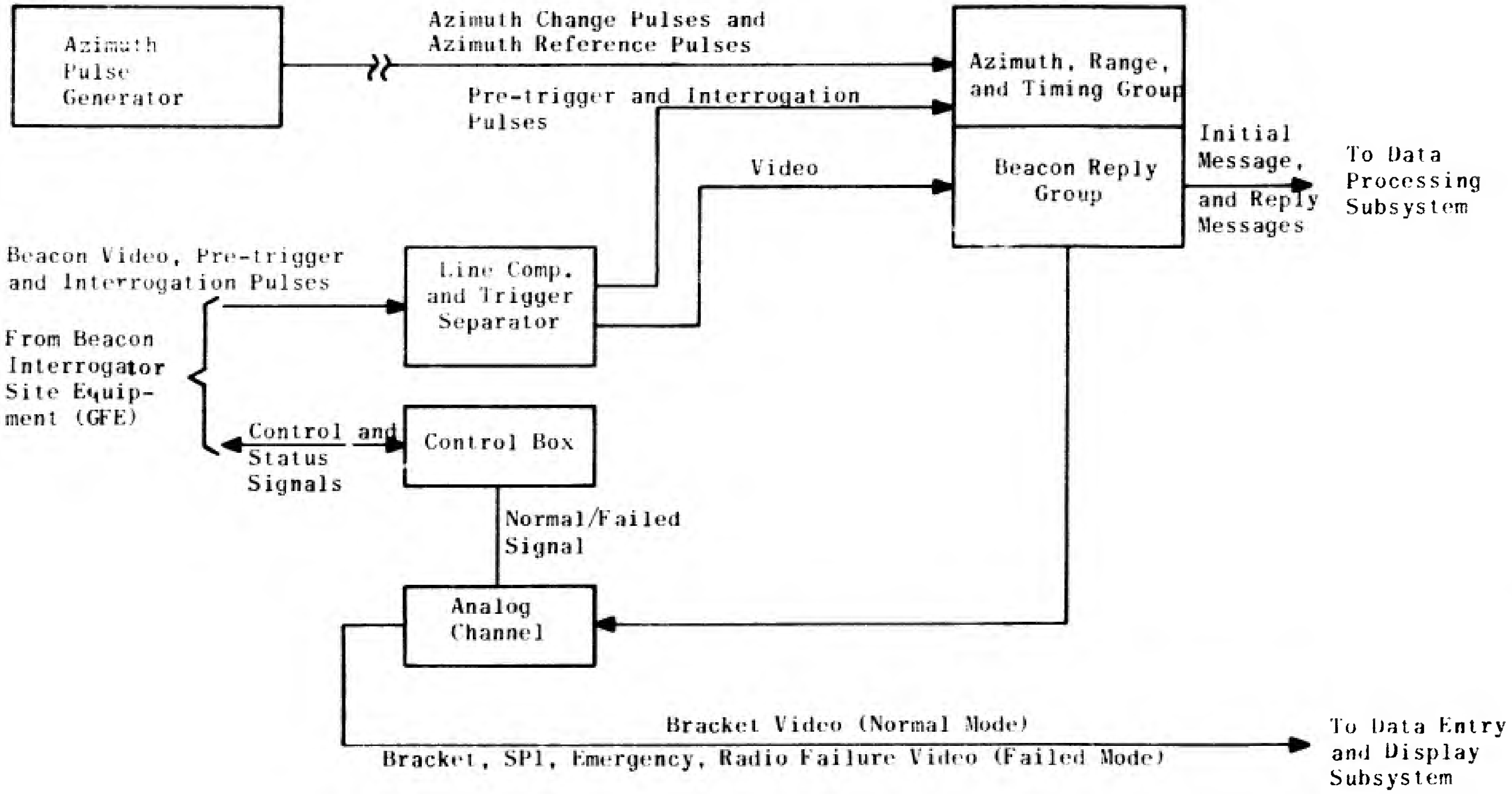


Figure 3-3. Beacon Data Acquisition Subsystem Configuration

3.3.2.2 (continued)

The BDAS requires one 30-bit DPS input channel. It transmits three types of messages to the DPS. At pretrigger time, the BDAS transmits an interrupt message to the DPS containing a sector pulse bit and a staggered pulse repetition frequency (PRF) sequence bit. At mode trigger time, prior to each sweep, the BDAS transmits a message containing the azimuth count and interrogation mode. Then, for each reply detected during the sweep, the BDAS transmits a message containing the beacon code as well as a count which indicates the range at which the reply was detected. Azimuth is reported with a quantization of 0.088 degrees; range is reported with a quantization of 1/16 nautical mile (nm).

3.3.2.3 Data Entry and Display Subsystem.- The DEDS provides the man/machine interface between the air traffic controllers and the ARTS III automation equipment. Refer to figure 3-4. The DEDS includes manual input devices to permit the controller to enter flight data into the DPS as well as to request and control the display of alphanumeric data. The DEDS also includes Cathode Ray Tube (CRT) display devices which present the controller with conventional radar and beacon sensor video supplemented with DPS controlled alphanumeric data.

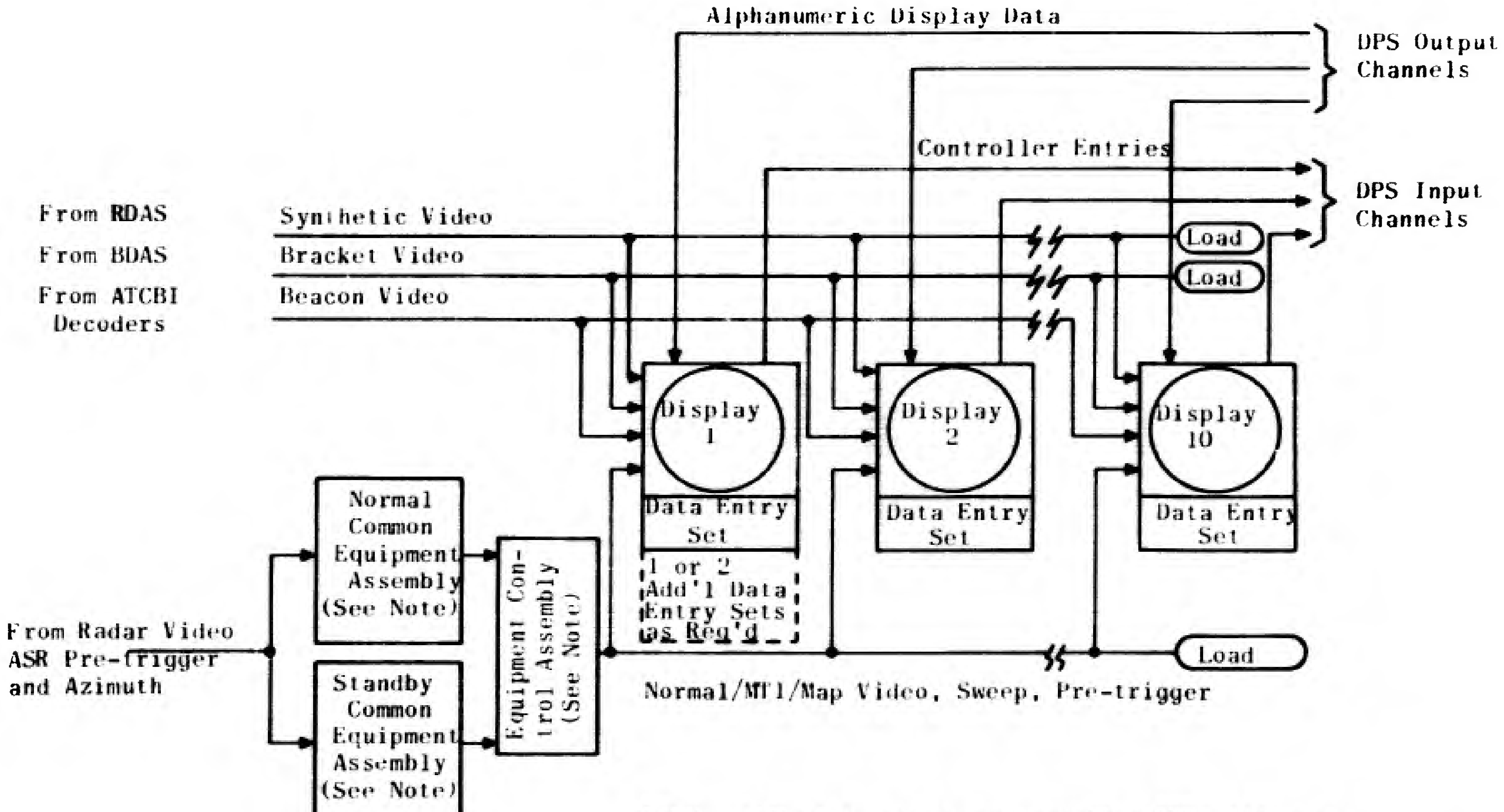
Alphanumeric data is displayed at the aircraft position for tracked aircraft and untracked aircraft. Data pertaining to pending arrivals, proposed departures, and coasting (or suspended) tracks appear in a tabular list. Special blinking displays are used to indicate emergency and radio failure conditions. A display area associated with each data entry set displays time-of-day, current altimeter setting, and a preview of keyboard-entered information.

Two different types of displays are provided in ARTS III: Type I, a vertical display; and Type II, a horizontal display. The Type I and II displays are functionally identical; they differ only in mechanical configuration. The displays provide a 22-inch diameter composite presentation of broadband radar/beacon PPI video and computer-generated alphanumeric data with a maximum range of 55 nm. This is accomplished by a CRT time-sharing technique in which the alphanumeric display data is generated during radar dead time. Each display requires one 30-bit DPS input/output (I/O) channel.

The speed of the character generation and deflection circuitry permits it to display the required amount of alphanumeric data utilizing the dead time periods. The output data rate of the DPS is adequate to permit six displays to be refreshed at the required rate with maximum required amount of alphanumeric data.

Where a system is equipped with more than six displays, the additional displays are limited to a range of 42 nm. The dead time between 42 and 55 nm. is used as a second time period for alphanumeric generation on these displays.

Each data entry device consists of an alphanumeric keyboard, a quick-look selector switch, and position entry control. Each display console can accomodate three data entry devices. The DPS periodically receives, via an input channel, responses from the data entry set(s) associated with that console.



NOTE: GFE with contractor-supplied ARTS III modification kit.

Figure 3-4. Data Entry and Display Subsystem Configuration

The keyboard is used by the controller to enter function commands and alphanumeric flight data into the DPS. Feedback from the DPS to the CRT display will present the entered data in a preview area so that a data entry message can be composed and inspected for validity by the controller before it is acted upon by the DPS. The quick-look selector push buttons enable the controller to select and display the alphanumeric data pertaining to aircraft that are under the cognizance of a controller at another operating position. The display of quick-look data is performed under control of the DPS. The position entry control is used to enter PPI position coordinate information into the DPS. This positional data is entered in conjunction with a keyboard message. It can specify the position of a track, of sensor video, or of an alphanumeric data item. Additional information is available in the "Technical Manual for the ARTS III Data Entry and Display Subsystem."

3.3.2.4 Radar Data Acquistion Subsystem.- The RDAS accepts basic timing information and analog video from the Search Radar (ASR). From this information the RDAS extracts video hit, target predetection, weather correlation, and clutter data. The RDAS accepts control and command words from the IOP and employs the parameters contained in these words to perform its functions.

Each radar sweep the RDAS transfers the video hit, target predetection, azimuth, weather correlation, and clutter data to the IOP in 30-bit computer words. Video hit words represent the result of binary analog to digital conversion of the radar video. The target predetection word provides a pointer to the radar detection software indicating possible areas of targets. The weather correlation words measure the degree of azimuth correlation in the weather clutter areas. The clutter words contain information derived from normal radar video indicating the areas within the surveillance where light or heavy weather clutter is present.

The RDAS contains 3 quantizers. One uses a long time constant integration of video hits to derive a threshold which is used to quantize (linear or log) normal video clear areas. The second quantizer employs a rank order adaptive threshold technique to quantize normal video in light weather clutter areas. A third quantizer similar to the second is used for Moving Target Indicator (MTI) video in heavy clutter areas. The RDAS contains internal circuitry which senses MTI limiting and automatically switches to the second quantizer in these regions. The internal swtiching to the second quantizer is inhibited in ground clutter regions. The selection of quantizers (equivalently, the selection of videos) is under IOP control.

The predetection of targets and the measurement of weather correlation is performed in the RDAS by a 4-bit sequential counter. The counter updates a sum for every range cell. The sum is a measure of hit density in azimuth.

Additional information on the RDAS is available in "Appendix A, Design Specification: Radar Data Acquistion Subsystem."

3.3.3 Equipment Interfaces.- Certain signals depend on the complement of a particular site. Interface data for a typical single radar/beacon system are given below. For a dual radar/beacon system, the interface data is duplicated for each radar/beacon system. Additional site variations include:

a) Microwave relay link instead of land line remoting at some sites
b) Lack of interfacility communication line and modem at some sites

Table 3-1 contains a summary of the interface signals including signal name, source, destination, cable information, signal electrical characteristics, and impedance data.

Table 3-2 contains the DPS input/output channel assignment.

TABLE 3-1. SUMMARY LIST OF INTERFACE DATA

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
1	Beacon Video	ATCBI-3 (Via DJBU)	Peripheral Cabinet (BDAS)	RG-59 B/U Coax	1 to 4 V	.35 to .4µs	75Ω or 1KΩ	BNC	1	150'	Separated video Via RML
2	Beacon Triggers	ATCBI-3 (Via DJB)	Peripheral Cabinet (BDAS)	RG-59 B/U Coax	25 to 50 V	.5 to 1.5µs	75Ω or 1KΩ	BNC	1	150'	Separated Triggers Via RML
3	Beacon Video & Triggers	ATCBI-3 (Via DJB)	Peripheral Cabinet (BDAS)	RG-59 B/U Coax	Video: .5V Min Triggers: .4V Min	Video: .35 to .4µs Triggers: .5 to 1.5µs	75Ω or 1Ω	BNC	1	12,000'	Mixed Video & Triggers Via Landline
4	Azimuth Change Pulses	APG (Via DJB)	Peripheral Cabinet (BDAS)	#22 AWG Shielded Twisted Pair	Landline: 2.6VP-P Min. RML: [illegible] NOM	1024 HZ NOM	5000Ω Min	MS3106A22-14S (Periph. Cab.)	1	12,000' (LL)	Length includes GFE Landline to Transmitter Site
	Azimuth Reference Pulse	APG (Via DJB)	Peripheral Cabinet (BDAS)	#22 AWG Shielded Twisted Pair	Landline: 2.6VP-P Min. RML: 2.5V	.25 HZ NOM	5000Ω Min		1	12,000' (LL) 150' (RML)	
	Range Error Readback	ATCBI-3 (Via DJB)	Peripheral Cabinet (BDAS)	#22 AWG Twisted Pair	Open Ground	NA	1KΩ to +5V		1	12,000' (LL) 150' (RML)	

(Table 3-1 continued on page 3-16)

(Table 3-1 continued from page 3-15)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
4	Range/ Azimuth Alarm	BSN PERF MON (Via DJB)	Peripheral Cabinet (BDAS)	#22 AWG Twisted Pair	Open/Ground	NA	1KΩ to +5V		1	12,000' (LL)	
	Monitor Fail	BON PERF MON (Via DJB)	Peripheral Cabinet (BDAS)	#22 AWG Twisted Pair	Open/Ground	NA	1KΩ to +5V		1	12,000 (LL)	
5	Interro- gator Power Control	Beacon Control Unit	ATCBI-3 (Via DJB)	#20 AWG	Open/Ground	NA	NA	MS3106A28-25 (Beacon Control Unit)	1	12,000' (LL)	
	Local Control Enable	Beacon Control Unit	ATCBI-3 (Via DJB)	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
	Channel Select Control	Beacon Control Unit	ATCBI-3 (Via DJB)	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
	Interro- gate Control	Beacon Control Unit	ATCBI-3 (Via DJB)	#20 AWG	Open/Ground	NA	NA		1	12,000 (LL)	
	Defruiter Control	Beacon Control Unit	ATCBI-3 (Via DJB)	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
	Interro- gator Power Readback	ATCBI-3 (Via DJB)	Beacon Control	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	

(Table 3-1 continued on page 3-17)

(Table 3-1 continued from page 3-16)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
5	No-Control Readback	ATCBI-3 (Via DJB)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
	Interrogate Readback	ATCBI-3 (Via DJB)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
	Default Readback	ATCBI-3 (Via DJB)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	12,000' (LL)	
6	Range Error	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA	MS3106A28-25W (Beacon Control Unit)	1	150'	
	Monitor Fail	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA	MS3106A22-1 1S (At Periph. Cab.)	1	150'	
	Emergency	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	150'	
	Mode 3/A	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	150'	
	Mode C	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	150'	

(Table 3-1 continued on page 3-18)

(Table 3-1 continued from page 3-17)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
6	Audible Alarm Buzzer	Peripheral Cabinet (BDAS)	Beacon Control Unit	#20 AWG	Open/Ground	NA	NA		1	150'	
	Buzzer Mute	Beacon Control Unit	Peripheral Cabinet (BDAS)	#20 AWG	Open/Ground	NA	1KΩ to +5V		1	150'	
	Normal/Failed Mode	Beacon Control Unit	Peripheral Cabinet (BDAS)	#20 AWG	Open/Ground	NA	1KΩ to +5V		1	150'	
7	Beacon Test Video	Radar Beacon Test Set	Peripheral Cabinet (BDAS)	RG-59 B/U Coax	1V Min.	Variable	75Ω	BNC	1	150'	
8	Zero Range Trigger	Peripheral Cabinet (BDAS)	Fixed Map Unit	RG-59 B/U Coax	25 ± 10V	1.0 ± .5µs	75Ω	BNC	1	150'	
9	FMU Inhibit	Fixed Map Unit	Peripheral Cabinet (BDAS)	RG-59 B/U Coax	3 to 5V	Variable	75Ω	BNC	1	150'	
10	Send Data	Peripheral Cabinet (BDAS)	Dacom Modem	RG-62 B/U Coax	± 6V	2400 HZ	100 Max (Source IMP)	BNC (Both Ends)	1	150'	

(Table 3-1 continued on page 3-19)

(Table 3-1 continued from page 3-18)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
11	Send Clock	Dacom Modem	Peripheral Cabinet (ICA)	RG-62 B/U Coax	± 6V	2400 HZ	5000 Min	BNC (Both Ends)	1	150'	
12	Receive Data	Dacom Modem	Peripheral Cabinet (ICA)	RG-62 B/U Coax	± 6V	2400 HZ	5000Ω Min	BNC (Both Ends)	1	150'	
13	Receive Clock	Dacom Modem	Peripheral Cabinet (ICA)	RG-62 B/U Coax	± 6V	2400 HZ	5000Ω Min	BNC (Both Ends)	1	150'	
14	Output Data	Peripheral Cabinet (CTA)	Mod 37 ASR	#20 AWG	± 25V	150 Baud	NA	(To Be Supplied)	1	150'	
	Input Data	Mod 37 ASR	Peripheral Cabinet (CTA)	#20 AWG	± 25V	150 Baud	NA		1	150'	
	Clear to Send	Peripheral Cab. (CTA)	Mod 37 ASR	#20 AWG	± 25V	Variable	NA		1	150'	
15	Input Data (30 bits + 2 Parity)	BDAS Card Rack Assy	IOP	#30 AWG Pairs	3.4V	NA	120Ω	PC Paddleboard (Both Ends)	32	10'	Type B (Internal) Input Channel
	Ext. Interrupt Re-Quest	BDAS Card Rack Assy	IOP	#30 AWG	3.4V	NA	120Ω		1	10'	

(Table 3-1 continued on page 3-20)

(Table 3-1 continued from page 3-19)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
15	Input Data Request	BDAS Card Rack Assy	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Acknowledge	IOP	BDAS Card Rack Assy	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
16	Input Data (8 Bits+1 Parity)	Peripheral Adapter (ICA)	IOP	#30 AWG Pairs	3.4V	NA	120Ω	PC Paddleboard (Both Ends)	9	10'	Type B (Internal) I/O Channel
	Ext. Interrupt Request	Peripheral Adapter (ICA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Data Request	Peripheral Adapter (ICA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Acknowledge	IOP	Peripheral Adapter (ICA)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
	Output Data (8 Bits +1 Parity)		Adapter (ICA)	#30 AWG Pairs	3.4V	750 NS Min	120Ω		9	10'	
	Ext. Function Acknowledge	IOP	Peripheral Adapter (ICA)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	

(Table 3-1 continued on page 3-21)

(Table 3-1 continued from page 3-20)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
16	Input Acknowledge	IOP	Peripheral Adapter (ICA)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
	Output Data Request	Peripheral Adapter (ICA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
17	Input Data (5 Bits+ 1 Parity)	Peripheral Adapter (CTA)	IOP	#30 AWG Pairs	3.4V	NA	120Ω	PC Paddleboard (Both Ends)	6	10'	[illegible]
	Ext. Interrup Request	Peripheral Adapter (CTA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Data Request	Peripheral Adapter (CTA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Acknowledge	IOP	Peripheral Adapter (CTA)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
	Output Data (5 Bits+ 1 Parity)	IOP	Peripheral Adapter (CTA)	#30 AWG Pairs	3.4V	750 NS Min	120Ω		6	10'	
	Ext. Function Acknowledge	IOP	Peripheral Adapter (CTA)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	

(Table 3-1 continued on page 3-22)

(Table 3-1 continued from page 3-21)

Ref. No	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
17	Output Data Request	Peripheral Adapter (CTA)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
18	Input Data (6 Bits+ 1 Parity)	Peripheral Adapter (MTC)	IOP	#30 AWG Pairs	3.4V	NA	120Ω	PC Paddleboard (Both Ends)	7	10'	
	Ext. Interrupt Request	Peripheral Adapter (MTC)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Data Request	Peripheral Adapter (MTC)	IOP	#30 AWG Pair	3.4V	NA	120Ω		1	10'	
	Input Acknowl-edge	IOP	Peripheral Adapter (MTC)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
	Output Data (6 Bits+ 1 Parity)	IOP	Peripheral Adapter (MTC)	#30 AWG Pairs	3.4V	750 NS Min	120Ω		7	10'	
	Ext. Function Acknowledge	IOP	Peripheral Adapter (MTC)	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	
	Input Acknowl-edge	IOP	Peripheral Adapter	#30 AWG Pair	3.4V	375 NS Min	120Ω		1	10'	

(Table 3-1 continued on page 3-23)

(Table 3-1 continued from page 3-22)

Ref No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequeny or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
18	Output Data Request	Peripheral Adapter (MTC)	IOP	#30 AWG Pair	3.4V	NA	Ω		1	10'	
19	Input Data (30 Bits)	Uniservo VI C Control	IOP	#22 AWG Twisted Pairs	-3.0 to -4.2V	NA	160Ω	Univac 7084908 (IOP) Paddleboard (Uniservo)	30	200'	Type A (External) Input Channel
	Ext. Interrupt Request	Uniservo VI C Control	IOP	#22 AWG Twisted Pairs	-3.0 to -4.2V	NA	160Ω		1	200'	
	Input Data Request	Uniservo VI C Control	IOP	#22 AWG Twisted Pair	-3.0 to -4.2V	NA	160Ω		1	200'	
	Input Acknowledge	IOP	Uniservo VI C Control	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
20	Output Data (30 Bits)	IOP	Uniservo VI C Control	#22 AWG Twisted Pair	-3.0 to -4.5V	750 NS Min	160Ω	Univac 7084908 (IOP) Paddleboard	30	200'	Type A (External) Output Channel
	Ext. Function Acknowledge	IOP	Uniservo VI C Control	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
	Output Acknowledge	IOP	Uniservo VI C	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	

(Table 3-1 continued on page 3-24)

(Table 3-1 continued from page 3-23)

Ref. No	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
20	Output Data Request	Uniservo VI C Control	IOP	#22 AWG Twisted Pair	-3.0 to -4.2V	NA	160Ω		1	200'	
21	Input Data (30 Bits)	9300 Processor	IOP	#22 AWG Twisted Pair	-3.0 to -4.2V	NA	160Ω	Univac 7084908 (IOP) Paddleboard (9300)	30	200'	
	Ext. Interrupt Requests	9300 Processor	IOP	#22 AWG Twisted Pair	-3.0 to -4.2V	NA	160Ω		1	200'	
	Input Data Request	9300 Processor	IOP	#22 AWG Twisted Pair	-3.0 to -4.2V	NA	160Ω		1	200'	
	Input Acknowledge	IOP	9300 Processor	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
22	Output Data (30 Bits)	IOP	9300 Processor	#22 AWG Twisted Pair	-3.0 to -4.5V	750 NS Min	160Ω	Univac 7084908 (IOP) Paddleboard (9300)	30	200'	Type A (External) Output Channel
	Ext. Function Acknowledge	IOP	9300 Processor	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	

(Table 3-1 continued on page 3-25)

(Table 3-1 continued from page 3-24)

Ref No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No of Lines	Max Length	Remarks
22	Output Acknowledge	IOP	9300 Processor	#22 AWG Twisted Pair	-3.0 to -1.5V	375 NS Min	160Ω		1	200'	
	Output Data Request	9300 Processor	IOP	#22 AWG Twisted Pair	-3.0 to -1.2V	NA	160Ω		1	200'	
23	Input Data (30 Bits + 2 Parity)	DEDS Console	IOP	#22 AWG Twisted Pairs	-3.0 to -1.5V	NA	160Ω	Univac 7084908 (Both Ends)	32	200'	Type A (External) Input Channel. Typical for Each Display Console
	Ext., Interrupt Request	DEDS Console	IOP	#22 AWG Twisted Pairs	-3.0 to -1.5V	NA	160Ω		1	200'	
	Input Data Request	DEDS Console	IOP	#22 AWG Twisted Pair	-3.0 to -1.5V	NA	160Ω		1	200'	
	Input Acknowledge	IOP	DEDS Console	#22 AWG Twisted Pair	-3.0 to -1.5V	375 NS Min	160Ω		1	200'	
24	Output Data (30 Bits +2 Parity)	IOP	DEDS Console	#22 AWG Twisted Pair	-3.0 to -1.5V	750 NS Min	160Ω	Univac 7084908 (Both Ends)	32	200'	Type A (External) Output Channel. Typical for Each Display Console

(Table 3-1 continued on page 3-26)

(Table 3-1 continued from page 3-25)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
24	Ext. Function Acknowl-edge	IOP	DEDS Console	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
	Output Acknowl-edge	IOP	DEDS Console	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
	Output Data Request	DEDS Console	IOP	#22 AWG Twisted Pair	-3.0 to -4.5V	NA	160Ω		1	200'	
25	Analog Channel Video	Peripheral Cabinet (DAS)	DEDS Console	RG-62/U Coax	0 to 2.5V	.4 US Min=	91Ω	BNC	1	150'	Hedge-Hopped to All Consoles
26	Azimuth Change Pulses	APG (Via DJB)	Com. Equip Assy (Standby)	#22 AWG Shielded Twisted Pair	Landline: 2.0VP-P Min HML: [illegible] Nom	1024 HZ	5000Ω Min	MS3102R18-1S (Com. Eq. Assy.)	1	150'	Fanout from Demarcation Junction Box
	Azimuth Reference Pulse	APG (Via DJB)	Com. Equip Assy. (Standby)	#22 AWG Shielded Twisted Pair	Landline: 2.0VP-P Min HML: 2.5V	.25 HZ	5000Ω Min		1	150'	

(Table 3-1 continued on page 3-27)

(Table 3-1 continued from page 3-26)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
27	Azimuth Change Pulses	APG (Via DJB)	Com Equip. Assy. (Normal)	#22 AWG Shielded Twisted Pair	Landline: 2.6VP-P Min RML: 4DBM Nom	10.24 HZ	5000Ω Min	MS3102R18-1S	1	150'	Fanout From Demarcation Junction Box
	Azimuth Reference Pulse	APG (Via DJB)	Com Equip. Assy. (Normal)	#22 AWG Shielded Twisted Pair	Landline: 2.6VP-P Min RML: 4DBM Nom	.25 HZ	5000Ω Min		1	I	
28	Range Marks 2NM	Com. Equip. Assy. (Both)	Equip Control Assy.	RG-62/U Coax	2 to 7V		91Ω	BNC	1	NA	
29	Range Marks 5NM	Com. Equip. Assy. (Both)	Equip Control Assy.	RG-62/U	2 to 7V		91Ω	BNC	1	NA	
30	Range Marks 10NM	Com Equip. Assy. (Both)	Equip Control Assy.	RG-62/U	2 to 7V		91Ω	BNC	1	NA	
31	Normal Video	Com. Equip. Assy. (Both)	Equip. Control Assy.	RG-62/U	2 to 4V		91Ω	BNC	1	NA	

(Table 3-1 continued on page 3-28)

(Table 3-1 continued from page 3-27)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
32	MTI Video	Com. Equip. Assy. (Both)	Equip. Control Assy	RG-62/U Coax	2 to 4 V		91Ω	BNC	1	NA	
33	Azimuth Strobe	Com. Equip. Assy. (Both)	Equip. Control Assy.	#22 AWG Twisted Pair	6 to 12 MA	6 MHZ	72Ω	MS3102-R-36	1	NA	
	Azimuth Sine Data	Com. Equip. Assy. (Both)	Equip. Control Assy.	#22 AWG Twisted Pair	6 to 12 MA	6 MHZ	72Ω		1	NA	
	Azimuth Cosine Data	Com. Equip. Assy. (Both)	Equip. Control Assy.	#22 AWG Twisted Pair	6 to 12 MA	6 MHZ	72Ω		1	NA	
	Pretrigger	Com. Equip. Assy. (Both)	Equip. Control Assy.	#22 AWG Twisted Pair	6 to 12 MA		72Ω		1	NA	
	End of Deadtime	Com. Equip. Assy. (Both)	Equip. Control Assy.	#22 AWG Twisted Pair	6 to 12 MA		72Ω		1	NA	

(Table 3-1 continued on page 3-29)

(Table 3-1 continued from page 3-28)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
34	Deadtime Trigger	Com. Equip. Assy. (Both)	Equip. Control Assy.	RG-62/U Coax	4± 1V		91Ω	BNC	1	NA	
35	A/N Trigger (1-6)	Com. Equip. Assy. (Both)	Equip. Control Assy.	RG-62/U Coax	4± 1V		91Ω	BNC	1	NA	
36	End of Live Time (1-6)	Com. Equip. Assy. (Both)	Equip. Control Assy.	RG-62/U Coax	4± 1V		91Ω	BNC			This Is Also A/N Trigger (7-10)
37	End of Live Time (7-10)	Com. Equip. Assy. (Both)	Equip. Control Assy.	RG-62/U Coax	4± 1V		91Ω	BNC	1	NA	
38	Map Video	Video Mapper	Equip. Control Assy.	RG-62/U Coax	3 to 5V		91Ω	BNC	1		
39	Map Video	Equip. Control Assy.	DETS Consoles (All)	RG-62/U Coax	3 to 5V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles

(Table 3-1 continued on page 3-30)

(Table 3-1 continued from page 3-29)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
40	Range Marks 2NM	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	2 to 7V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
41	Range Marks 5NM	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	2 to 7V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
42	Range Marks 10NM	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	2 to 7V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
43	Normal Video	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	2 to 4V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
44	MTI Video	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	2 to 4V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
45	Azimuth Strobe	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA	6MHZ	72Ω	BNC	1	300'	Hedge-Hopped To All Consoles

(Table 3-1 continued on page 3-31)

(Table 3-1 continued from page 3-30)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
45	Azimuth Sine Data	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA	6 MHZ	72Ω	BNC	1	300'	
	Azimuth Cosine Data	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA	6 MHZ	72Ω	BNC	1	300'	
	ΔY Sign	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA		72Ω	BNC	1	300'	
	Pre-trigger	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA		72Ω	BNC	1	300'	
	End of Deadtime	Equip. Control Assy.	DEDS Consoles (All)	#22 AWG Twisted Pair	6 to 12 MA		72Ω	BNC	1	300'	
46	Deadtime Trigger	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	4± 1V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles
47	A/N Trigger (1-6)	Equip. Control Assy.	DEDS Consoles 1-6	RG-62/U Coax	4± 1V		91Ω	BNC	1	300'	Hedge-Hopped To All Consoles

(Table 3-1 continued on page 3-32)

(Table 3-1 continued from page 3-31)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
48	End of Livetime (1-6)	Equip. Control Assy.	DEDS Consoles (All)	RG-62/U Coax	4 ± 1V		91 Ω	BNC	1	300'	Hedge-Hopped To All Consoles (This is also A/N Trigger 7-10)
49	End of Livetime (7-10)	Equip. Control Assy.	DEDS Consoles 7-10	RG-62/U Coax	4 ± 1V		91 Ω	BNC	1	300'	Hedge-Hopped To Consoles 7-10
50	Beacon Video	Non-Common Decoder	DEDS Console	RG-59/U Coax	0 to 4V		75 Ω	BNC	1	150'	GFE, Cable If REq'd
51	Select 2.5 Msec	DEDS Console	Non-Common Decoder	(To Be Supplied)	Open/Ground	NA	NA	MS3102R18-1S (Console End)	1	150'	GFE Cable If Req'd
	Select 1 Msec	DEDS Console	Non-Common Decoder		Open/Ground	NA	NA		1	150'	
	Select 7 Msec	DEDS Console	Non-Common Decoder		Open/Ground	NA	NA		1	150'	
	Select 11 Msec	DEDS Console	Non-Common Decoder		Open/Ground	NA	NA		1	150'	

(Table 3-1 continued on page 3-33)

(Table 3-1 continued from page 3-32)

Ref No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
51	Select 16 Msec	DEDS Console	Non-Common Decoder		Open/Ground	NA	NA		1	150'	
	Select 22 Msec	DEDS Console	Non-Common Decoder		Open/Ground	NA	NA		1	150'	
52	Azimuth Change Pulses	APG (via DJB)	RDAS	#22 AWG Shielded Pair	Landline: 2.6VP-P Min RML: 4DBM NOM	1024HZ	5000 Ω Min	MS3102R18-15	1	150'	Fanout From DJB
	Azimuth Reference Pulse	APG (via DJB)	RDAS	#22 AWG Shielded Pair	Landline: 2.6VP-P Min RML: 2.5V	.25 HZ	5000 Ω Min		1	150'	
	Normal Video	ASR	RDAS	RG 62/U	2.0V Peak, Pulse Spike 50V Max	.83 USEC	75 Ω	BNC	1	150'	
	MTI Video	ASR	RDAS	RG 62/U	2.0V Peak, Pulse Spike 50V Max	.83 USEC	75 Ω	BNC	1	150'	
	Pre-Trigger	ASR	RDAS	RG 62/U	25V Peak ± 5V	1 to 10 USEC	75 Ω	BNC	1	150'	
53	Target/Map Video	RDAS	DEDS	RG 62/U	2-4 Volts						
54	Input Data (30 Bits)	RDAS	IOP	#22 AWG Twisted Pairs	-3.0 to -4.5V	NA	100Ω	Univac 7081900	30	200'	Type A (External) Input Channel
	Input Data Acknowledge	IOP	RDAS	#22 AWG Twisted Pairs	-3.0 to -4.5V	375 ns Min	100Ω		1	200'	

(Table 3-1 continued on page 3-34)

(Table 3-1 continued from page 3-33)

Ref. No.	Signal	Source	Destination	Cable Data	Signal Amplitude	Frequency or Pulse Width	Nominal Termination Impedance	Connector Type	No. of Lines	Max. Length	Remarks
54	External Interrupt Enable	IOH	RDAS	#22 AWG Twisted Pairs	-3.0 to -4.5V	NA	160Ω		1	200'	
	Input Data Request	RDAS	IOP	#22 AWG Twisted Pair	-3.0 to -4.5V	NA	160Ω		1	200'	
55	Output Data (30 Bits)	IOP	RDAS	#22 AWG Twisted Pairs	-3.0 to -4.5V	750 NS Min	160Ω	Univac 7084908	30	200'	Type A (External) Output Channel
	Ext. Function Acknowledge	IOP	RDAS	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
	Output Acknowledge	IOP	RDAS	#22 AWG Twisted Pair	-3.0 to -4.5V	375 NS Min	160Ω		1	200'	
	Output Data Request	RDAS	IOP	#22 AWG Twisted Pair	-3.0 to 4.5V	NA	160Ω		1	200'	
	External Function Request	RDAS	IOP	#22 AWG Twisted Pair	-3.0 to -4.5V	NA	160Ω		1	200'	

TABLE 3-2. IOP INPUT/OUTPUT CHANNEL ASSIGNMENT

IOP-1			
IOP Channel Number	Peripheral Equipment of Subsystem		Relative Priority
0		Intracabinet Channels	Highest
1	Interfacility Comm. Adapter		
2	Magnetic Tape Unit		
3	Console Typewriter Adapter		
4	DEDS Console (or UNISERVO VI C, if appl.)		
5	DEDS Console (or 9300 Processor, if appl.)		
6			
7			
8			
9			
10	DEDS Consoles (as required by site)		
11			
12			
13			
14			
15			Lowest
	IOP-2		
0	Beacon DAS (input only)	Intracabinet Channels	Highest
1			
2			
3			
4	RDAS		
5	DEDS Consoles (as required by site)		
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			Lowest

3.3.4 Subsystem Descriptions.-

3.3.4.1 Hardware.-

3.3.4.1.1 Existing ARTS III Hardware.- The data processing, beacon data acquistion, and data entry and display subsystems are described briefly in this document in sections 3.3.2.1, 3.3.2.2, and 3.3.2.3, respectively. For a more detailed treatment of these subsystems the reader is referred to the appropriate ARTS III technical manuals.

3.3.4.1.2 Radar Data Acquisition Subsystem.- The RDAS is an add-on hardware subsystem to the ARTS III system. A brief functional description of this piece of equipment is contained in section 3.3.2.4 of this document. For more detail, the reader is referred to "Appendix A, Design Specification: Radar Data Acquistion Subsystem."

3.3.4.2 Software.-

3.3.4.2.1 Introduction.- This section contains the operational computer program specification for the Augmented Radar/Beacon Tracking Level (RBTL) system. The functional requirements, programming requirements, and operational restrictions are described. Where a specific method of implementing a functional requirement is given, or where a specific data base structure is shown, it has been provided as an illustration of a feasible approach; this does not, however, preclude the employment of a more desirable one.

The augmented RBTL operational program shall provide alphanumeric data to the display subsystem. A tabular list containing line identification, aircraft identification, and symbolic representation of code assignment and status shall be associated with each controller position. Alphanumeric tags shall be presented near the positions associated with the controlled aircraft. The tag includes aircraft identification, corrected reported altitude, and ground speed. Association shall be maintained through correlation with target data received from the BDAS and the RDAS. The display presentation on the PPI shall also include symbology for controlled and uncontrolled tracks. Furthermore, a relocatable keyboard input message "preview" area and a separate relocatable list for miscellaneous data shall be provided. The latter shall include current time, altimeter setting, emergency indicators, selected mode 3/A codes for special untracked target symbology, and (by controller request) a readout of selected computer memory locations.

The BDAS shall supply the computer with the digital beacon replies and sweep information. The beacon target detection function of the operational program shall accept and process these replies. The processing shall consist of maintaining target records (that is, strings of replies within narrow range limits). These beacon records shall be kept until sufficient information is received to

3.3.4.2.1 (continued)

generate a beacon report or until the record can be eliminated due to lack of information. The beacon report shall consist of target center azimuth, range, beacon code (if present), and altitude (if present). The report shall also contain amplifying information including a beacon quality indicator code, identity validity, altitude validity, and the Special Position Indicator (SPI) or a garble indicator. The report shall be inserted into the beacon report store for correlation with radar reports.

The RDAS shall provide to the radar processing software the following information: video hit data, predetected target data, weather correlation data, and clutter data. The radar processing software shall use the predetected target data as a pointer into the video hit data and shall perform target detection. The radar target report shall consist of range, center azimuth, and report quality.

The radar processing software will exercise control over the RDAS by monitoring its performance and sending back control information. The clutter data shall be used by the radar processing software to build up clutter maps enclosing both ground and weather clutter areas. The software will maintain two automatic maps and one manual map. One automatic map will enclose light clutter and the other will enclose heavy clutter. The manual map will enclose ground clutter. The radar processing software will call for the use by the RDAS of a rank quantizer operating on normal video in light clutter and a rank quantizer operating on MTI video in heavy clutter. The manual ground clutter map will be used to call for the use of a rank quantizer operating on MTI video in the mapped area. The radar processing software shall use the weather correlation data received from the digitizer to regulate the performance of the RDAS in clutter areas.

The beacon and radar reports belonging to the same target shall be merged into one report. The criteria for correlating a radar report with a beacon report shall be based upon the amount of separation between the two reports, in terms of range and azimuth. Figure 3-5 illustrates the flow of data through the beacon and radar processing functions.

Aircraft identification shall be entered into the computer complex through keyboard entry devices, through the ARTCC communication link, and through the local magnetic tape unit. Keyboard messages represent the controller/system interface. Keyboard messages directly related to air traffic control shall provide the capability to manually initiate and terminate tracks of aircraft, to modify track data, to assign a track to a controller, and to initiate and accept aircraft handoffs. Other miscellaneous messages shall permit the controller to request and delete the presentation of untracked target information, to repostion alphanumeric information on the display, to enter information such as time and altitude setting, and to request special printouts at the console typewriter. The ARTCC communication link shall provide the capability to automatically receive limited flight plan data and to initiate and accept aircraft handoffs between the ARTCC and ARTS III.

The operational program also provides for the automatic initiation of the tracking function, the automatic offset of alphanumeric tags to minimize format overlap, and the automatic printout at the console typewriter of any alarm or error messages.

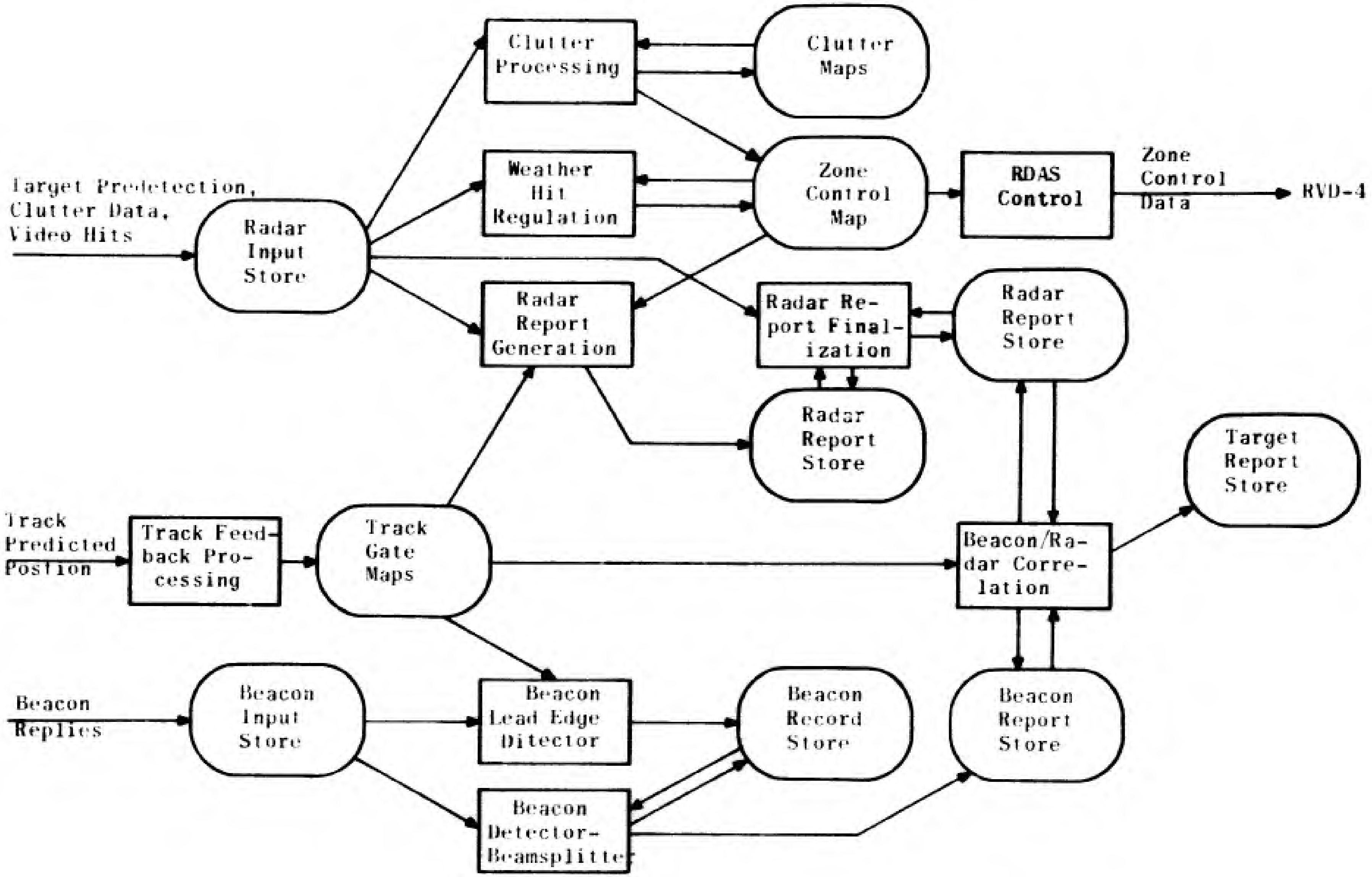


Figure 3-5. Combined Beacon/Radar Processing Flow

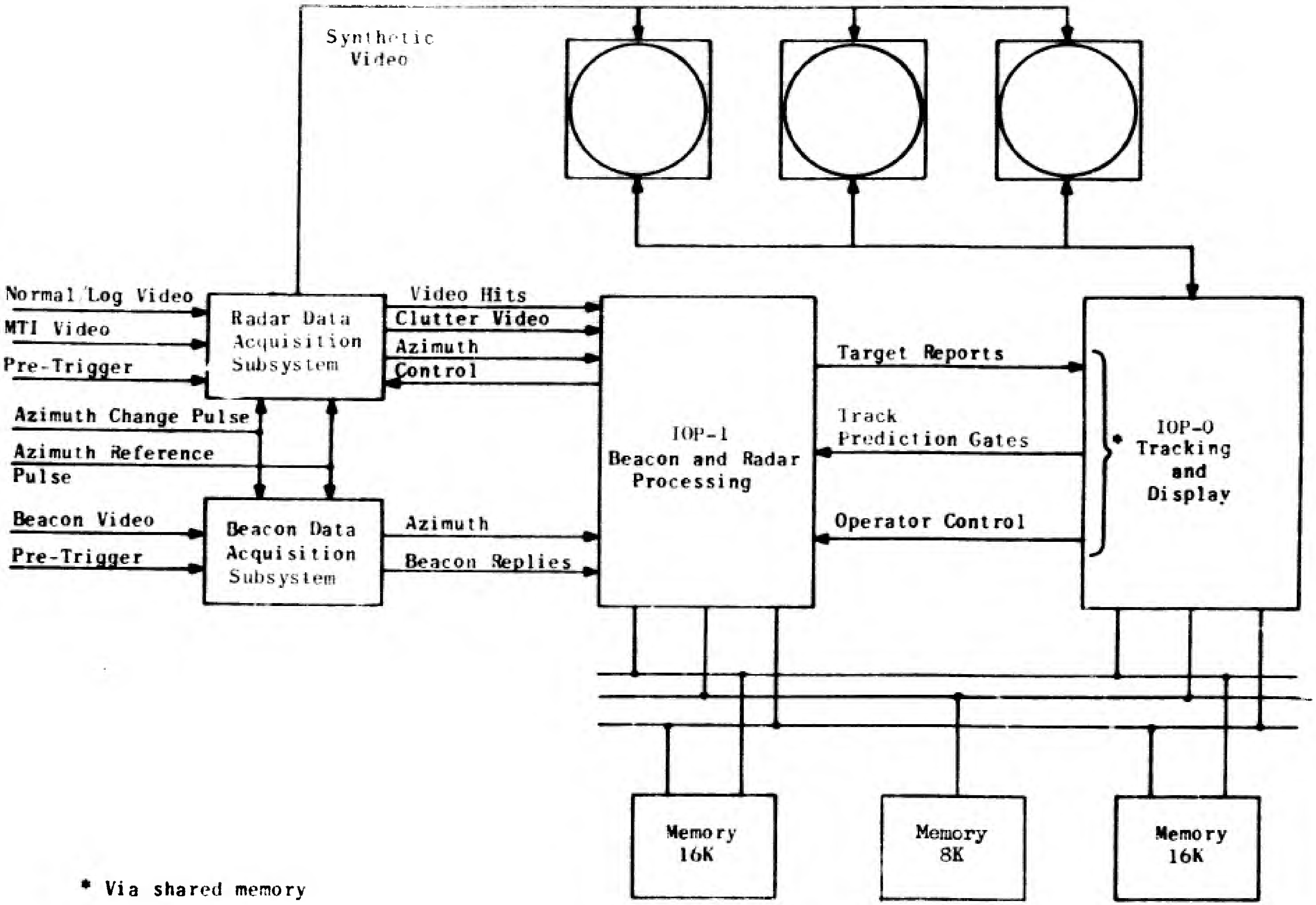
[illegible] General Approach.- The Augmented software shall be developed for a system utilizing one primary radar and one beacon interrogator system, but will retain the capacity for upgrading to a dual radar and beacon system. To a great extent, the system will make use of the presently existing ARTS III software. Notable areas of exception are the executive software, the radar input processing routine, the beacon/radar correlation routine, and the areas of the tracking and display routines which are effected by the addition of improved tracking and controller-computer interface. The augmented RBTL operational program shall be developed for a dual processor system. The system will be under the control of an executive which, although easily convertible to ARTS III multiprocessing executive, is a hybrid of a multiprocessor executive and a dedicated processor executive. The executive shall have the flexibility of assigning program tasks to one or both processors but will be set up in such a way that the beacon and radar processing tasks are always assigned to the same IOP. The general configuration of the augmented RBTL system is shown in [illegible]. The Augmented RBTL software will be written to run on both standard and modified failsoft IOPs.

The operational program shall be similar to the ARTS III program in that all functionally independent functions shall be segmented into separate subprograms. It shall be possible to add, replace, or delete subprograms from the operational program. All program coding shall be produced in symbolic language with symbolic addressing. Detailed flow diagrams are not contained in this document but shall be developed concurrently with the programming effort. The flow diagrams shall be used for design review and for the coding specification documentation.

Failure detection logic shall be an integral part of the operational program. [illegible] data checks, buffer time-out, and other sub-sections shall be used to detect failures. Failure messages, which identify the type of failure, shall be printed out on the console typewriter.

The radar processing software shall be provided with a routine which automatically initializes the RDAS in case of either communication loss or an out-of-sync condition. The computer will sense either of these situations and send a master clear to the RDAS. This will cause a termination of all I/O. The RDAS shall then be sent a full set of operating parameters and then given the command to start processing on the next radar sweep. If the RDAS is automatically initialized in this manner three times within a parametric number of sweeps, an error condition shall be declared.

The operational program design specification contained in the following sections represents an approach intended to satisfy all functional requirements while meeting the restrictions imposed by the system hardware - available memory, computer and peripheral capability, and so on. In all areas of software design there exist trade-offs between the functional capabilities and the utilization of hardware. In some cases these trade-offs cannot be adequately evaluated without incurring excessive cost and/or delays. In these instances the approach adopted is based upon the overall system performance. However, it does not imply that this design represents an optimal approach. If, in the design development stages, more desirable methods are found, those methods



* Via shared memory

Figure 3-6. Augmented RBTL General Configuration

3.3.4.2.2 (continued)

may be employed providing that all functional requirements are satisfied. Figure 3-7 illustrates the operational program data flow and control.

3.3.4.2.3 Executive Control.- The following paragraphs describe the requirements, design, and data base of Executive Control.

3.3.4.2.3.1 General Requirements.- The scheduler routine shall provide for the dispatch of program control to tasks within the operating system. Two types of queries shall exist within the scheduler: the popup query and the planned query. The popup query shall provide high priority entrance to tasks which are aperiodic or for which excessive overhead would exist if they were placed in the planned query. The planned query shall provide a number of lattice frameworks in which tasks may be placed so that task entrance is dependent upon the prior completion of other tasks or the lapse of a given amount of time. Tasks may be scheduled as both a popup and a planned task. This feature will permit a task to be scheduled periodically and yet still provide a fast reponse for critical functions.

The executive shall also include an initialization (preset) routine as well as the decision logic of task assignment. All interrupt routines (both internal and external) may be considered a part of the executive program. The executive shall include a set of interrupt routines providing an automatic recovery capability in the event of a prime power failure; see figure 3-8. All other interrupt routines, because they may be associated with a single subprogram, have been described with the associated subprogram rather than with the executive. Consideration has been given in the design to the future upgrading to a failsoft system.

3.3.4.2.3.2 Executive Design.- The following paragraphs describe the major sections of the executive design.

3.3.4.2.3.2.1 Popup Query.- The popup query algorithm shall allow for the execution of a task on the basis of a realtime clock value. The time value must be provided to the popup scheduler in conjunction with the request for task execution. The preamble for a task may contain both popup entrance and a planned entrance. Thus, the capability shall exist for any task to request the execution of any other task (including itself) as long as the requested task has a valid popup entrance. The popup query algorithm shall be executed before the planned query algorithm. Thus, there will be two functional elements in performing the popup query: 1) popup task request with associated time value, and 2) a scan of the popup task list.

Every time the popup scan is performed, a check will be made to determine if the active popup request time value is greater than the realtime clock. If this is the case, no popup task will be performed. Otherwise, there will be a task that is ready to be executed by some processor. The task execution time subtable will then be searched, starting at the top of the list, for items (i.e., time of execution) less than or equal to the realtime clock. The

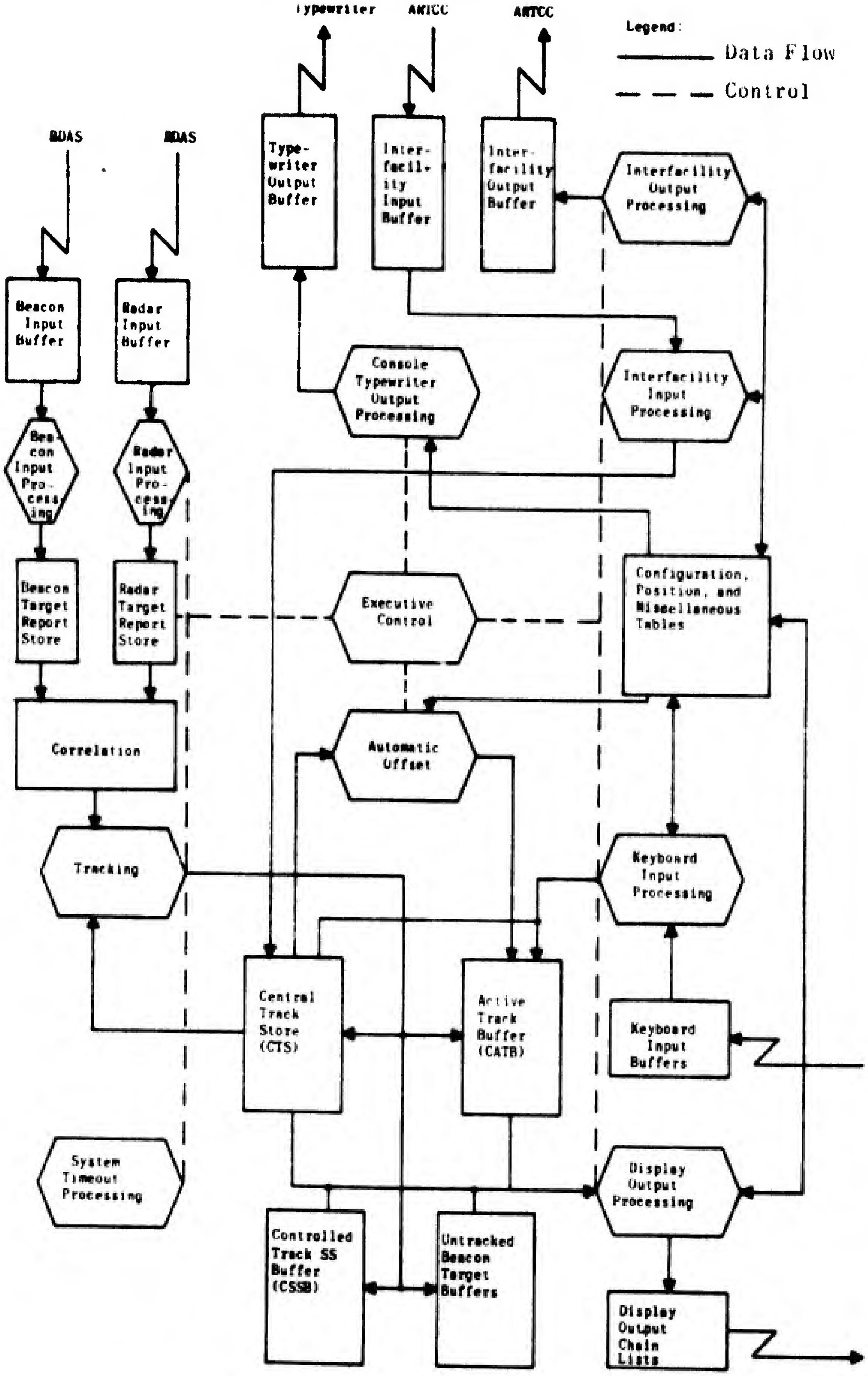


Figure 3-7. Operational Program Data Flow and Control

Subtable 1	Subtable 2	Subtable 3		
Symbolic Name	Task Execution Time	Task Link		
Task A	time for Task A	t	p	pointer to Task A preamble
Task B	time for Task B	t	p	pointer to Task B preamble
Task n	time for Task n	t	p	pointer to Task n preamble

where: t - test and set field, and
p - eligible processor(s).

Figure 3-8. Popup Query List Table

3.3.4.2.3.2.1 (continued)

capability shall be provided for a task to request a popup task to be executed. Associated with this request must be a time value telling when the task shall be executed and the task's symbolic name.

3.3.4.2.3.2.2 Planned Query.- The planned task scheduling algorithm shall be a structure called a lattice, in which the completion of certain tasks shall enable subsequent tasks to be executed. All tasks shall have a field which shall designate processors eligible to execute the task.

The following definitions are provided to aid the reader in the understanding of the subsequent discussion:

- Lattice - A framework, consisting of tasks, that defines the interrelationship between planned tasks. Each lattice will start with one or more tasks which have no predecessors. These tasks will generally have successor tasks which can be performed when the predecessor tasks are completed.
- Lattice Description Table (LDT) - A table that defines the lattices in terms of predecessor and successor tasks. An LDT record consists of the pointer to the task preamble store, the predecessor tasks, and the successor tasks for one task.
- Post Task Pointer (PTP) - A table that will contain the planned tasks which are currently eligible for execution.
- Cycle - A unique set of tasks that must be executed. Tasks executed in a cycle will be described by a unique lattice.
- Cycle Table - A table that will consist of pointers to particular lattices in the LDT. In addition, this table will contain an index which will point to one of the items of the cycle table. The number of items in this table will equal the number of cycles. Generally, there will be a one-to-one correspondence between cycle table items and lattices; however, it is the cycle table that orders the lattices, and therefore it is possible that two entries in the cycle table will point to the same lattice.

The PTP table will be constructed in order to minimize searches and references to a lattice. Special manipulation of this table will be required, since an objective of the planned scheduler will be to have no processor unique variables. This feature will allow one processor to advance to a new lattice and later another processor to do a planned query in the new lattice without knowing that a cycle had been advanced.

Task execution can begin when cycle initialization has been completed. The first available item in the PTP table shall be checked to determine if the processor performing the scheduler instructions is eligible to execute the task. This shall be accomplished by determining whether the processor number corresponds to a set bit in the correct position of the processor field for the record in the LDT. If the processor is not eligible to execute the task, the search through the table shall be continued until a task is found or until the last item is reached. When an eligible task is found, the "in-progress" bits shall be set using a test and set instruction. The test and set will ensure that two processors do not attempt to execute the task when it is only scheduled once. The LDT item shall have a pointer to the task entrance address table.

When the planned task is completed, the task shall return control to the scheduler. The scheduler shall remove the task from PTP table. The task record in the LDT shall be set "complete", and each of the post tasks shall be checked to determine if any tasks are eligible for execution (i.e., it shall be determined if all their pre tasks are complete).

When a post task is found that is eligible for execution, the record shall be set "eligible" via a test and set type instruction, and it shall be moved to the PTP table. The test and set procedure shall ensure that one task is not put into the PTP table more than once. When all the post tasks have been checked for eligibility, a pass through planned task scheduler shall have been accomplished. If the PTP table is ever emptied, no subsequent planned tasks can be performed.

After a task has been executed, the associated item in the PTP table shall point back to the LDT which must be updated to allow for further tasks to be performed. First, the LDT record shall be set "complete"; that is, the upper bit of the second word of the record shall be set. Next, it shall be determined if the task just finished has satisfied the precedence condition for subsequent tasks. This shall be accomplished as follows: pointers to the LDT record for a task's post tasks shall be included in the task's LDT record. Thus, each of the post tasks shall be checked to determine if they are eligible for execution. This shall be accomplished by determining if the contents of the addresses in pre task items have their sign bits set. If they are all set, then the post task shall be eligible to be placed into the PTP table. The LDT item shall be set with a test and set instruction to ensure that a task will not be put into the PTP table twice.

<u>3.3.4.2.3.2.3 Preset</u>.- The executive preset routine shall be referenced upon program start-up. Once executed, the preset routine may be destroyed, using this memory for data tables. The preset routine may be considered as a group of tasks required only for program start-up. The preset routine shall initialize all communication flags, tables, and buffer areas, and shall initiate the display input and output and the DAS inputs. Control shall then be transferred to the executive. The preset need not check the status of the peripheral equipment since the operational program provides these checks; for example, should a display channel be out, the operational program would immediately detect the failure and effect an alarm printout.

3.3.4.2.3.2.4 Power Failure Recovery.- Automatic recovery from a prime power failure shall be implemented in the following manner: a power tolerance interrupt shall be received when power drops below a tolerance level. An interrupt routine shall be provided to store all registers and to provide for orderly termination of all I/O activity. A minimum of 250 microseconds (usec) is available to perform this task. The interrupt routine shall then execute a jump instruction (f=61, j=0). This instruction cannot be executed below power tolerance (therefore can only be used as the last instruction in the power tolerance interrupt routine) and the program shall hang until power rises above the first tolerance level. If power does return, the jump shall be executed. The I/O shall then be reinitiated and control will be returned to the interrupted task. During this time (an indefinite duration), the internal clock will continue to increment.

If the power drops below a second tolerance level, the program shall not recover from the jump instruction; instead, a power restart interrupt shall be received when power is returned if the AUTO RESTART switch is selected. When the interrupt is received, reinitiate I/O and return control to the interrupted task. In this case, the internal clock shall not increment during the time the power is below the second tolerance level. Therefore, upon restart, the operator may be required to update system time. Also, because an excessive delay will result in the failure of positional correlation in tracking, active tracks shall be automatically placed in the tabular list (coast status) after restart. Manual positioning shall be required unless the target is reporting a discrete code.

3.3.4.2.3.2.5 Thread Update Task.- Since the operational program does the majority of its track file (controlled, uncontrolled and unused) processing through the use of various threads in Central Track Stores (CTS)and Track Number Pointer (TNP)(see section 3.3.4.2.14), it is mandatory that the simultaneous execution of tasks that use these threads does not result in the altering of a thread by one task while another task is using that thread. For example, if tracking automatically initiates a new track file (uncontrolled track) and display output processing is using the uncontrolled track thread at the same time, an immediate modification to the uncontrolled track thread by the tracking could result in erroneous display output processing.

A most desirable solution to this problem is to put the thread modifications under executive control. Through the executive lattice structure a task that updates the various threads is executed periodically. Therefore all thread user tasks simply request a change to one of the threads through the setting of various request fields in CTS.

The thread update task shall then provide for the update of the CTS controlled, uncontrolled, and unused threads, and also the update of the TNP thread. This task shall provide for both additions to and deletions from the above mentioned threads.

This task shall take the form of a planned task to be executed periodically by the executive. Upon execution, this routine shall check to see if any thread changes have been requested. When a thread change request is detected,

3.3.4.2.3.2.5 (continued)

this routine shall then determine which of the threads to update and then update that thread. When all the thread change requests have been honored, control will be returned to the executive.

3.3.4.2.3.2.6 Task Scheduling.- The division of tasks between popup and planned query and the definition of the lattice structures will be done in a way that minimizes executive overhead and lattice inactive time while insuring that no data is lost.

3.3.4.2.3.3 Executive Data Base.- The popup query algorithm will require one table consisting of three subtables as shown in figure 3-8. The symbolic name subtable will consist of the symbolic names of all tasks with popup entrances. The names will be limited to five characters. Associated with each name will be the time at which each popup task is to be executed and the address of the task preamble at which the task entrance conditions will be found.

Active Popup Request Time (APRT) - One variable will contain a time which specifies the smallest time value for which a popup task is to be executed.

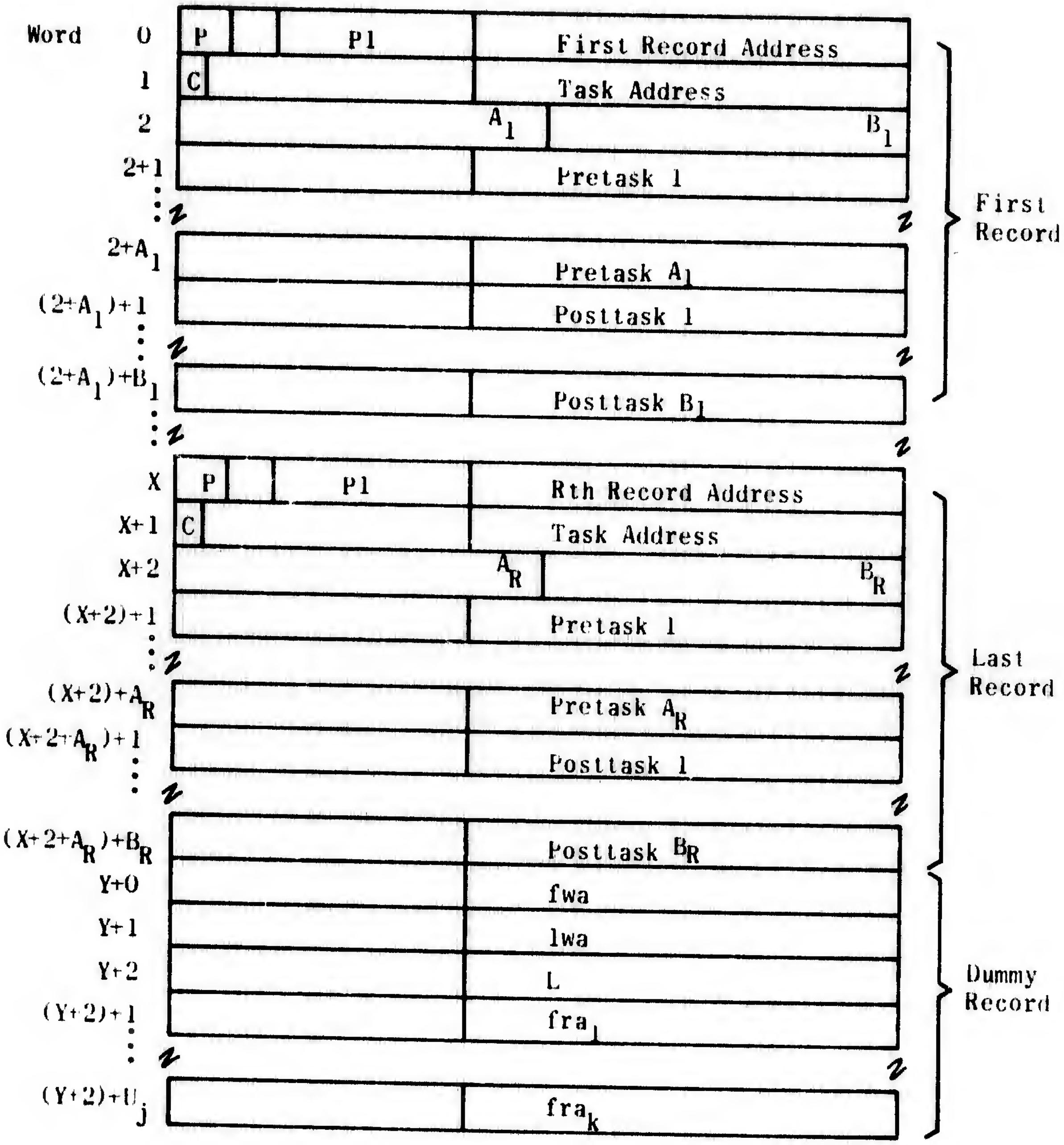
When the popup scheduler receives a request to schedule a popup task, it will compare the requested time with the APRT. If the APRT has a smaller value, the requested task will be placed into the popup list for later processing. Otherwise, the time will be placed in both the APRT variable and the popup query list table. It will be placed in the correct position in the task execution time subtable if it is a smaller value than the current value of the item. This will be accomplished by using the symbolic name that accompanies the request to search the symbolic name subtable to locate the implicit position of the symbolic name as the position in the task execution time subtable.

The planned query algorithm will require the LDT, the PTP, the cycle table, and the task entrance address table.

The LDT is shown in figure 3-9. The description of the figure is as follows:

where T = the number of lattices
R = the number of records per lattice
A_i = the number of pre tasks for record i, $A_i \geq 0$
B_i = the number of post tasks for record i, $B_i \geq 0$
U_j = the number of records in lattice j with no pre tasks.

$$\text{Word } X = 3(R-1) + \sum_{i=1}^{R-1} (Ai + Bi) \text{ for lattice } j \text{ and record } R > 1.$$



NOTE: Record descriptions for lattice j where $1 \leq j \leq J$.

Figure 3-9. Lattice Description Table (LDT)

$$\text{Word } Y = 3R + \sum_{i=1}^{R} (3 + A_i + B_i) \text{ for lattice } j.$$

$Y + Uj + 3$ = the number of memory cells used for lattice J.

The table size will be:

$$S = \sum_{j=1}^{T} \left[\sum_{i=1}^{R} (A_{ij} + B_{ij}) + U_j + 3(R+1) \right]$$

The table items are defined below:

P - P = 0 will indicate that a record for a task has not been moved to the PTP table; P = 3 will indicate that it has been moved to the PTP table.

P_1 - Primary eligible processor field

Record Address - Pointer to address this word is stored, i.e., to itself

C - C = 0 will indicate that the task is not complete; C = 1 will indicate that the task is complete

Task Address - Address of entrance address for this task

A_1 - Number of pre tasks for this task (i.e., first record of lattice j)

B_1 - Number of post tasks for this task (i.e., first record of lattice j)

Pretask i - Pointer to record (i.e., address +1) to pre task i in lattice j where i = 1, 2,...., A_1. i = 0 implies no pre task

Posttask i - Pointer to record (i.e., address) of post task i in lattice j where i = 1, 2,...., B_1. i = 0 implies no post tasks

There will be as many similar records as defined above as there are tasks in a lattice. Following these records there will be a dummy record (defined below):

fwa - First address of lattice j

lwa - First address of dummy record

L - Number of tasks with no pre tasks

fra_i - Pointers to records that have no pre tasks in lattice j where i = 1, 2,...,U_j

The PTP table shall have the first word of the record of the LDT for the task to be performed, except for the test and set field. The PTP table shall be as shown in figure 3-10.

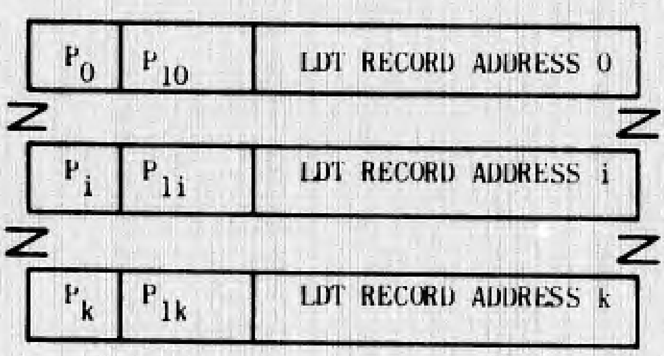


Figure 3-10. Post Task Pointer Table (PTP)

Where: P_i = 11, this shall indicate that the task has been selected for execution.

P_{1i} = primary eligible processor field

LDT RECORD ADDRESS i = link to record in the LDT table

The cycle table shall be as shown in figure 3-11. These LDT addresses shall be associated with the unique lattices, one of which exists for each cycle, and are executed in the order which they appear in the cycle table. The number of lattices corresponds to the number of unique LDT addresses in the cycle table. Each lattice shall consist of one or more tasks which shall be performed within a particular cycle.

The CT index shall be a dynamic element of the CT. Its value will be initially set to 1.

The task entrance address table contains the task entrance addresses for all the tasks in the operating system.

Housekeeping shall be required to ensure proper operating conditions when the scheduler is initiated to a new cycle.

The test and set designators shall be cleared for each record in a completed lattice. The CT index shall be incremented and the LDT address shall be loaded from the designated cycle table item. This LDT address shall be the first record of the cycle and the record must not have any pretasks since this would make the LDT inconsistent.

3.3.1.2.4 Radar Input Processing.- The following paragraphs describe the requirements, design, and data base of radar input processing.

3.3.1.2.4.1 General Requirements.- The radar input processing program shall control the interfacing of data with the RDAS. It shall process this data for the statistical detection and position reporting of radar target echoes. It shall additionally provide the control for the RDAS video channel selection, weather hit regulation, and other computer selectable operating parameters. A summary of the radar input processing task is given below:

a) Control the input of RDAS data into assigned storage areas. This data includes quantized target video hits, clutter monitoring data, target predetection indicators, weather data, radar antenna position, and RDAS status codes.
b) Search the predetection data and perform statistical detection tests to declare target reports.
c) Determine the range and center azimuth of detected targets.
d) Eliminate radar reports in clutter areas when the total hit count from the target falls below an acceptable level.
e) Assign report quality, merge reports from adjacent range cells, and pass completed reports to the beacon radar correlation program.

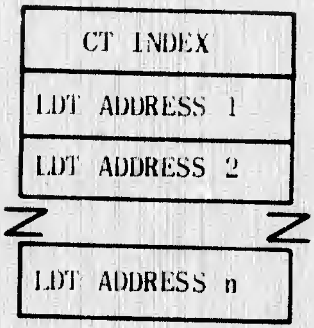


Figure 3-11. Cycle Table (CT)

3.3.4.2.4.1 (continued)

- f) Correlate weather hit data on a sweep-to-sweep and scan-to-scan basis for the two rank quantizers contained in the RDAS. Generate two 32-level gain maps for feedback control of hit percentages in the two rank quantizers. Provide control on a 2-mile by 32 ACP zone basis.
- g) Correlate light and heavy clutter monitor data on a sweep-to-sweep and scan-to-scan basis. Generate 2 quantizer select maps used to switch among three quantizers. Provide for quantizer selection on a 2-mile by 32 ACP zone basis.
- h) Output the zone control map which regulates the hit percentage and quantizer selection in the RDAS.
- i) Transfer command words to the RDAS for selection of operating parameters.
- j) Monitor the RDAS and radar input processing program performance. Generate error alarms for abnormal conditions.
- k) Control the generation and positioning of the Realtime Quality Control (RTQC) test target.

3.3.4.2.4.2 Design.- Radar input processing routine consists of three major program functions: RDAS input/output, target detection, and quantizer control. The RDAS I/O routine handles all communication between the computer and the RDAS. The input data includes video hits and clutter sensing data. The output data consists of zone control data used to regulate the RDAS on a 2-mile by 32 ACP zone basis and commands for specifying non-dynamic operating parameters. Target detection processes the video hit data to statistically declare and locate targets. Quantizer control utilizes two types of clutter sensing data determined by the RDAS. The data is used for selecting quantizers and for controlling video hits in weather clutter.

The scheduling of radar input processing functions shall be based on a timing cycle related to the triggers of the radar. One cycle, called the radar processing cycle, shall consist of a fixed number of radar sweeps, e.g., 24. The target detection function shall be referenced every cycle; however, the clutter processing shall be referenced only once every two cycles. When both target detection and clutter processing are to be called on a given cycle, clutter processing shall precede target detection.

3.3.4.2.4.2.1 Input/Output.- The I/O functions provide the link between the operational program and the RDAS. These functions include the establishment and maintenance of synchronized operation of the RDAS and the processing by the computer. The establishment of synchronization shall be performed by an initiation routine which shall be entered once from the preset on start up, and subsequent to the detection of any of certain malfunctions which might occur during the normal operating sequence for the purpose of re-initiation. Maintenance of communication continuity and synchronization during the normal operating sequence shall be accomplished in the RDAS channel interrupt processor. This shall include the selection of proper zone control and command words for the present radar azimuth.

3.3.4.2.4.2.1 (continued)

1) RDAS Initiation

Initiation of the RDAS shall be performed in a radar I/O preset routine via the following sequence:

a) Critical radar processing parameters (flags, pointers, indices and so forth) will be set to initial values for the purpose of re-synchronization during the automatic recovery sequence, as well as for the initial startup.

b) All I/O on the RDAS channel shall be terminated.

c) The RDAS shall be sent Command Word Zero with the Master Clear (MC) bit (bit 2^{29}) set to one. Upon receipt of this external function word, the RDAS shall inhibit all data transfer between itself and the computer.

d) The RDAS shall be sent Command Words One and Two containing a number of parametric values required for its operation. The remaining operating parameters shall be sent immediately thereafter as part of Command Word Zero, which for this transmission will have the MC bit cleared (MC=0). Upon receipt of the latter word, the RDAS will raise its Output Data Request (ODR) line to receive 15 words of nominal zone data (two quantizer select words, one system diagnostic word, and 12 gain words).

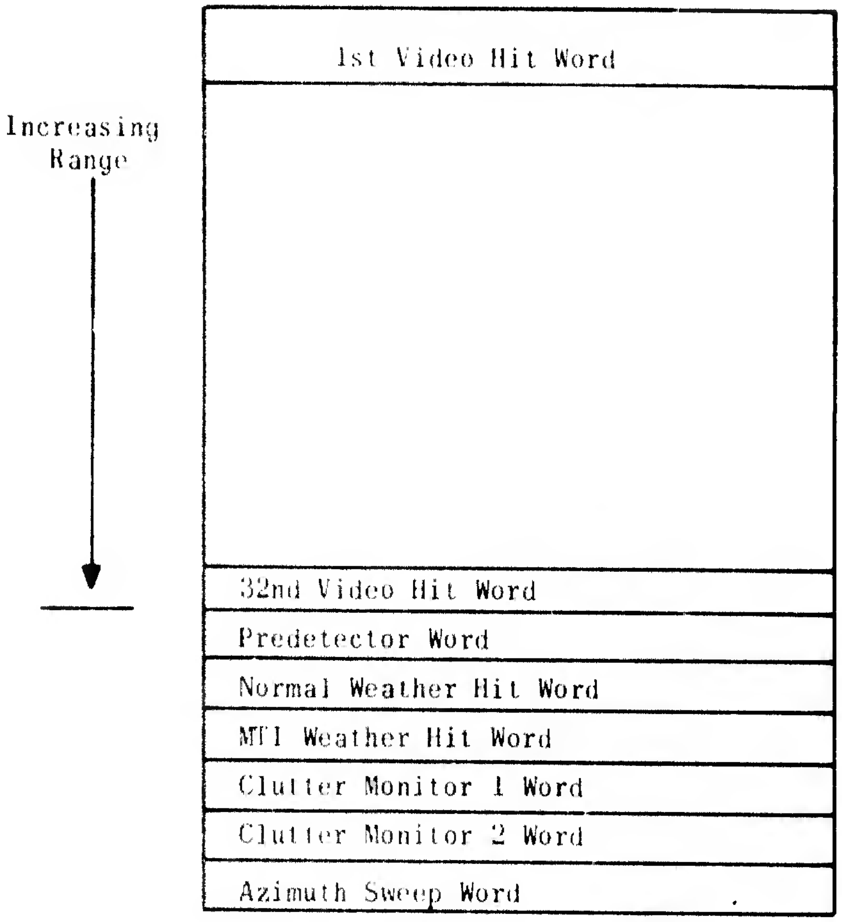
e) The computer shall initiate an output buffer containing the 15 zone data words for an arbitrary zone. Data for all zones shall be contained in the Zone Control Map Table (ZCMT) which shall be preset to nominal data. The RDAS shall begin processing with the next range zero trigger. The first data placed on the RDAS channel input lines shall be the video hit word for the 0-1 7/8 nm interval of the following sweep.

f) The computer shall initiate a continuously running input buffer chain to receive the video hit, predetector, weather regulation, clutter monitor, and azimuth sweep words. The input buffer scheme is described further in paragraphs which follow.

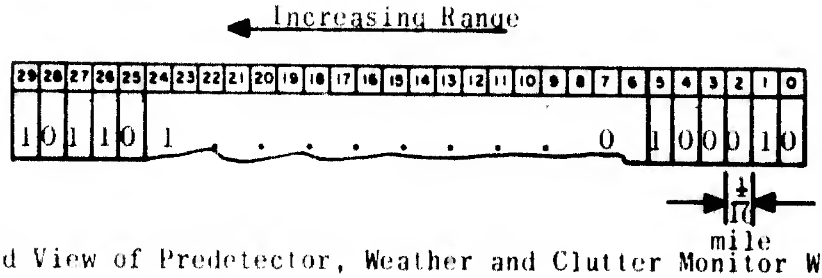
Computer processing of data received after a reinitiation sequence has begun shall be suspended. It shall recommence with the first data word received after the sequence has been completed and synchronization re-established.

2) Normal Input Scheme

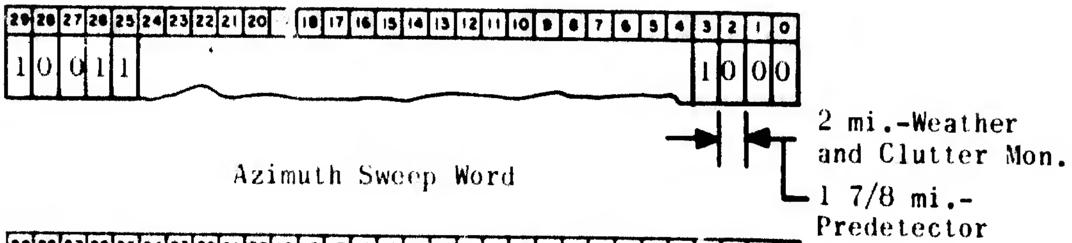
The data input to the computer during one radar sweep is shown in figure 3-12. This data includes 32 video hit words in which each bit represents quantized video in a 1/16 nm range interval along the sweep. Also included in the input data are a predetector word, two weather regulation words, two clutter monitor words, and an azimuth-sweep word. In the predetector word a hit in bit position j corresponds to a predetection in the jth video hit word. In the weather regulation and clutter monitor words, bit position j



Expanded View of Video Hit Words



Expanded View of Predetector, Weather and Clutter Monitor Words



Azimuth Sweep Word

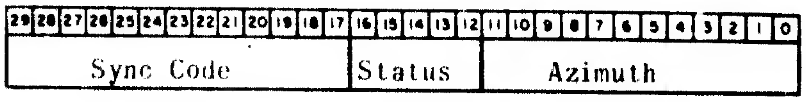


Figure 3-12. Format of Data in Single Sweep

3.3.4.2.4.2.1 (continued)

corresponds to a hit (that is, a weather or clutter indication, respectively) in the range interval from 2j to 2(j+1) nm (j=0,...29). The azimuth-sweep word supplies a synchronization code, RDAS status indicators, and radar sweep azimuth measured in ACPs.

The data for successive sweeps shall be similarly input to the computer through the use of a free-running input chain. This chain shall provide the basic timing control for the radar processing cycle. Once initiated, the chain shall run continuously without further processor control unless an out-of-synchronization condition occurs. The chain shall input the RDAS sweep data into a buffer of sufficient size to hold RSPCP (SP) sweeps of radar information (38 words per sweep).

For synchronizing the data processing with the inputting of data, the input buffer shall be divided into RBSPT (SP) segments, each containing (RSPCP/RBSTP) sweeps of data. A radar processing cycle commences with the receipt of the last data word in a buffer segment. Each time a buffer segment is filled, a buffer-filled flag corresponding to that segment shall be set. An input monitor interrupt shall be generated and the chain advanced to continue input with the next buffer segment. The layout of the segment input buffer scheme is shown in figure 3-13.

In response to the interrupt, a new radar processing cycle shall be inaugurated. This is accomplished by requesting the executive to schedule radar input processing as soon as possible on a priority basis. This will subsequently cause a new cycle to begin according to the sequence of radar processing tasks described in an earlier paragraph.

Also, as part of interrrupt processing, a check for proper data synchronization and operating status shall be undertaken. If any buffer segment word presumed to contain azimuth sweep data does not have a sync code in the most significant bit position, an out-of-synchronization condition shall be declared. In this case, an alarm flag shall be set and the automatic recovery sequence begun by requesting the executive to schedule the I/O preset routine prior to any other radar processing task. An out-of-sync flag shall also be set to suspend processing of radar data until synchronization is re-established. The RDAS operating status shall be tested by examining the indicators in each of the azimuth sweep words of the buffer segment. Response to the presence of each status indicator is described in the paragraphs on performance monitoring.

The buffer-filled flags shall be monitored by the radar processing subprograms to insure that processing is keeping up with the inputting of data. As the processing of the data in a segment is completed, its buffer-filled flag shall be cleared. If at any time the radar

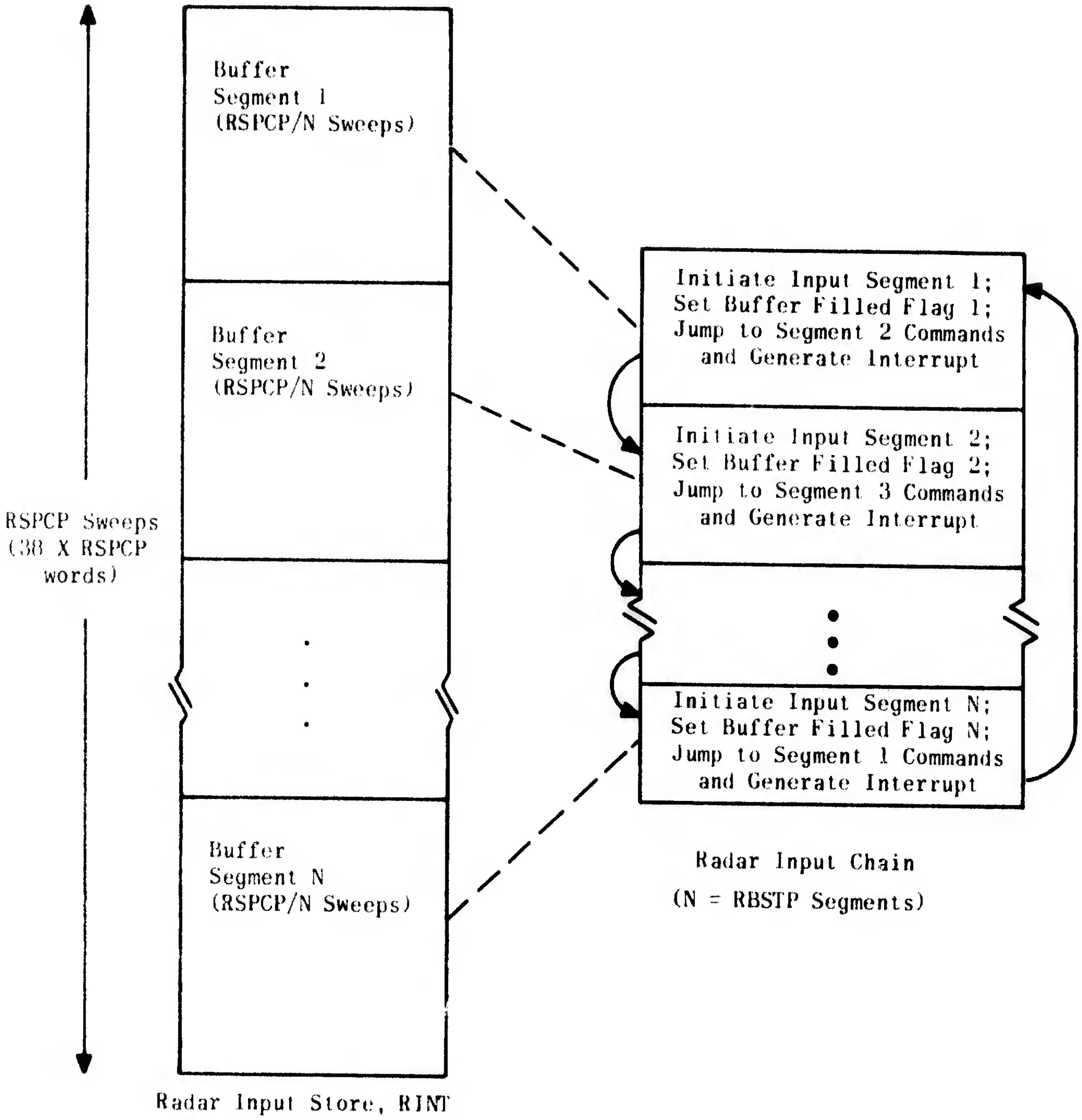


Figure 3-13. Radar Input Store Design

3.3.4.2.4.2.1 (continued)

interrupt processor determines that a buffer segment has been overwritten before the data for that segment has been processed, overload condition is declared. In response to this declaration, an alarm printout will be requested as described in the paragraphs on performance monitoring.

3) Normal Output Scheme

The computer shall be required to output to the RDAS two general categories of data: 1) command words and 2) zone control words. The format for these words are given in figures 3-14 and 3-15 respectively. Command words shall provide system operating parameters and configuration directives to the RDAS. They shall be used to initiate the RDAS during the start-up sequence and to change parameters and configuration once the system is operating. They shall be transferred to the RDAS during radar dead time. The RDAS will have its External Function Request (EFR) line raised to accept command words from the beginning of dead time to -1/2 nautical miles before zero range.

Zone control words shall provide the data which determines the operating conditions of the quantizer within 2 nm by 32 ACP (2.8^0) zones. The data for the 30 zones in a 32 ACP sector shall be packed into a block of 15 words (see figure 3-15). The table containing the data for all zones in the radar surveillance area is called the Zone Control Map Table (ZCMT). The table shall be considered as five subtables each consisting of one type of zone data. Each subtable will consist of 128 items (sectors). A general description of each follows, with more detail to be found in the System Data Base subsection.

In addition to providing which determines the operating conditions of the quantizers, the zone control data contains a word which determines the length and postion of the RTQC test targets.

The first subtable consists of the Quantizer 2 (Q2) select words, and shall be referred to as the Q2 select map (table). The bit settings in each word indicate the selection of the output of the Q2 quantizer in each 2 nm zone of the corresponding 32 ACP sector.

The second subtable consists of the Quantizer 3 (Q3) select words and shall be referred to as the Q3 select map (table). The bit settings in each word indicate the selection of the output of the Q3 quantizer in each 2 nm zone of the corresponding 32 ACP sector.

The third subtable consists of the system diagnostic words and shall be referred to as the system diagnostic map (table). The interpretation of the system diagnostic words depends upon the setting of bit 17 in the display video select field of command word 0. If

COMMAND WORD 0

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MC	0	0	DVS										AC					PWNM			PWNN			PNN					
																		$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$

MC = Master Clear
DVS = Display Video Select
AC = Alarm Clear

PWNM = Min. Pulse Width MTI
PWNN = Min. Pulse Width Normal
PNN = Percent Noise Normal

BIT	DISPLAY VIDEO
17	System Diagnostic
19-18	00 Off
	01 Amplitude Output Q1
	10 Amplitude Output Q2
	11 Amplitude Output Q3
20	MTI Limit
22-21	00 Off
	01 QS3 = 0, QS2 = 1
	10 QS3 = 1, QS2 = 0
	11 QS3 = 1, QS2 = 1
24-23	00 Off
	01 Clutter Density 1
	10 Clutter Density 2
	11 Selected Hit Proc. Output
26-25	00 Off
	01 Weather Hit Output Normal
	10 Weather Hit Output MTI
	11 Enhanced Display Output

COMMAND WORD 1

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	DMRN			CDN	CT1					CIN	ST					DT				WTN				PT			
			4	2	1		16	8	4	2	1		16	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1

DMRN = Diff. from Max. rank normal quantizer
CDN = Counter Decrement Normal
CT1 = Clutter Monitor Threshold 1
CIN = Counter Increment Normal
ST = Strobe Threshold
DT = Display Threshold
WTN = Weather Threshold Normal
PT = Predetection Threshold

Figure 3-14. Command Word Formats (Sheet 1 of 2)

COMMAND WORD 2

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	DMRM			C D M	CT2					C I M	C D S	C I S	NB	DH		0	0	0	0	WTM				0	0	0	0
			4	2	1		16	8	4	2	1											8	4	2	1				

DMRM = Difference From Max Rank MTI Quantizer

CDM = Counter Decrement MTI (0 = Decrement of 1,
1 = Decrement of 2)

CT2 = Clutter Monitor Threshold 2

CIM = Counter Increment MTI (0 = Increment of 2,
1 = Increment of 3)

CDS = Counter Decrement Selected

CIS = Counter Increment Selected

WTM = Weather Threshold MTI

NB = Normal Bias (0 = Multiplicative bias for Q2,
1 = Subtractive bias for Q2).

DH = Double Hit (00 = No double pulse generation
01 = Additional 1/64nm pulse adjacent to 1/64nm pulse output of TQ1, 2, 3.
10 = Additional 1/64 nm pulse 2/64nm farther in range than 1/64 nm output of TQ1, 2, 3.
11 = Additional 1/64 nm pulse 4/64 nm farther in range than 1/64 nm output of TQ1, 2, 3).

Figure 3-14. Command Word Formats (Sheet 2 of 2)

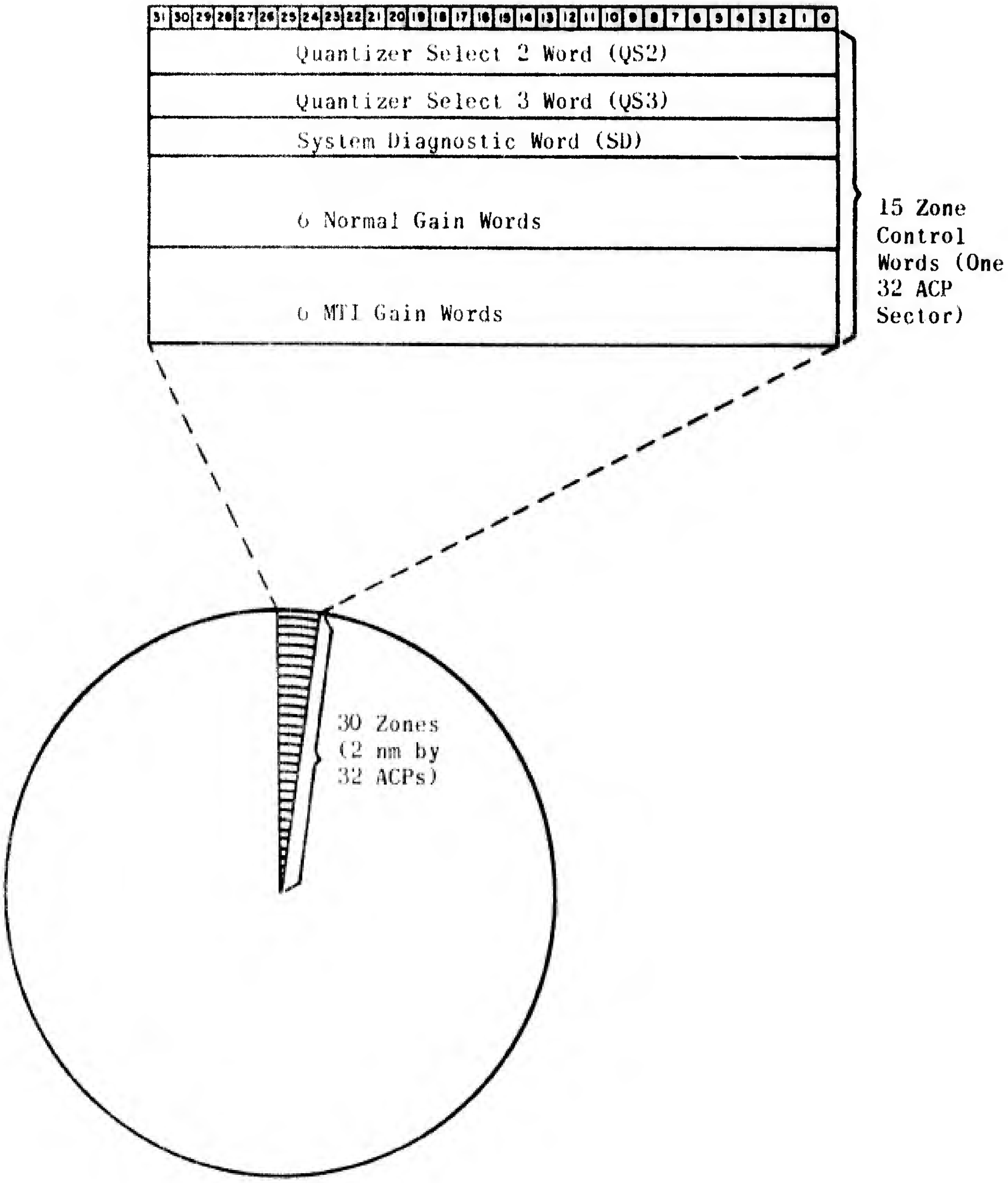
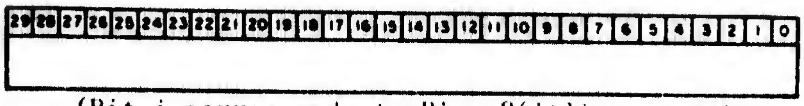


Figure 3-15. Format for Zone Control Data in One 32 ACP Sector (Sheet 1 of 2)

QS2 and QS3

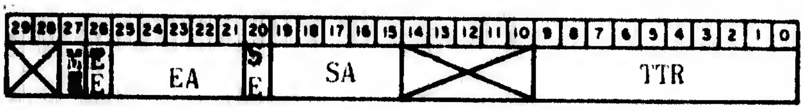


(Bit j corresponds to 2j - 2(j+1) nm zone)

QUANTIZER SELECT WORDS 2 AND 3
(Subtables QS2T and QS3T)

When Bit 17 in CWO = 0:

SD

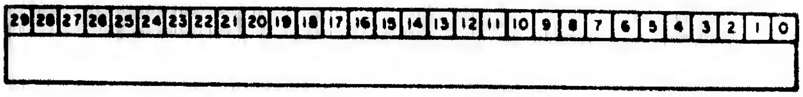


ME = Mask Enable
EE = End Enable
EA = End Azimuth

SE = Start Enable
SA = Start Azimuth
TTR = Test Tgt Range (LSB=1/16 nm)

When Bit 17 in CWO = 1:

SD



(Bit j corresponds to 2j = 2(j+1) nm zone)

SYSTEM DIAGNOSTIC WORDS (Subtable SDMT)

G1	0	G14	0	G13	0	G12	0	G11	0	G10
G2	0	G24	0	G23	0	G22	0	G21	0	G20
G3	0	G34	0	G33	0	G32	0	G31	0	G30
G4	0	G44	0	G43	0	G42	0	G41	0	G40
G5	0	G54	0	G53	0	G52	0	G51	0	G50
G6	0	G64	0	G63	0	G62	0	G61	0	G60

Field Gjk corresponds to (10 (j-1) + 2k) - (10(j-1)+2(k+1)) nm zone

NORMAL AND MTI GAIN WORDS (Subtables GNT and GMT)

(G corresponds to GN for GNT and GM for GMT)

Figure 3-15. Format for Zone Control Data in One 32 ACP Sector
(Sheet 2 of 2)

3.3.4.2.4.2.1 (continued)

Bit 17 in command word 0 is set to one, the bit settings in the system diagnostic words correspond to the zones in the same manner as those in the quantizer select maps. The system diagnostic word is used to provide a visual display of conditions useful for the analysis of system errors. Depending upon the setting of software parameters the system diagnostic word can be made to represent any zone oriented data internal to the computer (e.g. tracking feedback map, gain words, azimuth words).

If bit 17 in command word 0 is set to zero, the system diagnostic words shall determine the position and width of the RTQC test target.

The fourth subtable consists of the gain words for percent noise regulation of the Q2 quantizer, and shall be referred to as the Q2 gain word map (table). There shall be six words per item (sector), each divided into 6-bit fields corresponding to a particular zone. The gain value (0-31) for a zone shall be right-justified in the appropriate field.

The fifth subtable consists of the gain words for percent noise regulation of the Q3 quantizer and shall be referred to as the Q3 gain word map (table). The format is the same as for the Q2 gain words.

The zone data word output scheme after initiation shall be described in the following sentences. The RDAS will sense zone sector (32 ACP) boundaries, and when a crossing is detected it will raise the Output Data Request (ODR) line to accept zone data for the next sector. The output chain shall already have been initiated by the processor; consequently, transfer of the 15-word zone data block shall begin immediately. The computer shall generate an output monitor interrupt when the transfer is complete, in response to which it will determine the location of the next block of zone data and shall reinitiate the output chain. The RDAS will not raise its ODR until the next sector boundary crossing, at which time the foregoing procedure will be repeated.

If command word changes had been pending during the preceding zone sector, they shall be transmitted as external functions on a 32 ACP basis immediately following the output of zone data.

3.3.4.2.4.2.2 Radar Target Detection.- The radar target detection routine shall process the video hit data for target patterns and declare target reports when certain statistical criteria are satisfied. The routine shall be segmented into two functions: report generation and report finalization. Report generation shall be accomplished by means of a two-step decision process called predetection/final detection. The function of predetection is to identify hit patterns which could potentially be from targets. In response to each predetection, the final detector either declares a target report or rejects the predetection. The details of this two-step process are defined in the following paragraphs. Report finalization consists of azimuth beam splitting, hit count discrimination, and report firmness assignment. The sequence for processing in the radar target detection routine shall be report finalization and then report generation; however, these functions are described in the reverse order to simplify the explanations.

The radar target detection routine shall process approximately one segment of radar input data on each entry. The actual limits for processing shall be

3.3.4.2.4.2.2 (continued)

different for the report finalization and generation functions. The processing for report finalization shall begin one sweep after the stopping point of the last entry called (K1). The stopping limit (K2) shall be at the last sweep input from the digitizer. The limit for report generation shall start at K1 - $W_L/2$ and end at K2 - $W_L/2$, where W_L is the length for the target detection window. These limits are picked to ensure that the necessary video hit data is currently available for the radar processing functions.

3.3.4.2.4.2.2.1 Report Generation.- The report generation routine shall cycle through the predetection data and engage the predetector/final detector to test for targets. Although the digitizer initially predetects targets on an individual range cell basis, the range granularity of reporting the predetections to the computer is limited to 1 7/8 miles. The function of the predetection in the computer (called software predetection) is to reestablish the range cells wherein the digitizer predetection occurred. Software predetection is accomplished through use of the predetection word supplied by the digitizer and by the application of a Boolean test which has similar characteristics to the sequential predetector test in the digitizer. One predetection word is sent to the computer each sweep. Each of the 30-bits in this word is identified with one of the first 30 video hit words. A given bit (n) set in the predetection word implies that there exists a predetection in the 1 7/8 nm range interval covered by the video word (n). Software predetection shall be performed utilizing the video hit words corresponding to the bits set in the predetection word. It should be noted that the predetection word covers only the first 30 of the 32 video hit words input to the computer. Therefore, only the first 56¼ nautical miles shall be processed for targets.

For each case where a predetection bit is set, the software predetector shall examine the appropriate video hit words for target-like hit patterns. The software predetector shall be simultaneously performed on all 30 range cells covered by the video hit word. The predetection tests shall consist of the following Boolean expression:

$$Y = Z \bullet X_j \bullet (X_{j-1} \oplus \ldots \oplus X_{j-k}),$$

where:

Y is a logical variable representing the outcome for a given range cell (Y = 1 implies the predetection test is satisfied)

Z is an indicator defining whether a target is already in process at the given range cell (Z = 0 for a target in process, Z = 1 implies no target in process)

X_j represents the hit data for a given range cell at sweep j ($X_j = 1$ for a hit, $X_j = 0$ for a miss)

$\bullet$ represents a logical AND operation

$\oplus$ represents a logical inclusive OR operation

3.3.4.2.4.2.2.1 (continued)

k is a parameter defining the number of sweeps to be included in the logical sum (k is generally set equal to the increment used in the digitizer sequential counter, i.e. k = 2,3).

The final detector shall be called once for each range cell wherein a software predetection occurred. The final detector is described in the next paragraph. The software predetector shall advance one sweep at a time and process all predetection words falling within the sweep limits defined in an earlier paragraph.

3.3.4.2.4.2.2.1.1 Final Detection.- The decision to declare a predetection as a target or to reject the prdetection as noise shall be made by the final detector. The basic idea of the final detector is to statistically determine the presence of a target on the basis of the video hits at the range of the predetection and over a number of sweeps on either side. The final detector routine shall be referenced each time a predetection is determined. The final detector shall then examine the video hits in a window (sampling region) referenced about the detection range and azimuth. The window shall cover the video hits one range cell in width and W_L in length. The window shall be centered about the predetection azimuth. If the hit count equals or exceeds a detection threshold, a target is declared.

Normally, the detection threshold (T1) shall be applied; however, an alternate threshold (T2) shall be selected if the predetection lies in an area where target enhancement is to be accomplished. This feature shall be employed only where the tracking routine indicates there exists a weak target and where normal radar video, is utilized. The information from tracking shall be contained in the radar target detection map which is constructed on the basis of two-miles by 32 ACP zone. A one (1) in this map shall indicate that the target enhancement is desired. A complete description of this map and how it is developed is contained in the paragraphs on tracking. The Q2 and Q3 select map shall identify the two-mile by 32 ACP zones where no clutter is present. A zero (0) in both maps shall indicate a clear region. The details of maintaining this map are provided in the paragraph on clutter processing. When both of the above criteria are satisfied, the detection threshold T2 shall be selected. The ordering of the values for the two thresholds shall be such that T1 ≥ T2.

When a target report is declared, a radar record shall be established to hold the pertinent report data until the target center azimuth can be established through beam splitting. Otherwise, the final detection process shall be terminated and control shall be returned to the predetection process. The radar record shall be saved in a range ordered table. The data in this table shall include the hit count from target detection and also a variable called the sweep sum. This latter variable is utilized for the beam splitting algorithm and is defined in the next paragraph. Finally, the beamsplitting and other functions within the report finalization routine shall be exercised for this one new report. The description of these functions is contained in the next paragraph.

3.3.4.2.4.2.2.2 Report Finalization.- The report finalization routine shall complete the processing functions related to each target report declared by the final detector. The report finalization shall consist of beam splitting to determine target center azimuth, hit count discrimination, and assignment of report quality. The routine shall be entered in two ways. The first, called Type 1 entry, shall be made directly upon entrance to radar target detection from the executive. At this time, all radar records active from the last entry shall be processed from the sweep limits K1 to K2. These limits are defined in an earlier paragraph. In this manner, all previously detected target reports are processed prior to searching for new predetections. Additional entries into the report finalization shall be made for each new radar report established via the predetector/final detector. On these entries, the processing shall commence with the sweep following the end of the final detector window. The processing shall continue until the sweep limit K2.

The beamsplitting shall be performed via an algorithm called center of density. This algorithm shall estimate target center azimuth by calculating the centroid or balance point of the video hits in the vicinity of the target. The principle of the algorithm is to calculate the ratio of two sums (sweep sum and hit count) both of which are functions of the video hits at the range of the detected report. The sweep sum ($S\theta$) is actually a moment calculation. The lever arm shall be defined as the number of sweeps from the beginning of the target detection window. The weighting function shall be the video hits. Each hit (binary 1) shall have a weight of unity. The hit count (SX) is the number of ones over the window of summation.

The form of the calculation shall be as follows:

$$\overline{K} = \frac{S\theta}{SX} = \frac{\sum_{k} kX_k}{\sum_{k} X_k},$$

where

$\overline{K}$ = The target center estimate in terms of sweep numbers

k = A sweep indexing number within the window

X_k = The value of the video hit data for sweep k at the range cell of interest ($X_k = 1$ for a "hit" and $X_k = 0$ otherwise).

The target center shall be computed in terms of ACPs in the following manner. First, $\overline{K}$, the center of density of the final detection window, shall be computed using the formula shown above. If the difference between $\overline{K}$ and K_C, the center of the final detection window, is less than ½ sweep, $\overline{K}$ shall be declared as the target center. If this difference is greater than or equal to one-half, the target window shall be expanded in the direction of positive azimuth by twice the difference between $\overline{K}$ and K_C. Note that K_C', the center of this new window, shall be equal to $\overline{K}$. Now $\overline{K}$, the center of density of the new expanded window, shall be calculated and compared to K_C'. If this difference is less than ½ sweep, $\overline{K}$ shall be declared the target center azimuth. If not, the window shall again be expanded by twice the difference and a new center of density

3.3.4.2.4.2.2.2 (continued)

shall be computed. The process continues until either a maximum expansion limit MEX has been reached or the computed center of density of an expanded window is within ½ sweep of the center of the expanded window. When either condition occurs, the center of density is declared as the target center. The azimuth in ACPs shall be determined from $\overline{K}$. By using $\overline{K}$ as an index into the input buffer, the azimuth of the corresponding sweep shall be taken as the center azimuth.

The radar records established by the final detector routine shall be utilized to maintain the information regarding the ranges where beam splitting cannot be completed due to the sweep processing limit K2. The radar record store shall hold the intermediate sweep sum, hit count, and other indices required for the beam splitting process. Upon a Type I entry, the beam splitting routine shall sequence through the radar record store and process each report using the video hits up through the sweep K2. If the beam splitting cannot be completed on a given report, the sweep sum, hit count, and other required indices shall again be saved in the radar record store.

The Hit Count Discriminator (HCD) routine shall be called for each report wherein beam splitting is completed. The hit count of the report shall be defined as the number of hits (SX) included in the final beam splitting window. If the report has been obtained from a clutter area, the hit count shall be compared against a threshold parameter called the HCD. That is, a report shall be discarded if its hit count is less than the value of HCD; otherwise, it is accepted as a valid target report. The value for HCD shall be equal to the target detection threshold T1 plus a parametric increment Δ HC; i.e., HCD = T1 + Δ HC. The determination that a report is generated from a clutter region shall be accomplished through checking the quantizer selection maps at the range in azimuth of the report. Report quality for radar reports shall also be assigned on the basis of hit count. An eight level quality value (Q) shall be assigned as follows:

$$Q = SX - T1 \quad \text{if } SX - T1 \leq 7.$$

$$Q = 7 \quad \text{if } SX - T1 > 7.$$

After having the report quality assigned, the report shall be deleted from the radar record store and placed in the radar report store. This store shall be a pair of alternating, range ordered subtables. The reports held in one of the radar report subtables shall be merged, in range order, with newly completed radar reports. Furthermore, if two reports are found with a range separation of less than or equal to 1/16 mile and an azimuth separation of less than 1°, they shall be merged together. The report having the lower quality shall be discarded. In the event of identical quality, the report having the greater range shall be discarded, but the azimuth of the preserved report shall be the average of the azimuths from the two reports. Furthermore, the quality shall be incremented one level. In addition, each report transferred to the record store shall be checked to determine if it is the report for the RTQC test target. If it is, the RTQC report found flag shall be cleared. Finally, the radar-in-process flag shall be reset to one for each completed report. This permits new predetections to be sensed at the report range.

3.3.4.2.4.2.2.2 (continued)

Radar reports emerging from finalization will have their range and azimuth modified by fixed constant range and azimuth bias parameters.

3.3.4.2.4.2.3 Quantizer Control.- The quantizer control routine shall process clutter and weather hit data for the purpose of selecting quantizers and regulating the quantization of clutter video. The clutter data received from the RDAS is in the form of two clutter monitor words. One clutter monitor word provides an indication of the presence of light clutter, and one provides an indication of heavy clutter. The clutter processing software uses these words to construct a light clutter map (Q2 select map) and a heavy clutter map (Q3 select map).

The weather hit data received from the RDAS is in the form of two weather hit words. One weather hit word is processed by the weather hit regulation software to control the percentage hits in the Q2 quantizer; the other is processed to control Q3. Although the clutter processing and weather hit regulation functions are described separately in the following sections, they shall be performed in parallel to minimize overhead. The entry of these functions shall be once per two radar processing cycles.

3.3.4.2.4.2.3.1 Clutter Processing.- The purpose of this function is the derivation and maintenance of two clutter maps, one enclosing areas of light clutter and one enclosing areas of heavy clutter. The light clutter map is maintained by processing clutter monitor word one. The light clutter map will be called the Q2 select map. The heavy clutter map shall be maintained by processing clutter monitor word two. It will be called the Q3 select map. Smoothing shall be performed on the clutter monitor data to compensate for random clutter declarations by the RDAS. For both maps the smoothing shall be done both on a sweep-to-sweep and a scan-to-scan basis in the manner described herein. The Q2 select map shall be used to effect the selection of the Q2 quantizer while the Q3 select map shall be used to effect the selection of the Q3 quantizer by the RDAS. The process described below applies to both the Q2 and the Q3 select map.

Two clutter monitor words (clutter monitor 1 and 2) shall be received by the computer each sweep (figure 3-12). A bit set to one shall indicate a clutter hit for the corresponding two nautical mile interval. (Bit j corresponds to the interval between 2j and 2(j+1) nautical miles, j=0,...,29). Clutter hits are first integrated (summed) over the first MSZP (SP) sweeps in a 32 ACP sector to produce a clutter sum for each zone.

Sweep-to-sweep smoothing shall be accomplished by correlating the hit data within a zone, that is, by declaring a clutter hit or no-hit indication for the zone accordingly as its clutter sum exceeds or fails to exceed a threshold, CDPi (SP), i=2,3, the clutter density parameters for the Q2 and Q3 select maps respectively.

Scan-to-scan correlation (or smoothing) shall be achieved through use of an up-down 3-bit sequential counter which shall be provided for each zone. These counters constitute the clutter map store, which is illustrated in figure 3-16,

3.3.1.2.4.2.3.1 (continued)

and each represents an integrated zone clutter hit count (or simply, a zone count). The zone counter shall be incremented by CIPi (SP), i=2,3, in response to a clutter hit declaration, or decremented by one in response to a clutter no-hit declaration. The clutter increment parameter, CIPi, shall have a value of 1, 2, or 4. Zone counts shall always be between 0 and 7; consequently, incrementation will be limited at 7 and decrementation limited at 0.

Finally, a clutter-present indication is made for each zone in which its zone count exceeds or equals the clutter threshold parameter, CTPi (SP), i=2,3, and the corresponding bit will be set to 1 in the clutter-present parameter, CPPi, i=2,3, here defined. The bit will be set to 0 in CPPi if its zone count falls below the CIPi.

The value of three clutter-present parameters generated for successive sectors - CPPi(n), CPPi(n+1), CPPi(n+2) - shall be used for quantizer selection during the next scan for each zone of sector (n+1) in the following manner: if the azimuth soaking parameter, ASPi (SP), here defined, has a non-zero value, the clutter-present image will be extended to the zones adjacent in azimuth and an intermediate value of the quantizer select parameter, QSPi, here defined, shall be obtained:

$$QSPi(n+1) \leftarrow CPPi(n) \oplus CPPi(n+1) \oplus CPPi(n+2),$$

where + denotes the "inclusive or" function and QSPi(n+1) represents the quantizer select word for sector n+1 in quantizer select map i(i=2.3). Otherwise, if ASPi = 0,

$$QSPi(n+1) \leftarrow CPPi(n+1)$$ (i.e. the clutter present word for sector n+1 becomes the quantizer select word).

If the range soaking parameter, RSPi (SP), here defined, has a non-zero value, the clutter-present image will be extended to the RSPi zones adjacent in range, and further intermediate values of the quantizer select parameter shall be obtained by iterating the following RSPi times:

$$QSPi(n+1) \leftarrow \left[QSPi(n+1)*2\right] \oplus QSPi(n+1) \oplus \left[QSPi(n+1)/2\right].$$

This simply says that the quantizer select word is shifted left and "or" ed with itself, then shifted right and "or" ed with itself to extend the range of the map. This shifting is performed as many times as necessary to extend the map RSPi bits.

At this point, QSPi(n+1), i=2,3, will be logically "or" ed with the corresponding word in the manually entered video select map and will then be inserted into the ZCMI (figure 3-15) as quantizer select words two and three (QS2 and QS3).

The bit settings of QS2 and QS3 will select the following quantizers (in the absence of limit or strobe conditions):

Bit Settings		Quantizer Selected
QS2	QS3	
0	0	Q1
1	0	Q2
0	1	Q3
1	1	Q3 (based on manual video select map)

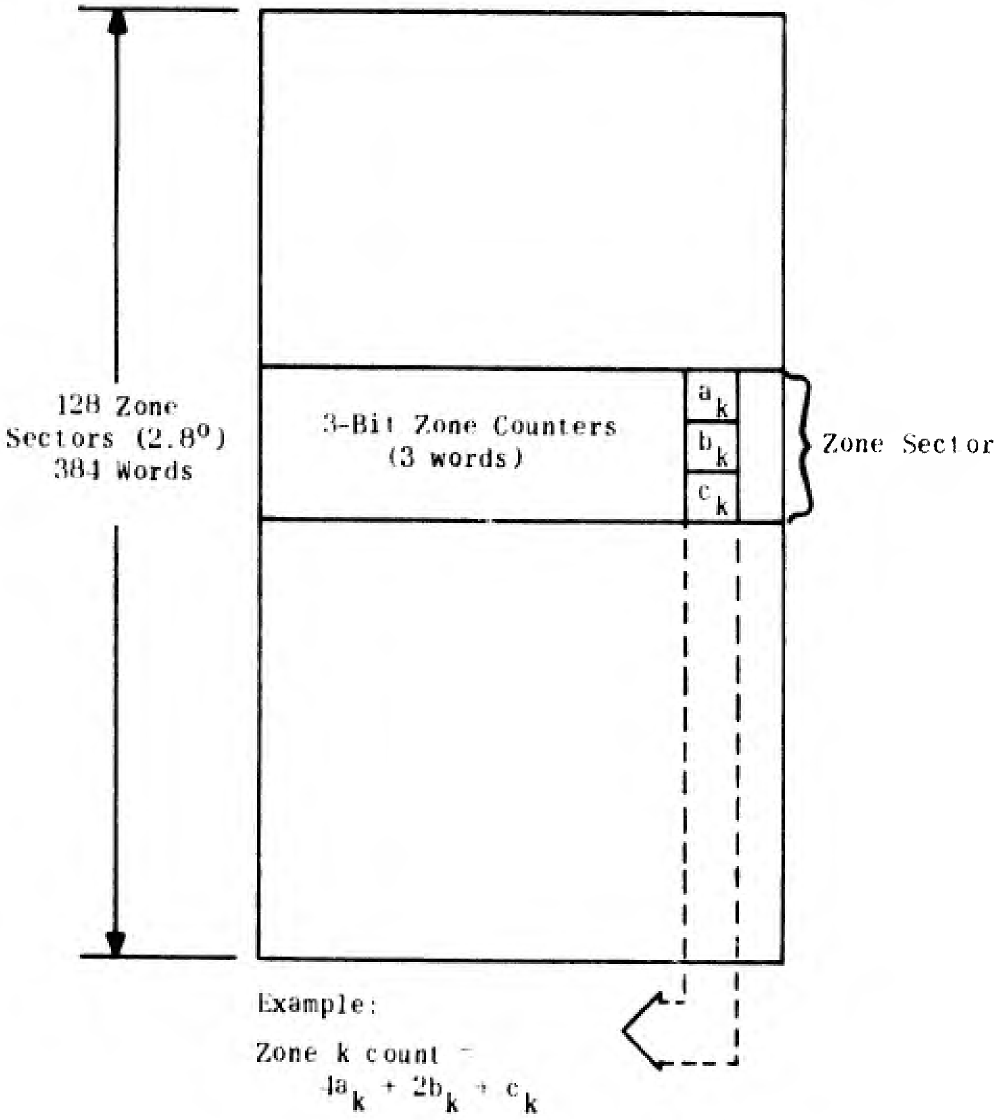


Figure 3-16. Clutter Map Store (2 MAPS - one for QS2 and one for QS3)

The clutter processing is performed on an aperiodic basis. The routine may be entered any time there is at least one input buffer segment available for processing and sufficiently early that it can process to the end of the last input buffer segment filled at the time of entry without the danger of data overrun. Clutter processing shall be performed in tandem with weather hit regulation once per two radar processing cycles. An alarm shall be set in the case that insufficient data is available to measure the clutter density for a particular zone sector. In such cases, modification of the corresponding zone counters and quantizer select words will be inhibited. (See also 3.3.4.2.4.2.4., Performance Monitoring).

<u>3.3.4.2.4.2.3.2 Weather Hit Regulation</u>.- The purpose of weather hit regulation is to control the hit output of the normal (Q2) and MTI (Q3) rank quantizers contained in the RDAS. For each of the two rank quantizers,control will be exercised independently over zones of dimension 2 nm by 32 ACP by adjusting the gain on the center taps of the respective quantizers. The gain adjustment is made by the weather hit regulation software which processes two weather hit words (normal and MTI) each sweep. Each bit within a weather hit word represents a weather leading edge hit/no hit indication for a 2 nm interval. For each of the two weather hit regulation loops, the weather hits shall be summed sweep-to-sweep over a 32 ACP sector to produce two zone weather sums, WHN (normal quantizer) and WHM (MTI quantizer). These sums will be compared to an upper and a lower threshold, WH1N and WHON (Normal) and WH1M and WHOM (MTI). If the sum exceeds the upper threshold, a 5 bit gain value (GN for normal, GM for MTI) shall be decremented by 1 for that zone. If the sum is less than the lower threshold, the gain (GN or GM) will be incremented by one. If the sum lies between the upper and lower thresholds, the gain will be left unchanged. Therefore, if GN(n) and GM(n) represent the normal and MTI gain on scan n, the following relationship holds:

For normal gain -

$$
\begin{array}{lll}
GN(n+1) = GN(n)-1 & \text{if} & WHN > WH1N \\
GN(n+1) = GN(n) & \text{if} & WHON \le WHN \le WH1N \\
GN(n+1) = GN(n)+1 & \text{if} & WHN < WHON
\end{array}
$$

For MTI gain -

$$
\begin{array}{lll}
GM(n+1) = GM(n)-1 & \text{if} & WHN > WH1N \\
GM(n+1) = GM(n) & \text{if} & WHOM \le WHM \le WH1M \\
GM(n+1) = GM(n)+1 & \text{if} & WHM < WHOM
\end{array}
$$

If the new gain falls outside the range of values 0 to 31, the old gain value will not be modified. The normal and MTI gain words shall be held in the zone control map. The processing shall be accomplished on a periodic basis using the weather hit words contained in the video store.

<u>3.3.4.2.4.2.4 Performance Monitoring</u>.- Monitoring of RDAS performance shall not be accomplished by a single subprogram or routine. Instead, each performance monitoring task shall be assumed by that major subprogram to which it is

most logically related. For example, analysis of the digitizer alarms shall be performed in the radar target detection subprogram, counting the number of beacon-radar correlations that shall be performed in the correlation subprogram and so forth. Tasks which have relatively low frequency and response criteria, such as the declaration of RDAS malfunction "all-clear", shall be performed during system timeout processing.

The radar performance monitor functions include periodic checks for abnormal processing conditions. Both the monitoring of RDAS status, RDAS interface, and computer processing shall be provided. System alarms shall be generated at the console typewriter when alarm conditions are first detected. In many cases, printout of the alarms will continue on a periodic basis as long as the abnormal condition persists, followed by an "ALL CLEAR" printout after a parametric number of consecutive error-free scans. Control of RDAS alarm lights shall also be a performance monitoring function. In the event of a detected error, and where possible, the RDAS shall continue processing by exercising automatic recovery procedures, but radar reports resulting from data of questionable quality shall not be made available to the tracking subprogram or for possible correlation with beacon reports. The RDAS malfunctions which shall be detectable and their consequential alarms are described in the following paragraphs and summarized in table 3-3.

1) Radar Timing.- A radar timing alarm shall be generated whenever a range or azimuth alarm is indicated in an azimuth sweep word received from the digitizer. The corresponding alarm light on the digitizer shall be illuminated during intervals of persistent failures (more than 45 (SP) errors detected in one (SP) scan). An alarm light shall remain lit for a minimum of 7 (SP) scans. Radar processing shall continue in the event of an alarm condition however, radar reports shall be withheld from the tracking and correlation subprograms.

   An alarm message shall be generated every minute (SP) until the problem disappears. A radar timing "all-clear" message shall be typed out after one (SP) full scan of proper (error-free) timing. Normal reporting of radar reports shall also resume at this time.

2) RDAS Interface.- An alarm indicating a malfunction regarding the computer RDAS interface shall be generated whenever one of two conditions occurs: Either the IOP did not respond to the RDAS request (ODR) for output of zone data in timely fashion or it did not honor its request (IDR) to have input data transferred. These two types shall be know as a zone service alarm and RDAS service alarm, respectively. The RDAS shall indicate that either type of alarm had been detected by setting the appropriate status bit in an azimuth-sweep word. The computer will determine whether an alarm condition is persistent and will illuminate the proper RDAS alarm light for such periods or for a minimum number of scans.

TABLE 3-3. RDAS MALFUNCTION ALARMS

ALARM	DETECTION CRITERIA	PROGRAM RESPONSE	TELETYPE PRINTOUT
● Radar Timing Range Alarms	Input interrupt processor is informed of a range alarm condition detected by the RDAS (bit 2^{15} set to one in an azimuth sweep word).	Radar processing shall continue; radar reports shall be withheld from correlation and tracking while alarm persists. Normal processing resumes after n scans of error-free operation. Alarm lights on RDAS lit if malfunction is persistent.	RDAS TIMING 1
Azimuth Alarm	Input interrupt processor is informed of an azimuth alarm condition detected by the RDAS (bit 2^{14} set to one in an azimuth sweep word).		RDAS TIMING 2
● RDAS Interface Zone Service Alarm (Zone Data Output)	Input interrupt processor is informed by the RDAS that the IOP did not respond to its ODR in time (bit 2^{13} set to one in an azimuth sweep word).	Processing will continue until an out-of-sync condition occurs, at which time a resynch will be attempted. Processing will be suspended and RDAS alarm lights lit during a period of persistent error.	RDAS FAIL 4
RDAS Service Alarm	Input interrupt processor is informed by the RDAS that the IOP did not respond to its IDR in time (bit 2^{12} set to one in an azimuth sweep word).		RDAS FAIL 10
● All Clear Alarms	System timeout determines that n scans of error-free operation have elapsed since the detection of a radar timing or RDAS interface alarm.	Normal operation is resumed, if no other alarms are in effect. RDAS alarm lights are extinguished.	ALL CLEAR k (k corresponds to alarm type)

(TABLE 3-3 continued on page 4-74)

(TABLE 3-3 continued from page 3-73)

ALARM	DETECTION CRITERIA	PROGRAM RESPONSE	TELETYPE PRINTOUT
• Parity RDAS Parity Error (IOP output)	Input interrupt processor is informed by the RDAS that it had received a data word with bad parity (bit 2^{16} set to one in an azimuth sweep word).	If I/O has terminated, resynchronize by sending current command words and reinitiating I/O chains. Otherwise, send command words only & continue to process normally. Light alarm on the RDAS for n seconds.	RDAS PARITY 1
Input Parity Error	IOP detects parity error during input from the RDAS. Interrupt processor entered with status code set to 1.		RDAS PARITY 2
• I/O - Input	System timeout discovers that input chain is not progressing normally, i.e., input data is not being transferred.	Resynchronization between IOP and RDAS shall be attempted.	RDAS FAIL 1
Output (Zone Data, Command Words)	System timout discovers that the output chain is not progressing normally, i.e., output data not being transferred.		RDAS FAIL 2
• Video Processing	System timeout determines that radar input processing has been suspended or is not receiving timely entry from the executive.	System shall continue to operate in beacon-only mode.	RDAS FAIL 20

(TABLE 3-3 continued on page 3-75

(TABLE 3-3 continued from page 3-74)

ALARM	DETECTION CRITERIA	PROGRAM RESPONSE	TELETYPE PRINTOUT
• Processing Overloads			
Input Buffer	Interrupt processor detects that an input buffer segment has been over-written before previous data had been completely processed.	All processing shall be advanced the equivalent of one input buffer segment. Excessive over-loads shall result in this temporary suspension of radar processing.	RDAS OVERLD 1
Radar Record Store	Radar input processing discovers that storage is inadequate for current radar records.		RDAS OVERLD 2
Radar Report Store	Radar input processing discovers that storage is inadequate for current radar reports.		RDAS OVERLD 3
• Synchronization			
Sync Code	Interrupt processor detects a sync code missing in any input buffer location which is to be occupied by an azimuth sweep word.	Resynchronization shall be attempted.	RDAS SYNC 1
Zone Monitor	Radar input processing (quantizer control) detects insufficient sweep data to perform zone update.	If frequency of occurrence is excessive, radar processing shall be suspended after a number of re-sync attempts.	RDAS SYNC 2

(TABLE 3-3 continued on page 3-76)

(TABLE 3-3 continued from page 3-75)

ALARM	DETECTION CRITERIA	PROGRAM RESPONSE	TELETYPE PRINTOUT
• Alignment			
Test Target	Radar input processing fails to detect RTQC Test target at expected range, azimuth. System timeout declares the alarm..	None, other than the teletype printout	RDAS RTQC 1
Correlation	System timeout determines an insufficient ratio of radar-beacon correlations to the number of beacon targets in the system.		RDAS RTQC 2

3.3.4.2.4.2.4 (continued)

Radar processing shall be continued despite a RDAS interface alarm, but radar reports shall be withheld from correlation and tracking. An alarm message will be printed at the console typewriter every minute (SP) as long as the malfunction exists. An "all-clear" message shall be typed after one (SP) full scan of error-free operation, at which time normal radar target reporting will resume.

3) Parity.- Parity errors shall be detected if they should occur on either of two types of data transfer: by the RDAS, if output data (a command word or a zone data word) was received with bad parity, or by the IOP, if input data was received from the RDAS with bad parity. In the latter case, if the processor has stored the bad parity word and terminated I/O, the program shall initiate a resynchronization procedure. Buffer indices will be set to overwrite the bad data, and consequently a brief interruption of radar processing will result. On the other hand, if the processor corrects the parity before storage (and jumps to the parity interrupt processor) the program shall continue to process using the specious data. However, it shall monitor the number of such occurrences and, if the frequency of parity errors becomes too great, shall suspend radar processing.

The program shall respond to parity errors detected by the RDAS by sending the current command words once again - regardless of whether the error was detected in a command word or zone data word. The RDAS will operate on erroneous zone data for at most 32 ACPs. The parity alarm light on the RDAS shall be turned on immediately and will remain lit for a minimum of a parametric number of seconds. Error messages, in all cases, will be printed at the console typewriter.

4) Input/Output.- The instruction chains which govern input and output progression shall contain flag set and clear (IOSET, IOCLEAR) instructions which shall give indication of normal and timely data transfer. These flags shall be periodically checked by the system timeout subprogram to determine whether an alarm condition exists. If one is noted, an attempt to restart the program shall be made (with concommitant alarm printouts), during which time radar processing shall be temporarily suspended.

5) Video Processing.- System timeout shall also monitor performance indicators set by radar input processing. These indicators will reflect either that radar input processing has been suspended or is not receiving timely entry from the executive. Unless resynchronization is already in progress, the program will attempt a re-initialization, and during the interim operate in a beacon-tracking mode.

3.3.4.2.4.2.4 (continued)

6) Radar Processing Overload.- The radar processing overload alarm shall be generated whenever input processing falls too far behind or a report table overflow occurs. Radar processing shall continue although data losses will be experienced. The alarm shall be regenerated every minute (SP) if the conditions continue.

The condition that the radar processing has fallen behind shall be sensed via the buffer filled flags set by the radar input chain. The condition shall be checked every time a routine of the radar input processing program is referenced by the executive. The automatic recovery procedure shall be to set all processing indices executive. The automatic recovery procedure shall be to set all processing indices and variables ahead one buffer segment. One flag shall be maintained for target processing. An additional flag shall be maintained for quantizer control. Sensing of table overflow shall be performed on tables defined for holding intermediate or final radar reports. In particular, the radar record store and radar report store shall be monitored. Recovery shall be through the discarding of the report producing the overflow.

7) Synchronization.- The radar input interrupt processor shall investigate every azimuth-sweep word for the presence of the correct synchronization code (bits 17-29). A re-initiation shall be attempted in the event of an improper or missing sync code.

An out-of-sync condition may be suspected if the zone update procedures in the quantizer control (and clutter processing) subprogram discover an insufficience of data for any zone. If the insufficience is merely transient, no action other than an alarm printout shall occur. Otherwise, the reinitiation procedure shall be begun.

8) Alignment.- Failure to detect the RTQC test target in each of the three quantizers at least M (SP) times based on a specific time interval shall result in an alarm declaration via the console typewriter. The alarm shall be continued every minute (SP) until the condition disappears. A detection failure shall be noted at north crossing time if the RTQC found flag is not set.

Failure to achieve a minimum (SP) of radar-beacon correlations relative to the number of beacon reports in the system shall be considered as a possible misalignment between the BDAS and RDAS. Corrective response to the error message shall require operator intervention either to re-align the hardware or compensate for the misalignment by adjusting bias parameters in the program.

3.3.4.2.4.2.5 RTQC Test Target Control.-

3.3.4.2.4.2.5.1 RTQC Generation.- The radar processing software shall contain a routine which will be responsible for the control of the RTQC test target. This routine will be called on initiation (or reinitiation) of the RDAS, whenever bit 17 in command word 0 is changed from one to zero, and whenever the position or width of the RTQC test target is modified. The characteristics of the RTQC test target will be contained in two stored words, the RTQC Range Word (RPW0) and the RTQC Azimuth Word (RPW1) (figure 3-17).

When the RTQC control routine is called, it will first clear to zero all system diagnostic words in the zone control map and then reference the RTQC azimuth word to obtain the test target azimuth. The routine will then subtract 16 ACPs from the test target azimuth. The resulting azimuth will be used as a pointer into the zone control map. When the 32 ACP sector in which this resulting azimuth falls has been determined, the system diagnostic word for that sector will be modified as follows (see figure 3-15 for system diagnostic word format):

1) The range in the TGTR field of the RTQC range word (RPW0) will be inserted in the TTR field of the System Diagnostic (SD) word.

2) The lowest order 5 bits in (TTA-20_8) will be inserted in the SA field of the SD word and the SE field will be set to one.

3) The RM field in RPW0 will be inserted into the ME field of the SD word.

4) The TTW field in the RTQC azimuth word (RPW1) will be checked to determine the zone sector in which the end azimuth of the test target lies. If it lies within the same sector wherein the (TTA-20_8) lies, the EA field within the SD word will be filled with the lowest order 5 bits of the TTW field and the EE field in the SD word will be set to one. If the end azimuth does not lie in the same sector as TTA-20_8 ACP, the EE field will be set to zero.

If the end azimuth of the test target does not fall into the same sector as (TTA-20_8), the TTW field in RPW1 will be used to determine the sector in which the end azimuth lies. The system diagnostic word for this zone will then be modified as follows:

1) The range in the TGTR field of RPW0 will be inserted into the TTR field of the SP word.

2) The lowest order 5 bits of (TTW + TTA) will be inserted into the EA field of the SD word and the EE field will be set to one.

3) The RM field in RPW0 will be inserted into the ME field of the SD word.

<table>
<tr><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="3" rowspan="2">0 0 0</td><td colspan="13" rowspan="2">0 ——— 0</td><td colspan="2" rowspan="2">QST</td><td rowspan="2">RM</td><td rowspan="2">0</td><td colspan="10">TGTR</td></tr>
<tr><td colspan="10">LSB = 1/16 nm</td></tr>
</table>

RTQC RANGE WORD (RPWØ)

TGTR = Test Target Range
RM = Range Mask (0 = No Range Mask)
1 = Range Mask)
QST = Quantizer Select Test (00 = Q1, 01 = Q2,
10 = Q3, 11 = Q3)

<table>
<tr><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="3" rowspan="2">0 0 1</td><td colspan="12">TTW</td><td colspan="3" rowspan="2">0 0 0</td><td colspan="12">TTA</td></tr>
<tr><td colspan="12">LBS = 1 ACP</td><td colspan="12">LSB = 1 ACP</td></tr>
</table>

RTQC AZIMUTH WORD (RPW1)

TTW = Test Target Width
TTA = Test Target Azimuth

Figure 3-17. RTQC Range and Azimuth Words

3.3.4.2.4.2.5.2 Quantizer Sequencing.- The radar processing software will contain a routine which selects a different quantizer in the zone(s) containing the RTQC test target each scan. The routine will be entered at zero azimuth crossing and will first check the QST field in the RPW0 word to determine which quantizer was selected for testing on the last scan. If Q1 was selected on the last scan, Q2 will be selected on this scan. If Q2 was selected on the last scan, Q3 was selected, Q1 will be selected on this scan.

When the desired quantizer is determined, the QST field will be updated and RPW0 and RPW1 will be checked to determine the zone(s) in which the RTQC test target lies. The quantizer select words (QS2 and QS3) will be modified to select the appropriate quantizer in the zone(s) containing the RTQC test target.

3.3.4.2.4.3 Radar Input Processing Data Base.- The data base for radar input processing consists of tables for receiving input from the RDAS, holding intermediate radar record data, and providing radar reports for beacon/radar correlation. Also included are clutter mapping tables, zone control data parameters to control the RDAS system parameters, and so forth. System data base elements referenced by radar input processing (such as the zone control map table) are briefly described in this section, as well as in section 3.3.4.2.14, where a detailed description may be found. With that exception, an explanation of each principal table is given in the paragraphs which follow. Relevant program parameters are described in table 3-4.

1) Radar-In-Process Mask Table (RIPM1T) - This 32-word table (figure 3-18) contains information indicating whether a radar target is in process at a given range. Each word is an in-process mask with the following bit significance:

   Bit j of word k (j=0,..., 29 and k=0,...,31) corresponds to the 1/16 NM range interval between (30k + j)/16 and (30k + j + 1)/16 NM. Each bit position shall indicate the presence (if set to zero) or absence (if set to one) of a target in process at the corresponding range. The radar in process mask shall be cleared at the range of a target in process in the radar target detection subprogram immediately upon detection of a target. The mask shall be set after the target report has been finalized.

2) Radar Record Store (RRCD1T), RRCD2T) - The radar record store consists of two RRCDTQ-word (SP) subtables (figure 3-19). They shall contain data pertaining to targets which have been detected but not completed (incomplete records), and target data in a form to be used by report finalization (complete records). All the data for a single record (complete or incomplete) shall be contained in two words, the first word in subtable one (RRCD1T) and the other in subtable two (RRCD2T) occupying the same relative tabular position as the first. Data items included in the reoord store shall be a record type (bit 29, word 1 = 1 for an incomplete record, = 0 for a complete record), sweep sum, window length, range of

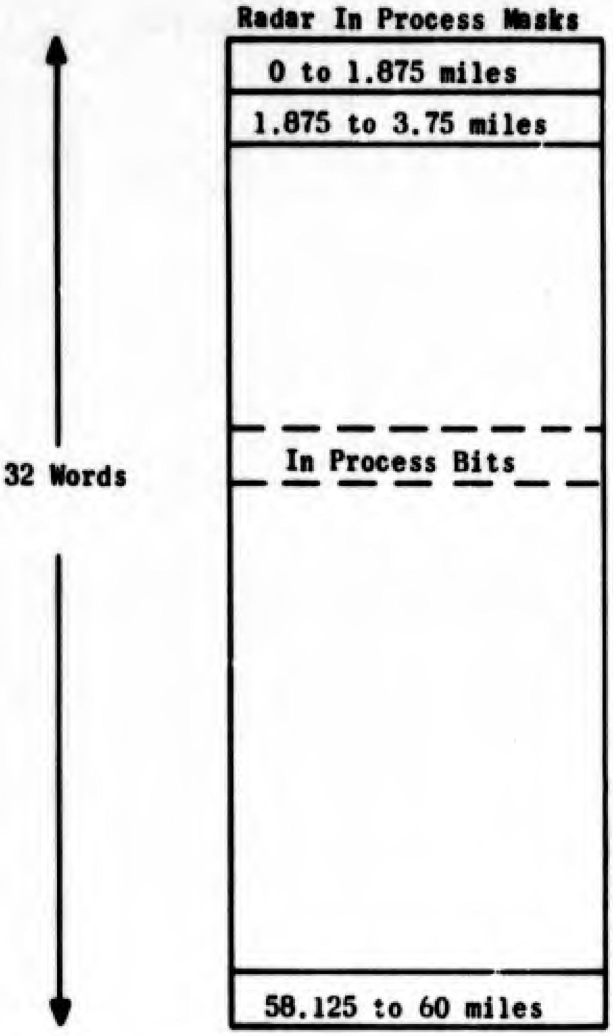
TABLE 3-4. RADAR INPUT PROCESSING PARAMETERS

ITEM	DESCRIPTION	VALUE
MSZP	Minimum sweeps per zone for processing clutter	0-63 (32, nominal)
CDPi	Clutter Density Parameter - for clutter hit declaration (i=2,3)	0-63 hits (14, nominal)
CIPi	Clutter Increment Parameter (i=2,3)	0,1 (2 or 4, nominal)
CTPi	Clutter Threshold Parameter - for clutter declaration (i=2,3)	0-7 hits (5, nominal)
ASPi	Azimuth Soaking Parameter (i=2,3)	0-63 sectors (1, nominal)
RSPi	Range Soaking Parameter (i=2,3)	0-29 zones (1, nominal)
RSPCP	Radar sweeps per processing cycle (i.e., per radar input buffer segment)	6k (k=4, nominal)
RBSTP	Radar buffer segments in input table	3 (nominal)
WHON	Lower weather hit regulation threshold - normal	0-63 hits
WHOM	Lower weather hit regulation threshold - MTI	0-63 hits
WH1N	Upper weather hit regulation threshold - normal (WH1 - WHO)	0-63 hits
WH1M	Upper weather hit regulation threshold - MTI	0-63 hits
WL	Window length for final detector	17-21 sweeps, 17 nominal
k	Number of sweeps (minus 1) used by the software predetector	2 or 3
T1	Final detection threshold, normal case	0-WL hits
T2	Final detection threshold, enhancement (T2 - T1)	0-WL hits

(TABLE 3-4 continued on page 3-83)

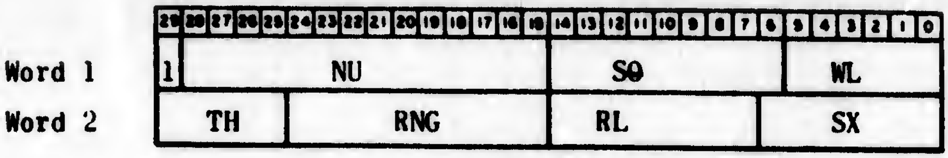
(TABLE 3-4 continued from page 3-82)

ITEM	DESCRIPTION	VALUE
ΔHC	Final detection threshold increment for determination of hit count discrimination	0-(WL-T1) hits
HCD	Hit count discriminator threshold (=T1 + Δ HC)	T1-WL hits
Sync Code	Bits 29-17 in Azimuth Sweep Word (Radar Input Data)	12525_8, SC+0
MEX	Maximum expanded window length	17-64 hits

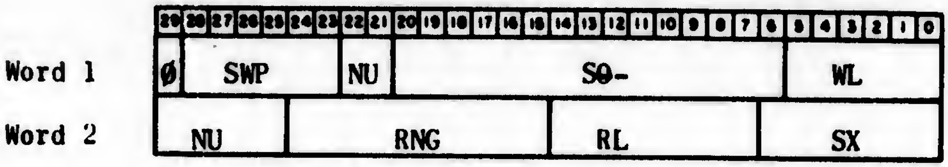


NOTE: Each bit represents 1/16 mile of range.

Figure 3-18. Radar In Process Mask Table



Incomplete Record Format



Complete Record Format

SΘ	Sweep sum
WL	Required window length
RNG	Range of report, nm, SC + 4
RL	Run length of sums
SX	Hit count
TH	Threshold value
SWP	Sweep number of current index
NU	Not used

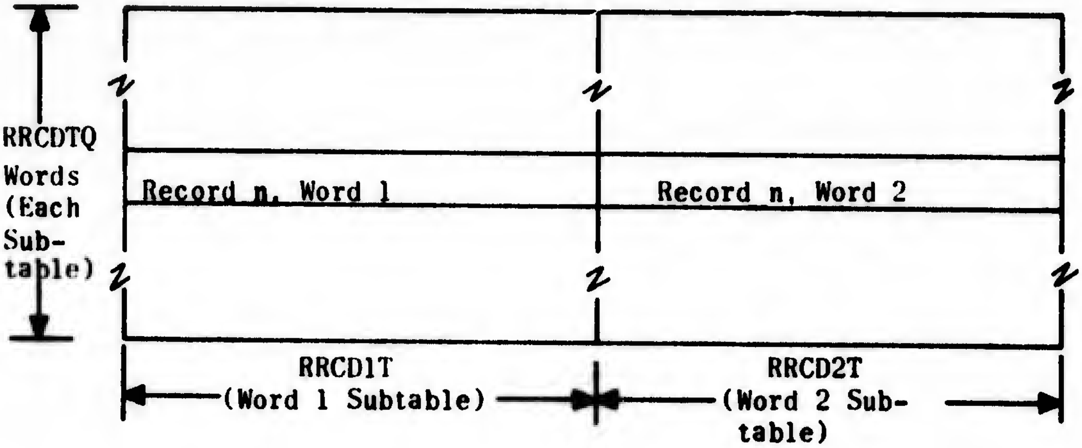


Figure 3-19. Radar Record Store

3.3.4.2.4.3 (continued)

of report (NM, Scaled + 4), window length, run length, bit count, threshold, and sweep number of current index. (See figure 3-19 for format).

3) Radar Report Store (RRS1T) - The radar report store is an RRPTQ - word circularly-stored table (figure 3-20) containing finalized radar reports (one word per report). Reports which have not been used by the correlation routine shall be range-ordered in a continuous block of the table (allowing wrap-around). That is, concerning any two reports, the one with lesser range shall be nearer the bottom of the table. Each report word will contain the following data items:

Bits 0 - 11 azimuth of target center, ACPs, SC + 0

Bits 12 - 14 report quality (Q) assignment (value 0 - 7, right-justified)

Bits 15 - 24 range of target, nm, sc + 4 (LSB = 1/16 nm)

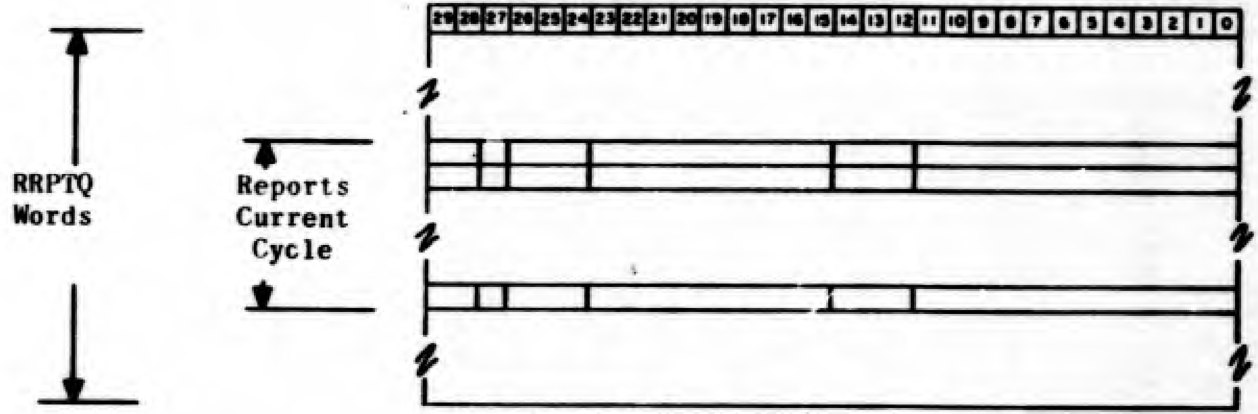
Bits 25 - 27 unused (nominally set to zero)

Bits 28 - 29 radar hold count, RHCP (SP), to maintain availablity of report until completion of its correlative beacon report (if it exists)

4) Clutter Map Store (CMST) - The clutter map store is a 384 - word table (figure 3-16) containing the 3-bit zone counters for each 2 nm by 32 ACP zone in the radar surveillance area. The table shall be divided into 128 three-word items, each item correponding to a 32 ACP zone sector. Bit 8 of each word for a given sector shall correspond to the zone bounded in range by 2k and 2(k-1) nm (k=0, ...,29). For zone k its value shall be given by $(4a_k + 2b_k + c_k,)$ where a_k, b_k, c_k are the corresponding bit values contained in words 1, 2, 3 of the item, respectively. The zone counters are maintained by the clutter processing routine and used to provide sweep-to-sweep correlation (integration) of clutter bits (see paragraph 3.3.4.2.3.1). Two clutter map stores will be maintained, one for generating quantizer 2 select word and another for quantizer 3 select word.

5) Zone Control Map Table (ZCMT) - The Zone Control Map shall be contained in five subtables consisting of 128 items each (figure 3-15). Each item corresponds to a 32 ACP sector of the area of surveillance. The data within an item corresponds to each of the 30 2 nm zones within a sector.

Subtable QS2T contains the Quantizer Select 2 (QS2) words. The aggregate constitutes the Quantizer Select 2 map.



Radar Report Store, RRS1T.

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RHC		*	*	*	Range LSB = 1/16 nm										Q			Azimuth LSB = 1 ACP											

Radar Report Format

Figure 3-20. Radar Report Store

Subtable QS3T contains the Quantizer Select 3 (QS3) words. The aggregate constitutes the Quantizer Select 3 map.

If bit k in both QS2 and QS3 is set to zero, the normal quantizer Q1 is selected for the zone bounded in range by 2k and 2(k+1) nm (k=0,...,29). If bit k in QS2 is set to one but in QS3 is set to zero, the normal quantizer Q2 is selected in the zone described above. If bit k in QS2 is set to zero and in QS3 is set to one, MTI quantizer Q3 is selected. Finally, if bit k in both QS2 and QS3 is set to one, the MTI quantizer Q3 is selected. The latter condition is set into QS2 and QS3 based on a manual video select map which encloses ground clutter.

Subtable SDMT contains the system diagnostic (SD) words, one word per item, the aggregate constituting the system diagnostic map. The SD words have different interpretations depending upon the setting of Bit 17 in the display video select field of command word 0. If bit 17 equals zero, the SD word contains RTQC test target information. Bits 0-9 contain the Test Target Range (TTR) field (LSB = 1/16 nm). Bits 15-19 contain the start azimuth for the RTQC mask and bit 20 is the Start Enable (SE) field. Bits 21-25 are the End Azimuth (EA) for the RTQC test target, while bit 26 is the End Enable (EE) field. Finally, bit 27 is the Mask Enable (ME) field.

If bit 17 in command word 0 equals one, the bit positions correspond to the 2nm X 32ACP zones in the same manner as described for the quantizer select words.

Subtable GWNT contains the normal gain words (GNj), six words per item (sector), j=1,...,6. Each word shall contain five 6-bit gain fields, GNjk, k=0,...,4. Field GNjk corresponds to the (5j+k+1) st zone, i.e., the zone bounded in range by (10(j=1)+2k and (10(j-1)+2k+2) nm (see figure 3-15). The most significant bit in each field shall be zero, and the five least significant bits shall contain the normal gain value for the corresponding zone.

Subtable GWMT contains the MTI gain words (GMj), six words per item (sector), j=1,...,6. This subtable shall have the same format as the normal gain table, GWNT.

Both the normal and MTI gain words shall be updated each scan by the weather hit regulation routine (3.3.4.2.4.2.3.2).

6) Radar Input Store (RINT) - This is a 38 x RSPCP (SP) word table designed to receive input data from the radar digitizer. It is divided into RBSTP(SP) = N subtables (segments), each of sufficient size to hold RSPCP/N sweeps of data (see figure 3-13). The entire table is filled and refilled under control of a continuously running input chain. Interspersed with the input buffer segment

3.3.4.2.4.3 (continued)

initiation instructions of the chain are others which provide interrupts whenever a buffer segment is filled.

Data for a single sweep consists of 32 video hit words, a predetector word, two weather regulation words, two clutter monitor words, and an azimuth sweep word - the format for which is also given in figure 3-13.

7) Command Words (DICWOP, DICW1P) - Operating parameters for the digitizer are contained within two command words formatted as shown in figure 3-14. Field definition is as follows:

   a) Command Word Zero (DICWOP)

Bits 27-28 Command Word Identifier (=00)
Bit 29 Master Clear Enable/Disable (1/0)
Bits 17-26 Display Video Select (DVS)

BIT(s)	DISPLAY VIDEO
17	System Diagnostic Map
19-18	00 Off
	01 Amplitude Output Q1
	10 Amplitude Output Q2
	11 Amplitude Output Q3
20	MTI Limit Map
22-21	00 Off
	01 QS2=1, QS3=0
	10 QS0=0, QS3=1
	11 QS2=1, QS3=1
24-23	00 Off
	01 Clutter Density 1
	10 Clutter Density 2
	11 Selected Hit Processing Output
26-25	00 Off
	01 Weather Hit Output-Normal
	10 Weather Hit Output - MTI
	11 Enhanced Display Output

Bits 12-16 Digitizer Alarm Light Control (On/Off - 1/0) according to type:
Digitizer Service (Bit 12)
Zone Service (Bit 13)
Azimuth Alarm (Bit 14)
Range Alarm (Bit 15)
Parity Error (Bit 16)
Bits 9-11 Minimum Pulse width - MTI (LSB = 1/63 nm; Range of values 1/64 to 7/64 nm).
Bits 6-8 Minimum Pulse width - Normal (LSB = 1/16 nm; Range of Values 1/64 to 7/64 nm).
Bits 0-5 Percent Noise - Normal (LSB = ¼ percent; Range of Values ¼ to 15-3/4 percent).

3.3.4.2.4.3 (continued)

b) **Command Word One (DICW1P)**

Bits 27-28	Command Word Identifier (=01)
Bit 29	Unused (=0)
Bits 24-26	Difference from maximum range - normal quantizer (LSB-1; range of values 1 to 7 hits).
Bit 23	Counter Decrement normal quantizer (0 or 1)
Bits 18-22	Clutter Monitor Threshold One (LSB - 1: range of values 1 to 31 hits)
Bit 17	Counter Increment Normal Quantizer (0: Incr. 2, 1: Incr. 3)
Bits 12-16	Strobe Threshold (LSB = 1; range of values 1 to 31 hits)
Bits 8-11	Display Threshold (LSB = 1; range of values 1-15 hits)
Bits 4-7	Weather Threshold Normal (LSB = 1; range of values 1-15 hits)
Bits 0-3	Predetection Threshold (LSB = 1; range of values 1-15 hits)

c) **Command Word Two (DICW2P)**

Bits 27-28	Command Word Identifier (=10)
Bit 29	Unused
Bits 24-26	Difference from maximum rank - MTI Quantizer (LSB=1; range of values 1 to 7 hits)
Bit 23	Counter decrement - MTI Quantizer (0 = Decr. 1, 1 = Decr. 2)
Bits 18-22	Clutter Monitor Threshold Two (LSB - 1; Range of values 1 to 31 hits)
Bit 17	Counter increment - MTI Quantizer (0 = Incr. 2, 1 = Incr. 3)
Bit 16	Counter decrement - selected (0 = Decr. 1, 1 = Decr. 2)
Bit 15	Counter increment-selected (0 = Incr. 2, 1 = Incr. 3)
Bit 14	Normal Bias Select (0 = Multiplication Bias for 62; 1 = Subtractive Bias for Q2)
Bits 12-13	Double Hit Select (00 = No double pulse generation 01 = 1/64 nm pulse adjacent to pulse output of TQ1, 2, 3 10 = 1/64 nm pulse 2/64 nm farther in range than pulse output of TQ1, 2, 3 11 = 1/64 nm pulse 4/64 further in range than pulse output of TQ1, 2, 3
Bits 4-7	Weather Threshold - MTI (LSB = 1; Range of values 1 to 15 hits)
Bits 0-3	Unused

3.3.4.2.5 Beacon Input Processing.- The following paragraphs describe the requirements and design of beacon input processing.

3.3.4.2.5.1 General Requirements.- The beacon input processing task shall be to accept replies from the Beacon Data Acquisition Subsystem (BDAS), correlate them on a sweep-to-sweep basis, and store the declared target messages for use by the beacon/radar correlation subprogram.

The input received from the BDAS for each sweep shall consist of an interrupt word, an initial word, and up to thirty reply words. The initial word specifies the azimuth value (parts of 4096), interrogation mode, and various alarms. A reply word consists of the reply range, 3/A or C code, X bit, Special Position Indicator (SPI) bit, and a garbled reply indicator. An additional bit may also be set if the 3/A code is a special code indicating emergency or radio failure. The reply words shall normally be in ascending order of range and have the format shown in figure 3-21. The initial word shall be checked for reasonable azimuth, proper interrogation mode (mode interlace), and alarm bit setting, with alarm printouts generated in case of failure.

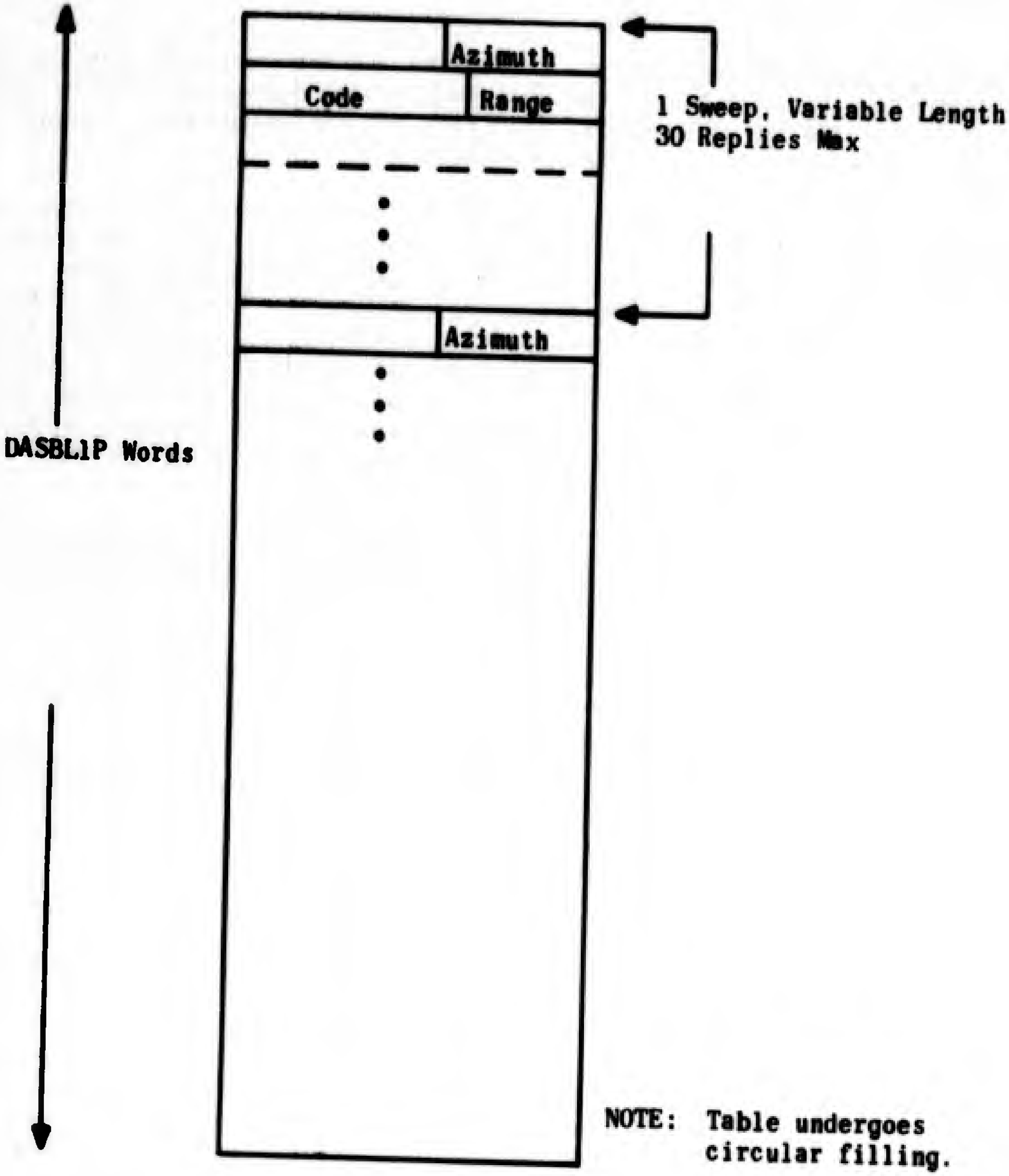
The reply words shall be used for correlation with previously received reply words for possible generation of target report messages. System parameters shall be used for determining firm targets, split targets, and ring-around conditions. Declaration of a firm target shall result in the storage of applicable data in the beacon target report store for subsequent processing by the beacon/radar correlation subprogram. This data shall consist of range, center azimuth, mode 3/A code, mode C code (if present), validity field for each code, SPI bit, and a weak/strong target indicator (W) based on azimuth confidence. A count of the interrupts received shall be maintained to determine Pulse Repetition Frequency (PRF) rate and an alarm printout shall be initiated if the count is not within limits.

Receipt of an internal test target shall also be verified once each scan. A test target shall be located approximately 32 ACPs in a clockwise direction from 180° at a range of 59 1/16 nautical miles. Failure to locate the test target shall result in a failure printout.

3.3.4.2.5.2 Design.- Beacon input processing shall be referenced from the executive as a planned (periodic) task. It shall operate on a basic cycle time of approximately 62.5 ms. A diagram of the data processing flow is shown in figure 3-22. Input shall be controlled by a continuously running input chain maintaining one rotating (circular) input buffer.

Upon entry, the beacon input processing subprogram shall determine (from the buffer control words) the location of all new input.

On a periodic basis, replies shall be merged with the target record. Starting with the sweep last processed plus one, sweep n shall be merged with the data previously stored in target record A, and this merged data shall be stored in target record B. Sweep n+1 shall be merged with target record B and stored



NOTE: Table undergoes circular filling.

Figure 3-21. Beacon Input Store, IBA1X

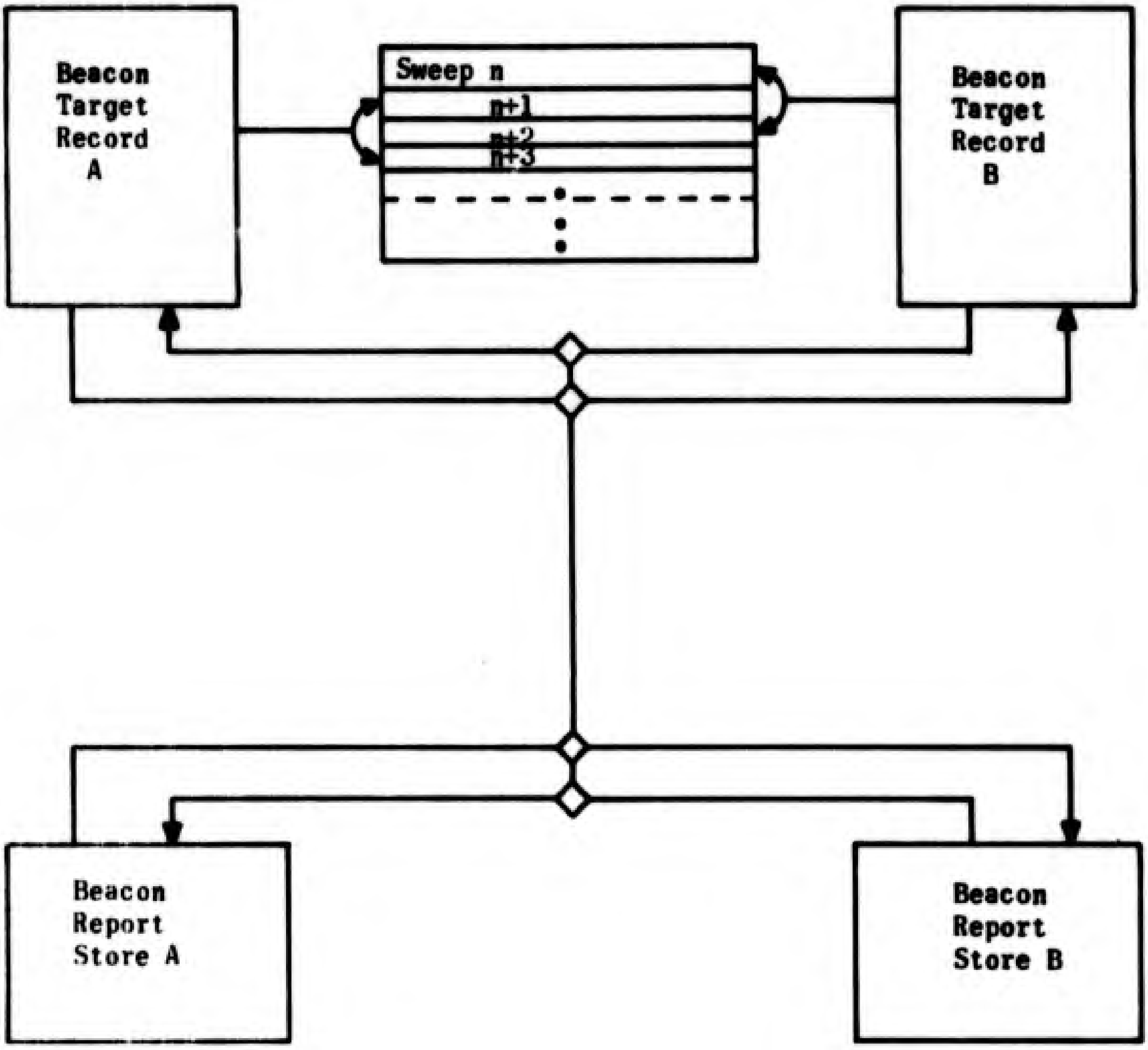


Figure 3-22. Beacon Input Process Flow

3.3.4.2.5.2 (continued)

in target record A. This alternating merge shall continue until the sweep determined by the radar input azimuth (RNIS flag set) or by beacon input processing azimuth (RNIS flag not set) or until the last reply index, REPE, determined by the input BCW, has been reached. The end of a given sweep is detected by testing for the negative azimuth word.

During the merging process, the new reply ranges shall be matched against the target record ranges. A match (within 1/16 nm) shall result in a hit. If no match is found, the result shall be a new record for a reply and a miss for a target record. The merge and store process preserves range order in the beacon record stores. Correlation of a parametric number of replies shall result in declaration of a target, determination of a target split (that is, not enough hits in a parametric number of sweeps), or a ring-around condition (that is, too many hits in a parametric number of sweeps).

The target detection logic shall consist of predetector and expanding window logic. The predetector shall be used for determining target leading edge (T_L). The predetector shall declare T_L if m hits are detected before n consecutive misses. For low values of m and n, this approach closely approximates the sliding window detector but does not require tables and has more flexibility.

Once T_L is declared, a window shall be constructed beginning with the first hit used for T_L declaration. This window shall be maintained by hit and sweep counters and shall expand each sweep. The expansion of the window shall continue for a minimum of Rmr sweeps (SP) to insure that a split target is not declared as two targets (See table 3-5). After minimum run length has been attained, the target trailing edge (T_T) shall be declared when My4r (SP) consecutive misses are received. If the trailing edge is not declared after RNGr sweeps (SP), the target shall be considered ring-around.

Upon detection of T_T, the number of hits shall be examined to insure that a minimum number of hits have been received. Less than this amount will cause the target to be discarded as fruit. Detection is a two level process using two minimum hit counts, Hy4r and Hy4rT. These hit counts are successively weaker and the lower value indicates confidence brought about by having a track in the immediate vicinity of the hits being processed. The hit count is first checked for Hy4r and if it fails this test, the target present map (figure 3-23) shall be checked to determine whether a track is present near the hits being processed. If the map indicates track presence, the weaker threshold, Hy4rT, shall be used. Less than Hy4r (or Hy4rT when a track is present) hits shall result in discarding the record as fruit.

Ring-around targets shall be declared if a ring discard flag, Rd (table 3-5), is not set. All targets considered ring-around (declared or not) shall be maintained for a parametric number of sweeps (INHB) in order to inhibit further attempts to declare a target at that range. Split targets shall be detected using the expanded window technique but may be flagged as weak targets (low azimuth confidence).

TABLE 3-5. BEACON DETECTION PARAMETERS

Parameter	Function	Value Range
My3	Value of MISS at which record discarded prior to leading edge detection	2-8
Hy3	Value of HIT at which leading edge shall be declared	2-5
My4r	Minimum value of MISS at which trailing edge shall be declared	2-8
Hy4r	Minimum allowable hits per target	3-27
Rmr	Minimum allowable run length (sweeps) Used in target split determination Must be greater than or equal to My4r plus Hy4r	5-35
TQyr	Number of HITS for strong target	4-27
RNGr	Maximum number of sweeps allowed before target is declared a ring-around	30-60
INHB	Total sweeps to inhibit a ring-around Must be less than scan PRF rate	31-1600
Rd	Ring discard flag. Ring-around targets shall be discarded if this flag is set and declared if not set	0-1
COFF (=f)	Coefficient of BAMS/SWEEP for center azimuth and computation. f=4096/N, where N equals number of sweeps per scan	--
Hy4rt	Minimum allowable hits per target, track correlated (Hy4rt - Hy4r)	--
REPE	Index to last beacon sweep processed by beacon input processing during one reference by the executive	0-7

NOTE: y = a for aircraft responding to mode 3/A only
y = c for aircraft responding to mode 3/A and mode C
r = range index
0 = 0-16 nm
1 = 16 1/16-32 nm
2 = 32 a/16-48 nm
3 = 48 1/16-64 nm

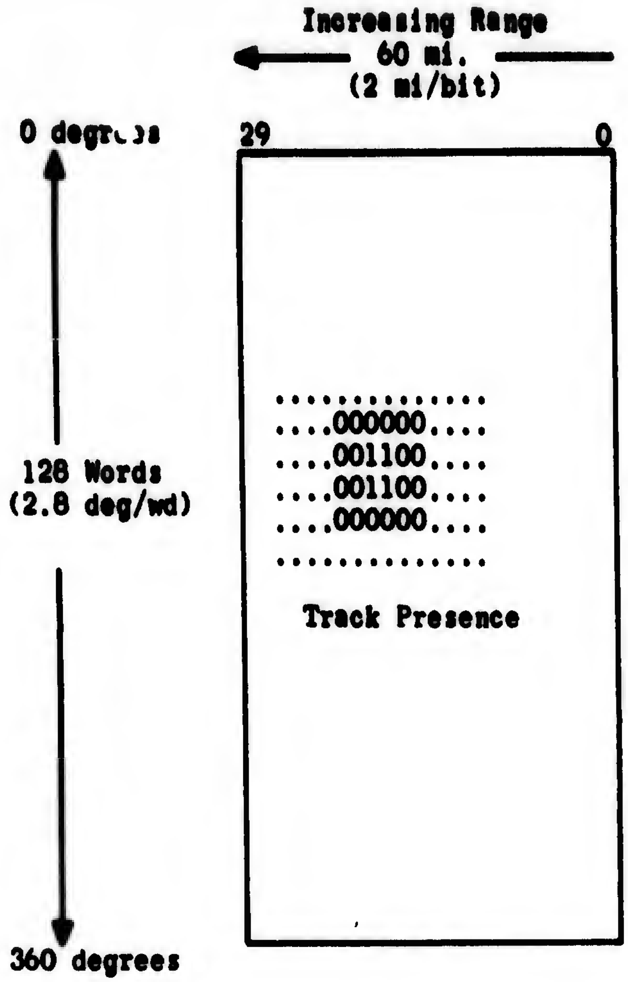


Figure 3-23. Track Present Map, TPMT

3.3.4.2.5.2 (continued)

If a target is to be declared, a center azimuth must be computed. During a target run, the following counters shall be maintained: HIT, SWEEP, and MISS (see figures 3-24 and 3-25). The MISS counter is used only for trailing edge detection and shall be cleared upon receipt of each hit. In addition, a fourth counter (SUMH) shall be maintained by adding the value of SWEEP each time a hit is detected. These counters shall be used in the computation of center azimuth by a "center of density" technique. Center azimuth (AZc) shall be computed using the azimuth at trailing edge (AZMt) and a constant (COEF) which represents a system parameter for conversion to BAMS/sweeps (table 3-5). The equation to be used is as follows:

$$AZc = AZMt - COEF\ (SWEEP - SUMH/HIT).$$

The range and computed azimuth shall be used to form the first word of the target report to be stored in the beacon report store (figure 3-26) for subsequent processing by the correlation subprogram. Prior to storing this word, a check is made to determine if the target is in the internal test target sector. If it is, the range, azimuth, and 3/A code shall be compared against prestored internal test, target parameters. If a match is found, a test target found counter shall be incremented. The target shall then be declared (Jump Key 2 not set) or discarded (Jump Key 2 set).

If a valid altitude (Mode C) code is available, it shall be converted from grey code to Binary Coded Decimal (BCD). A modified table-look up technique shall be used where combinations of bits are used as indices in obtaining the converted binary value from a corresponding table. Once the binary altitude is formed, it shall be corrected for barometric pressure if equal to or below an altitude level corresponding to the current altimeter setting. The formula used in the correction is as follows:

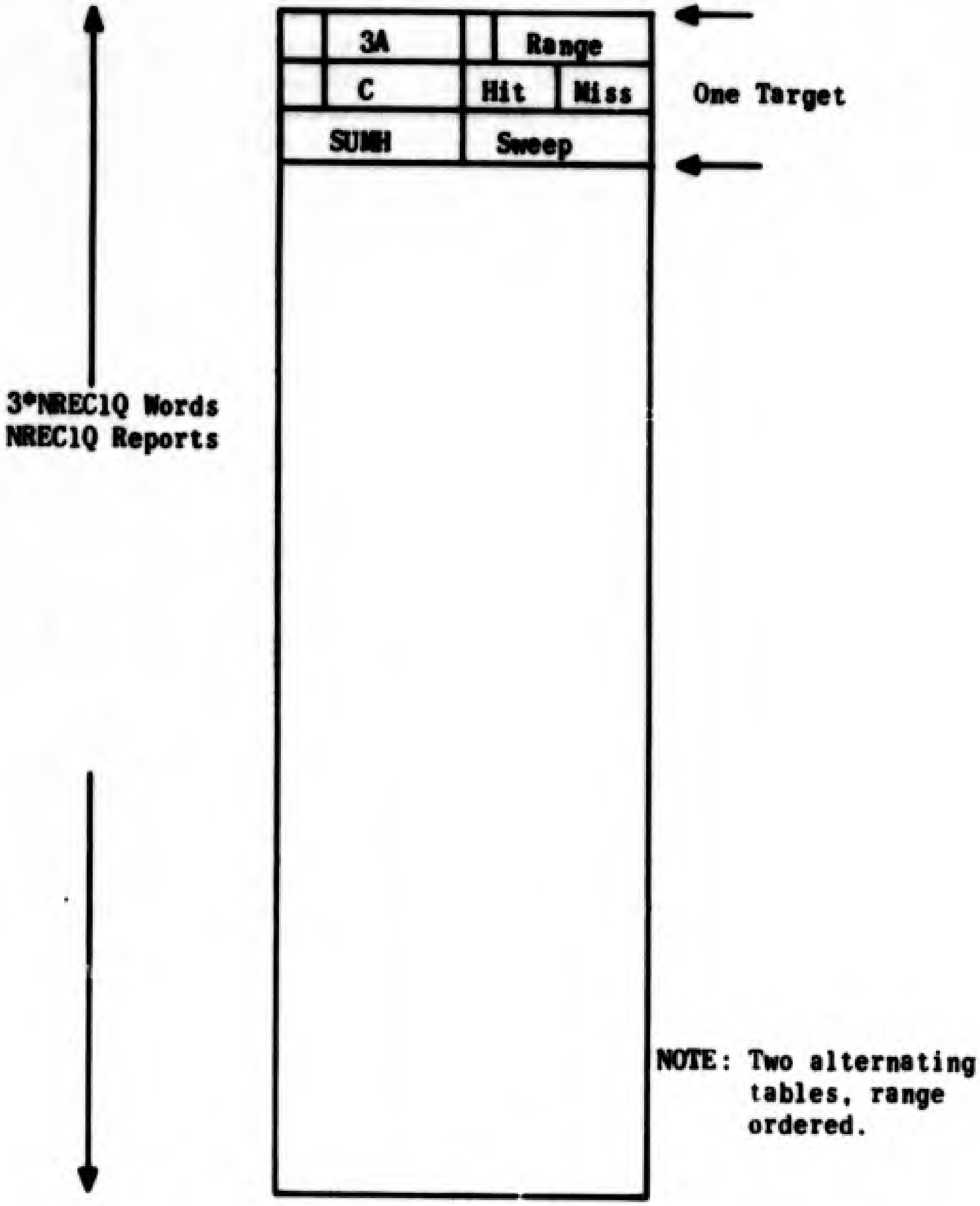
$$A = H\ \Delta b(925 + 13\Delta b),$$

where:

A = altitude in feet corrected for barometric pressure
H = Mode C pressure altitude in feet
b = altimeter setting
$\Delta b = 29.92 - b.$

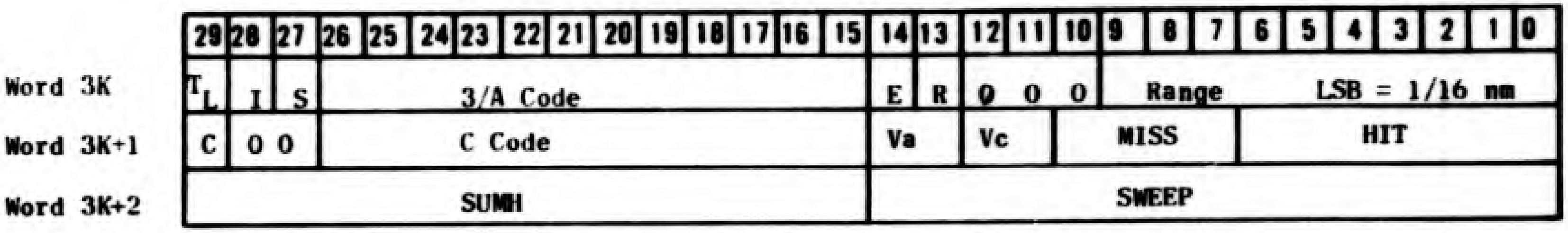
The corrected binary altitude shall then be converted to BCD.

Validation shall be maintained on 3/A and C codes on each hit received after leading edge declaration. The validation of a 3/A code shall include the S, E, and R bits (figure 3-25). The validity fields, along with the 3/A code, converted altitude, and SPI bit will comprise the second word of the report stored in the beacon report store. A target quality indicator hit shall also be set indicating a strong azimuth confidence if TQyr hits (SP) were received during target run length. A reasonableness check shall be made on each azimuth to assure it is a clockwise direction from the previous azimuth received and



NOTE: Two alternating tables, range ordered.

Figure 3-24. Beacon Record Store, RECA1X and RECB1X



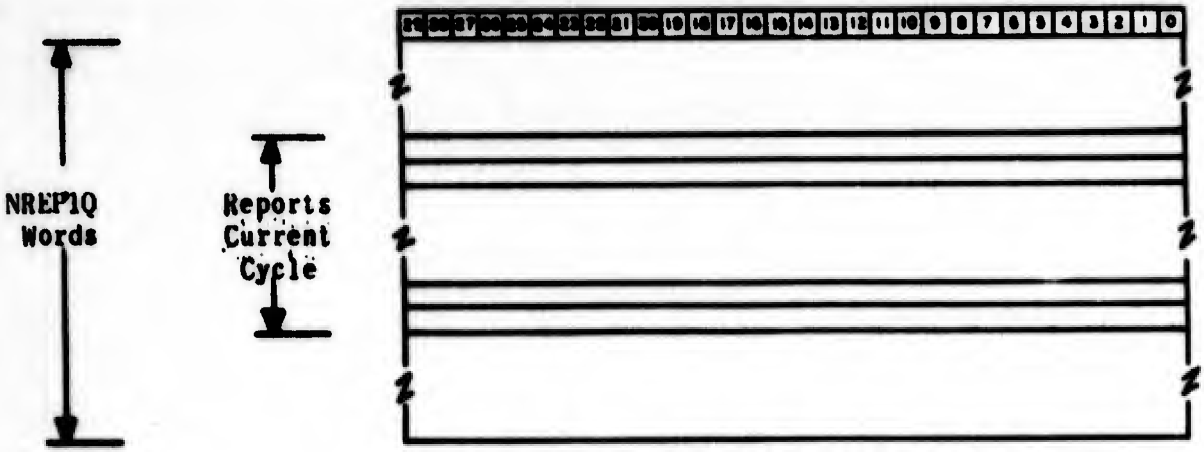
NOTE: K Ranges from 0 through NREC1Q-1
3/A Code and C Code same as in reply word formats

T_L = Leading edge detected flag
I = Initial Mode 3/A code received flag
S = Special Position Indicator
E = Emergency - 3/A code should be 7700
R = Radio Failure - 3/A code should be 7600

C = Aircraft responding to Mode C
Va = 3/A code validity
- 0 = All codes garbled
- 1 = One code ungarbled
- 2 = One ungarbled and one garbled agree
- 3 = Two consecutive ungarbled codes agree

Vc = C code validity
- 0 = No C replies received
- 1 = All C replies garbled
- 2 = At least one ungarbled reply
- 3 = Two consecutive ungarbled codes agree

Figure 3-25. Beacon Record Word Formats (In-Process Storage)



Beacon Report Store, REPRIT

<table>
<tr><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="13">Azimuth LSB = 1 ACP</td><td>E</td><td>R</td><td colspan="5">Ø</td><td colspan="10">Range LSB = 1/16 nm</td></tr>
<tr><td>S</td><td colspan="2">Va</td><td colspan="12">3/A Code</td><td>W</td><td colspan="2">Vc</td><td colspan="12">Altitude</td></tr>
</table>

Beacon Report Format

Figure 3-26. Beacon Report Store

3.3.4.2.5.2 (continued)

within a pre-stored number of ACPs. Mode bits shall be checked for valid settings (either 3/A or C codes follow) and also to assure that a proper mode interlace is being observed. A PRF counter shall be maintained (incremented once each sweep) and checked each scan for proper rate. The internal test target counter shall also be checked once each scan to assure the target was found. Error printouts shall be initiated if any of these tests fail.

Entry to the beacon input processing subprogram may be triggered upon detection of a parity error. An alarm printout shall be initiated for this type of error. An overload condition may also arise when the input data overruns the processing. If too many replies were received, the additional ones shall be lost. An overload alarm printout shall occur in this case.

3.3.4.2.5.3 Beacon Input Processing Data Base.-

The Beacon Report Store and Track Present Map referred to in the foregoing section are common to the Beacon Radar Correlation and Tracking subprograms, respectively. Details may be found in 3.3.4.2.14, System Data Base, but a brief description of each is given below. The Beacon Input Store and Beacon Record Stores are used only by beacon input processing and are fully described here. Relevant program parameters are also described in tables 3-5 and 3-6 .

1. Beacon Input Store (figure 3-21). A DASBL1P-word (SP) circularly stored table, containing azimuth and reply words from the DAS. Reply word formats are shown in figure 3-27.
2. Beacon Record Stores (figure 3-24). Two NREC1Q-report (SP) (i.e., two 3 x NREC1Q-word) alternating range-ordered tables, containing the records for each target being processed. Record word formats (3 record words per target) are shown in figure 3-25.
3. Beacon Report Store (figure 3-26). An NREP1Q-Word (SP) circularly stored table, containing the reports for all targets declared by beacon input processing. Each beacon report consists of two words formatted as also shown in figure 3-26. An index to the next available storage location in the Beacon Report Store is available at AREA (LHW).
4. Track Present Map (figure 3-23). A 128-word table maintained by tracking which reflects the zones (12 nm x 32 ACPs) which are in the proximity of an active track. A track is to be considered present between 2K and 2(K+1) nm and between 32J and 32(J+1) ACPs if bit K is set in word J of the Track Present Map (K = 0,...,29) and j = 0,...,127).

3.3.4.2.6 Beacon Radar Correlation.-

The following paragraphs describe the requirements and design of beacon/radar correlation.

TABLE 3-6. BEACON COUNTER, FLAGS, AND STORAGE

Item	Processing Function	Value Range
HIT	Measure of the number of replies received during a target run.	0-31
MISS	Measure of the consecutive number of times no reply was received for a record.	0-15
SWEEP	Count of the number of interrogation sweep modes during a target run. Used to determine ring-around condition and in computation of center azimuth.	0-1600
SUMH	Summation of SWEEP count at each hit. Used in computation of center azimuth	0-1830
T_L	Leading edge has been declared when set.	0-1
Va and Vc	3/A and C code validity fields	0-3
W	Target Quality Indicator: 0=weak, 1=strong	0-1
C	Indicates Mode C interrogation responses if set.	0-1
RINGC	Number of ring-around targets during the past time interval.	-
AZc	Center Azimuth in BAMS, scaled +29	-
AZMt	Last recorded sweep azimuth in BAMS, scaled +29.	-
T_T	Target Trailing edge has been declared if set.	0-1
PRF1Q	Beacon prf	300-445 pps
DASBL1P	Length of Beacon Input Store (=11· $\left[\text{PRF1Q}/8\right]$, nominal)	407-605 words nominal
NREC1Q	Maximum number of records in Beacon Record Store.	45 records or 135 words - nominal
NREP1Q	Maximum number of Words in Beacon Report Store.	125 reports or 250 words-nominal

	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Interrupt Word	0	0	TYPE			Zeros																							T	Y
Initial Input Word	1	Zeros							M	V	D	N	O	A	C	0	0	0	Azimuth LSB = 1 ACP											
3/A Reply	0	G	S	A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1	E	R	X	0	0	Range LSB = 1/16 nm									
C Reply	0	G	0	D1	D2	D4	A1	A2	A4	B1	B2	B4	C1	C2	C4	0	0	X	0	0	Range LSB = 1/16 nm									

1 Initial word and up to 30 reply words per sweep (all 3/A or C codes)

TYPE Type of interrupt received
000 = I/O External Interrupt Line Parity Error
001 = I/O Input Data Line Parity Error
010 = Input Chain Monitor Interrupt (not used)
011 = Output Chain Monitor Interrupt (not used)
100 = External Interrupt (normal)
T = Staggered Mode Bit (unused)
Y = Sector Synchronization Bit (unused)
M = Minimum Range Limit On
V = Overload Indicator
D = BDAS Alarm
N = Sensor Alarm
A = Mode 3/A Replies follow
C = Mode C Replies follow

G = Garble Indicator
S = Special Position Indicator
Ai Bi Ci Di = Code's Binary Representation
E = Emergency (7700 Code)
R = Radio Failure (7600 Code)
X = X Bit (not applicable to ARTS III)
LSB = Least Significant Bit

Figure 3-27. Beacon Reply Word Formats (Input from BDAS)

3.3.4.2.6.1 General Requirements. The task of the beacon/radar correlation routine shall be to correlate beacon and radar reports representing the same aircraft and to derive a common position (i.e., merged) report.

3.3.4.2.6.2 Design.- This routine shall operate on data stored in the beacon report store and the radar report store. Ultimately, it shall pass each report through to the target report store, as a beacon only report, a radar only report, or as a merged report.

Due to the beamwidth of the respective equipment, the existence of the completed beacon report implies a completed radar report (if any), but not vice versa. Therefore, during each processing cycle all beacon reports shall be removed from the beacon report store, an attempt shall be made to correlate each with available radar reports, and then they shall be inserted into the target report store, either as a beacon only or as a merged report.

A radar report may be completed before its beacon correlative (if it exists). For that reason some radar reports shall be held in the radar report store throughout RHCP (SP) additional processing cycles, a duration not to exceed the expected time required to complete the beacon report, or until correlated with a beacon report. If correlation has not been achieved in this time interval, the radar report will be inserted into the target report store as a radar only target.

The beacon reports to be processed in a given cycle shall be first ordered according to range, which shall be similar in that respect to the radar reports available in the radar report store. The processing shall take advantage of this order. If two radar reports were within 1/16 nm in range and one degree in azimuth, the report with lower quality shall have been eliminated. Thus, the reports appearing in the radar store shall be separated by at least 1/16 nm in range and one degree in azimuth. Correlation begins with an attempt to correlate the beacon report which is nearest in range, with the radar report which is nearest in range. Four situations may occur:

1) Correlation is achieved. That is, the ranges of the two reports are within MRNGP(SP) nm and their azimuths are within MAZP(SP) ACPs. In this case the beacon and radar reports shall be merged into a single report. The range and azimuth of the merged report shall be linear combinations of the two ranges and azimuths, respectively:

$$R_M = RXP \cdot R_B + (1-RXP) \cdot R_R$$

$$A_M = AXP \cdot A_B + (1-AXP) \cdot A_R,$$

where RXP, AXP are system parameters based on a minimum variance estimate. The merged report shall contain a 3-bit field indicating the quality of the radar report. The target report store shall finally receive the merged report.

3.3.4.2.6.2 (continued)

2) The ranges of the two reports are within MRNGP nm but the azimuths are not within MAZP ACPs. In this case the beacon report will be inserted in the target report store as a beacon only report. If the Report Hold Count, RHC (see figure 3-28), is zero, the radar report will be reformatted and inserted in the target report store as a radar only target. Otherwise, the RHC for this report will be decremented by 1, and the radar report placed back into the radar report store to become eligible for possible correlation during the next processing cycle.

3) The radar report is farther in range than the beacon report. In this case the beacon report will be inserted into the target report store as a beacon only target. The radar report will be the first to be considered for possible correlation with the next beacon report (if any).

4) The radar report is closer in range than the beacon report. In this case, the radar report will be inserted into the target report store or placed back into the radar report store, according to the value of its report hold count, in the same manner as described under 2). Whichever the case, the beacon report shall then be tested for possible correlation against the next radar report greater in range than the last.

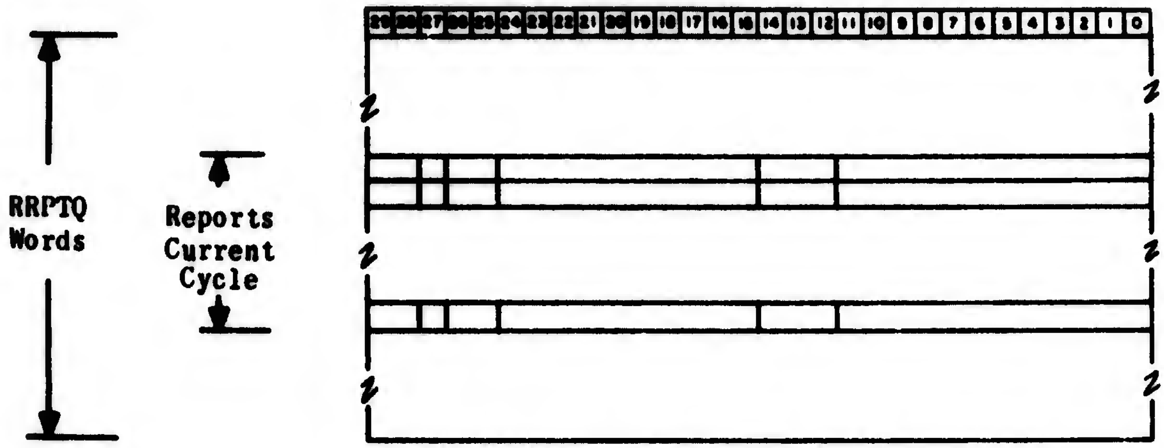
After the attempt has been made to correlate the first report, the next beacon report greater in range will be considered and the cycle described above shall be repeated. After the last beacon report has been processed, radar reports may be left which are farther in range than the last beacon. When this occurs, they shall be disposed of in the manner described in 2).

This routine shall use the current BDAS azimuth (or the digitizer azimuth if the DAS is inoperative) to determine a sector (11 1/4°) boundary crossover. If a new sector is detected, the sector target access store for the last sector will be updated to reflect the total number of reports for that sector and the address in the target report store of the first report for that sector. Also, the current real time clock value will be stored in the sector time store indicating when processing of the new sector began.

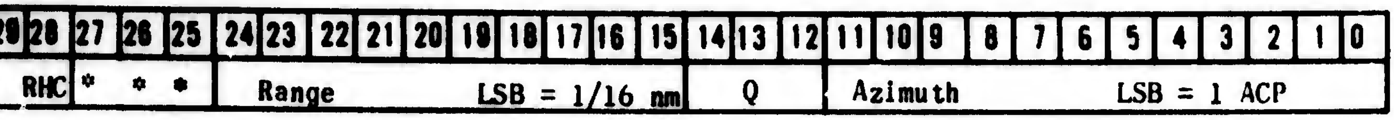
The correlation routine shall provide a count of the number of beacon-only targets and merged radar-beacon targets as a performance monitor function for the purpose of detecting possible misalignment of the RDAS and BDAS.

Correlation shall operate on a cyclic basis coincident with but subsequent to, beacon input processing. That is, it shall be entered from the executive approximately every 62.5 ms following the completion of BIP.

3.3.4.2.6.3 Beacon Radar Correlation Data Base.- The radar, beacon and target report stores referred to in the foregoing section are common to the Radar Report Finalization, Beacon Input Processing and Tracking subprograms, respectively. The sector target access store and the sector time store are also referred



Radar Report Store, RRS1T



Radar Report Format

Figure 3-28. Radar Report Store

3.3.4.2.6.3 (continued)

to by the tracking subprogram. Details of these five tables may be found in 3.3.4.2.14, System Data Base, but a brief description of each is given below. The range-ordered beacon report table is used only by beacon/radar correlation and is fully described here. Relevant program parameters are also defined (table 3-7).

1) Beacon Report Store (figure 3-29) is an NREP1Q - word (SP), circularly stored table, containing the 2-word beacon reports declared by Beacon Input Processing. The data available for processing on a given cycle is between INBRO (UHW) and AREA (LHW) -1, which are indices to the first word of the first report and the second word of the last report, respectively.

2) Beacon Report Store - Range Ordered (figure 3-29) is an NREP1Q - word (SP), non-circular table, containing the beacon reports for the current processing cycle. The reports are stored at the beginning of the table in order of increasing range. The processing limit is given as the total number of report words to process (minus one) in INBRO (LHW).

3) Radar Report Store - Range Ordered (figure 3-28) is an RRPTQ - word (SP), circular table, containing the radar reports for a given processing cycle. Storage and retrieval of reports is effected using push-pull instructions.

4) Target Report Store (figure 3-30) is a TRSTQ - word (SP) circular table containing all reports (beacon only, radar only and merged radar-beacon) for tracking (two words per report). The index to the available storage location is given in AREAT (LHW).

5) Sector Target Access Store (figure 3-31) is a 32-word table containing information to access the target report store on a sector (11 1/4^{o}) basis. The index to the first report in sector R is contained in the LHW of Word R (R=0,...,31).

6) Sector Time Store is a 32-word table containing the times (real time clock) at which processing of each of the sectors last began. (Figure 3-31).

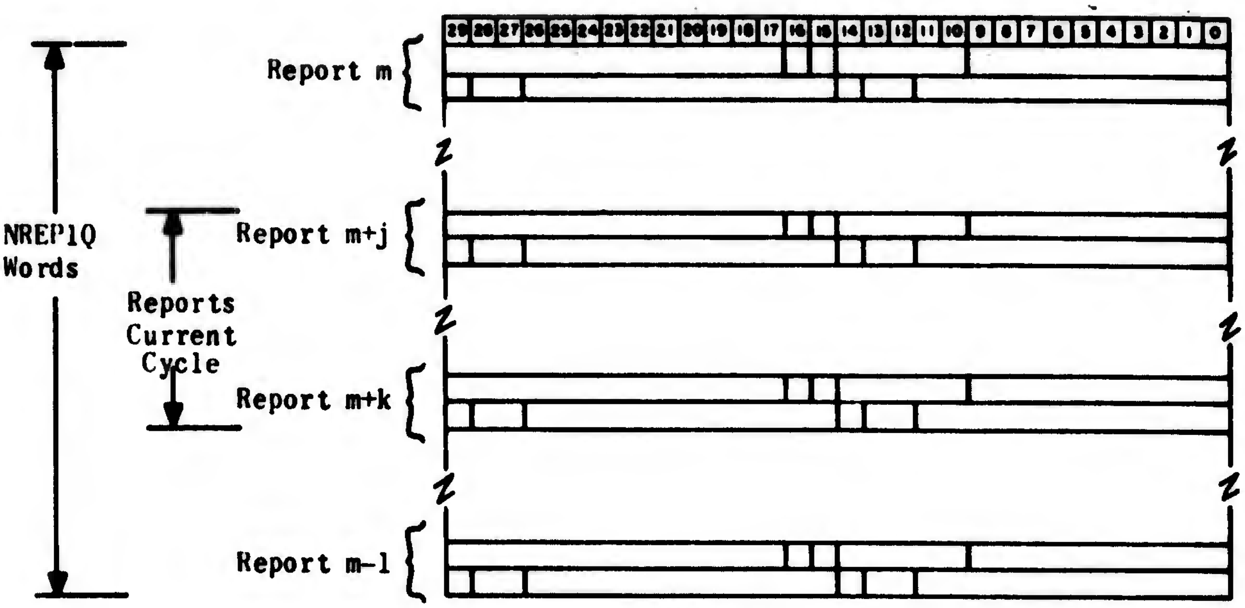
TABLE 3-7. BEACON RADAR CORRELATION PARAMETERS

Mnemonic	Function	Value
NREP1Q	Length of Beacon Report Stores	250 (Nominal)
RRPTQ	Length of Radar Report Stores	90 (Nominal)
TRSTQ	Length of Target Report Stores	750 (Nominal)
RHCP	Radar Report Hold Count	0-3
MRNGP	Maximum deviation between ranges of correlated reports	N.M., SC+4 (1/16 nm - nominal)
MAZP	Maximum deviation between azimuth of correlated reports	ACPs, SC+0 (17 ACPs or approx 1.5° - nominal
RXP	Minimum Variance Parameters fcr merged report range	0-1 (.5 - nominal)
AXP	Minimum Variance Parameters for merged report azimuth	0-1 (.635 - nominal)

3.3.4.2.7 Keyboard Input Processing.- The following paragraphs describe the requirements, design, and data base for keyboard input processing.

3.3.4.2.7.1 General Requirements.- Keyboard data shall be input to the ARTS III operational program via a separate input channel for each Data Entry Display System (DEDS). The input data from each DEDS shall consist of one Type I word (display console settings: range scale and off-centering) and three Type II words (keyboard data: quick look selection, trackball coordinate changes, and data/function characters). The sections which follow list the detailed processing requirements for the Type I and Type II keyboard input words.

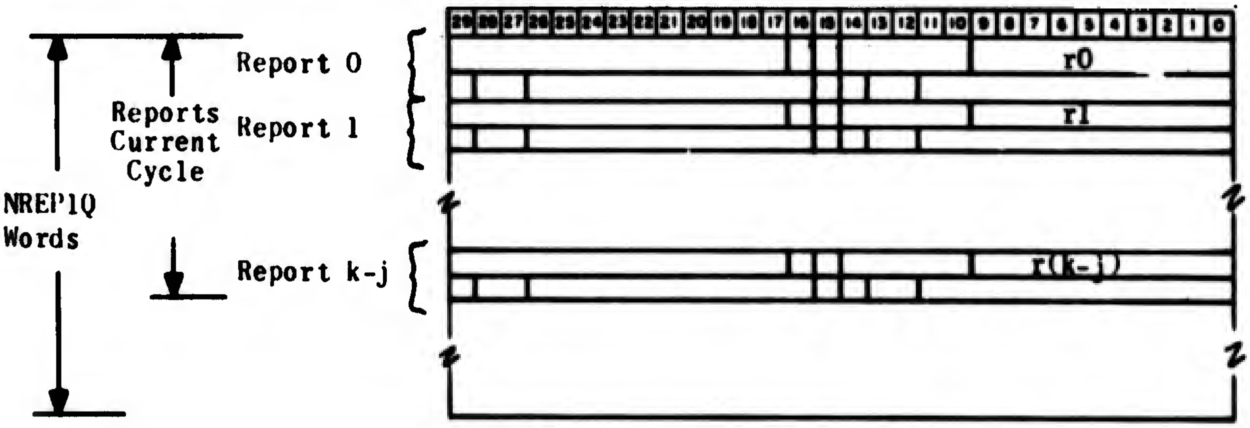
3.3.4.2.7.1.1 Type I Input Data Words.- The Type I data word shall contain the associated display console's range and off-centering data. The automatic offset task, the controlled track single symbol filtering (by X, Y) task, and the uncontrolled track single symbol and LDB (Limited Data Block) filtering (by X, Y) task shall also use range scale and off-centering data.



Beacon Report Store, REPR1T

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Azimuth LSB = 1 ACP													E	R	0					Range LSB = 1/16 nm									
S	Va		3/A Code												W	Vc		Altitude											

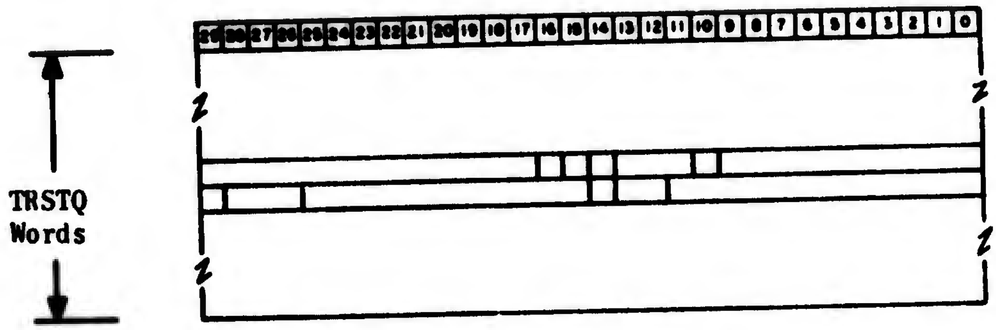
Beacon Report Format



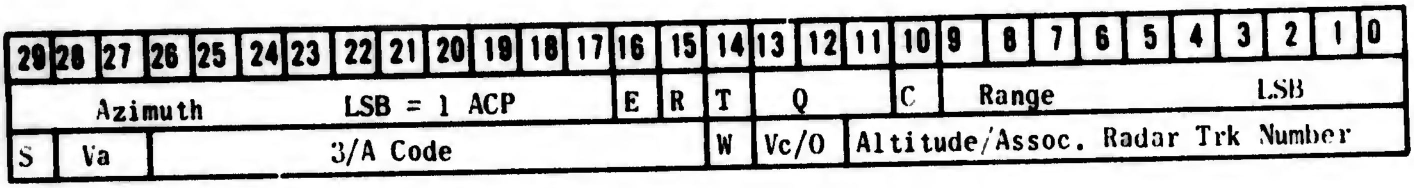
$(r0 \leq r1 \leq . . . \leq r(k-j))$

Beacon Report Store, Range Ordered, BRP1T

Figure 3-29. Beacon Report Stores



Target Report Store, TRS1T



(Beacon-only, if Q=0; Radar-only, if Word 2=0; Merged if T=1)

Target Report Format

Figure 3-30. Target Report Store

	29 28 27 26 25 24 23 22 21 20 19 18 17 16 15	14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	No. of tgts, Sector 0	Index to Sector 0 tgts.
Word 1	No. of tgts, Sector 1	Index to Sector 1 tgts.
Word 31	No. of tgts, Sector 31	Index to Sector 31 tgts

Sector Target Access Store, SASTIT

	29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Time of Sector 0 start, LSB = 1/1024 second
Word 1	Time of Sector 1 start, LSB = 1/1024 second
Word 31	Time of Sector 31 start, LSB = 1/1024 second

Sector Time Store, STIMEIT

Figure 3-31. Target Sector Data

3.3.4.2.7.1.2 Type II Input Data Words.- Each Type II data word shall contain data pertinent to a specific controlling position on a display console (with up to three active controlling positions per console). Each controlling position on a console has a unique data entry keyboard, trackball, and quick look selection switch. The quick look data bits shall be stored for use by the display output task in displaying track format readouts. Only one quick look bit will be set at any one time. Each quick look bit corresponds to a particular controlling position (system parameter).

The trackball coordinate changes represent the coordinate change increments (including sign) accumulated since the last transmission of data from the display console to the computer. This data shall be used to update the controller's trackball symbol coordinates. The trackball coordinates shall also be saved for later use if the trackball function code is received.

The data/function character code in the Type II display input word represents the current state of the controller's keyboard. Since each keyboard status is sensed by the computer approximately every 33 milliseconds, special checks shall be made (for example, to detect the depression of a new keyboard character as opposed to continuously depressing the same key). This detection logic shall be facilitated by using the idle function character which denotes the idle state of a keyboard. The rule is that for successive entries of the same data or function character, the idle character must be received (by the computer) between the successive entries.

As data and function character entries (keyboard depressions) are detected, the appropriate changes shall be made to the controller's preview display. A preview display consisting of message characters and a readout area shall be associated with each keyboard. The readout area shall present error readouts and controller-requested readouts. The message characters shall be presented on the display console as entered. The paragraphs which follow describe all of the data/function characters input from the keyboards.

3.3.4.2.7.1.2.1 Control Function Characters.- Certain of the data/function characters in the Type II input data words shall be interpreted as preview control characters. They include the clear, backspace, enter, trackball enter, idle, and disconnect characters.

3.3.4.2.7.1.2.2 Clear Function Character.- The clear character shall cause the message enterer's preview area to be erased. If the keyboard is in the multiple function mode, the multiple function shall continue to be displayed in the preview area. If the preview area contains an error readout, it is erased.

3.3.4.2.7.1.2.3 Backspace Function Character.- The backspace character shall cause the last displayed character in the preview area to be deleted (so that the next entered character will occupy the location of the deleted character). Any number of characters may be deleted from a preview area by consecutively depressing the backspace key. Thus, single or multiple character corrections may be made to a preview area without the necessity of erasing the whole message and starting over. The backspace character shall be ignored after a trackball; that is, the trackball entry cannot be deleted by a backspace entry.

3.3.4.2.7.1.2.4 Enter Function Character.- Receipt of the enter character shall trigger processing of the preview message as a complete display input message, and shall inhibit further modification of the preview data. Only after the input message has been processed shall additional data/function characters be recognized by the computer complex. After successful processing of the entire preview message is complete, the preview lines shall be cleared (except the multiple function, if entered) and made available for new keyboard entries. If any part of the keyboard message is illegal or illogical, and therefore unacceptable to the computer, message characters shall be retained and a descriptive error indication shall be added to the preview area. No further data/function character data shall be accepted from that keyboard until the clear or disconnect function character is received.

3.3.4.2.7.1.2.5 Trackball Enter Function Character.- The trackball enter function character shall be treated exactly as an enter function character (except for the first trackball received in a reposition operational function, which, if entered immediately after the reposition function, shall be considered as identity data). In addition, the current trackball coordinates shall be considered as part of the preview message to be processed.

The trackball coordinates shall be returned to a home position except when the trackball is used as identity data in a track reposition message or when the multiple function mode is used for track drop and track handoff messages.

3.3.4.2.7.1.2.6 Idle Function Character.- The idle character shall indicate that a keyboard is in the idle state. The idle character shall be transmitted to the computer whenever no keyboard character or function key is being depressed.

3.3.4.2.7.1.2.7 Disconnect Function Character.- The disconnect character shall indicate that no keyboard is connected to the particular terminal indicated. The preview area lines shall be erased. In addition, whenever a disconnect character is received on a previously connected keyboard, an error message (KEY IN FORMAT) shall be printed on the console typewriter.

3.3.4.2.7.1.2.8 Operational Data/Function Characters.- The operational data/function characters 0 through 9, A through Z, period, plus, triangle, virgule, asterisk, space, and F1 through F16 shall be used to designate specific tasks to be performed with respect to initiating and controlling tracks, selecting track readouts, relocating tabular data, making configuration changes, and so forth. All such operational tasks are summarized in table 3-8.

The operational data/function characters shall be displayed in the enterer's preview area in the next available character slots. The data characters shall be displayed exactly as entered (an alphanumeric shall be displayed as that alphanumeric). Data characters entered after a space (field separator) shall be presented on a new line. The operational function characters shall be displayed as special characters as follows:

Operational Function Character	Preview Display
F1	ST _
F2	RP _
F3	SU _
F4	DR _
F5	HD _
F6	DA _
F7	F _
F8	MP _
F9	SV _
F10-F16	IL _

Upon receipt of the first character following the F7 (multifunction) entry, a space shall be inserted in the preview area by the program. In this way, all messages will begin with two characters and a space (this three character field may be preceded by the M for the multiple function mode).

If the letter M is specified as the first preview character of a message, the program shall provide for multiple entries of the message function without requiring re-selection of the function. The automatic re-selection of the entered function shall occur upon completion of processing a previewed message (instead of erasing all message characters, all but the first four characters shall be erased). The automatic re-selection of a function shall be disabled upon receipt of a new function.

3.3.4.2.7.1.2.9 Illegal Characters.- If a character received in a Type II data word is not within the repertoire of the keyboard, the readout "ILL CHAR" shall be displayed in the associated keyboard's preview area. The error readout shall be cleared upon receipt of a clear, enter, or disconnect.

Table 3-8
KEYBOARD INPUT MESSAGES

FUNCTION	MESSAGE FORMAT(1)	PURPOSE
TRACK START	F1, ACIDΔ(OP), ABC or Virgule or Plus (OP), Enter or Slew(3)(4)	Initiate a new track file. (4 unique discrete BC must be entered if no ACID is entered).
	F1, OKΔ(OP), Identity (ADT)(2), Enter	Enable auto-acquisition for an existing track file.
	F1(OP), OKΔ(OP), Identity (ADT)(2), Slew	Activate an existing track file. If the function is entered and ACID is used, the existing track file may be obtained from the FP Temporary Store.
TRACK REPOSITION	F2(OP), OKΔ(OP), Identity (ADS)(2)(6), Slew	Reposition the Full Data Block of an active track file.
TRACK SUSPEND	F3, OKΔ(OP), Identity (ADST)(2), Enter(5)	Change the status of an active or store track file to suspend.
TRACK DROP	F4, OKΔ(OP), Identity (ADST)(2)(6), Enter(5)	Terminate the identified track file.
	F4, ALL, Enter	Terminate all track files (except flight plans) controlled by the enterer or, if the enterer is a paired position, by the enterer's paired controller, provided that the enterer is paired with only one controller.

(Table 3-8 continued on page 3-116)

(Table 3-8 continued from page 3-115)

FUNCTION	MESSAGE FORMAT(1)	PURPOSE
TRACK HANDOFF	F5(OP), OKΔ(OP), ControllerΔ(OP)(7), Identity (ADS)(2)(6)(8), Enter(5)	Track Handoff Initiate. (For handoffs to ARTCC, completion requires successful completion of ARTCC/ARTS III communication.)
	F5(OP), OKΔ(OP), Identity (ADS)(2)(6)(8), Enter(5)	Track Handoff Accept. (For handoffs from ARTCC, completion requires successful completion of ARTCC/ARTS III communication unless controller enters OK - a "forced" accept.)
	F5(OP), Identity (ADS)(2)(6)(8), Enter(5)	Track Handoff Recall. (For handoffs to ARTCC, completion requires successful completion of ARTCC/ARTS III communication.)
	F5, OKΔ, Identity (ADS)(2)(6), Enter(5)	Forced Handoff Recall for track in handoff to ARTCC, i.e., no ARTCC communication.
	F5(OP), *, Identity (ADS)(2)(6)(8), Enter	Disable auto-handoff on the identified track file.
	F5, Enter	Enable/disable auto-handoff on all tracks controlled by the enterer.
FLIGHT DATA ENTRY	F6, ACID, ABCΔ or VirguleΔ or PlusΔ(OP), ControllerΔ or Entry Fix/Exit Fix(9)Δ(OP), ETA/PTD(9)(OP), Enter	Reserve a track file for the entered Flight Plan data.

(Table 3-8 continued on page 3-117)

(Table 3-8 continued from page 3-116)

FUNCTION	MESSAGE FORMAT[1]	PURPOSE
MULTIFUNCTION: BCN	F7(OP), B(OP), Slew	Identify an uncontrolled track for a beacon/speed readout (Limited Data Block).
	F7, B, Code (2 digits; 00-77), Enter	Select/deselect a beacon code.
CFG	F7, C, Controller, Controller(OP), Enter	Consolidate 2nd entered controller (enterer if omitted) with 1st entered controller, i.e., transfer control of all store tracks and flight plans controlled by (includes flight plans which would subsequently by assigned to) 2nd entered controller (or enterer) to 1st entered controller.
	F7, C, Enter	Deconsolidate to entering controller (i.e., return control of all store tracks, flight plans, and subsequent flight plans assigned to another controller as a result of a previous consolidation entry, to enterer).
	F7, C, Controller,*, Status (P or C or M), Controller(OP), Controller(OP), Enter	Modify the status of the 1st entered controller. Statuses are defined: C = controller position; M = maintenance position; P = paired position. If P is entered, the associated controller(s) must be entered.
	F7, C, Numeric (1-5), Enter	Resectorize to a different Entry Fix/Exit Fix configuration (i.e., reassign all store tracks, flight plans, and future flight plans in accordance with the requested configuration).

(Table 3-8 continued on page 3-118)

(table 3-8 continued from page 3-117)

FUNCTION	MESSAGE FORMAT	PURPOSE
CFG (continued)	F7, C, P1 or P2, Enter	Request a console typewriter printout of the current configuration: P1 = Keyboard configuration (statuses); P2 = Entry Fix/Exit Fix configuration.
	F7, C, 0, Enter	Select/inhibit the Interfacility subprogram.
DIS	F7, D, Slew or Enter	Select or erase Full Data Block readout.
	F7, D, Identity (ADT)$^{(2)}$Δ, A or P(OP), Enter	Display track file data in preview area.
EMG	F7, E, Identity (ADST)$^{(2)}$, Enter$^{(5)}$	Inhibit display of EM, RF, HJ, SA in the identified Full Data Block.
FIL	F7, F, Enter	Display current filter limits in enterer's preview area.
	F7, F, Filter limits (6 digits), Enter	Modify display's filter limits.
	F7, F, T or M or N or R, Enter	Select/inhibit the display of single symbols: T = controled SS; M = uncontrolled Mode C SS; N = uncontrolled non-Mode C SS; R = uncontrolled radar only SS.
	F7, F, Range limit (0-15), Enter	Modify the minimum range at which radar only SS will be displayed on enterer's display.
HVY	F7, H, OKΔ(OP), Identity (ADST)$^{(2)}$, Enter$^{(5)}$	Select/inhibit display of the heavy jet indicator in the identified track file.

(Table 3-8 continued on page 3-119)

(Table 3-8 continued from page 3-118)

FUNCTION	MESSAGE FORMAT	PURPOSE
IFD	F7, I, Day (1-7), Time (4 digits)(OP), Enter	Initiate flight plan input from magnetic tape for Day (1 = Sunday, 2 = Monday, etc.).
	F7, I, Enter	Inhibit flight plan input from magnetic tape.
KEN	F7, K, Enter	Enable auto-offset, display of all single symbols, and display of store tabular lists.
LDR	F7, L, Leader direction (1 digit: 1, 2, 3, 4, 6, 7, 8, 9), Identity(ADS)$^{(2)}$, Enter$^{(5)}$	Modify the offset direction of the identified track file.
	F7, L, Leader direction (1 digit: 1, 2, 3, 4, 6, 7, 8, 9), Enter	Modify the initial offset direction of all track files becoming active at this keyboard.
MOD	F7, M, OKΔ(OP), Identity(ADST)$^{(2)}$, Data$^{(9)}$, Enter$^{(5)}$	Modify the identified track file with the entered data.
OFF	F7, O, Enter	Select/inhibit auto-offset for this display.
PRE	F7, P, Slew	Relocate enterer's preview area.
RDM	F7, R, Enter	Select/inhibit memory readout for this display

(Table 3-8 continued on page 3-120)

(Table 3-8 continued from page 3-119)

FUNCTION	MESSAGE FORMAT	PURPOSE
RDM (continued)	F7, R, Address (6 octal digits)Δ, N(0-9) (OP), Enter	Select/erase readout of N consecutive memory addresses (if N is omitted, 1 is assumed; if 0 is entered N is assumed to be 10).
	F7, R, Address (6 octal digits)Δ, Contents (10 octal digits), Enter	Change the contents of the specified memory address (Jump Key 1 on IOP (DP)) must be set.
SYS	F7, $S^{(10)}$, Slew	Relocate the system data.
	F7, $S^{(10)}$, Time (6 digits) or Altimeter Setting (4 digits), Enter	Modify the system time or altimeter setting.
	F7, $S^{(10)}$, Enter	Inhibit ATIS and GSI.
	F7, $S^{(10)}$, ATIS (1 alpha character), Enter	Select/modify ATIS.
	F7, $S^{(10)}$, ATIS (1 alpha character), Asterisk, Enter	Select/modify ATIS and inhibit GSI.
	F7, $S^{(10)}$, Asterisk, GSI (1-13 alphanumeric characters), Enter	Select/modify GSI and inhibit ATIS.
	F7, $S^{(10)}$, (1 alpha character), GSI (1-13 alphanumeric characters), Enter	Select/modify ATIS and GSI.
TAB	F7, T, Slew	Relocate the enterer's store tabular list.
	F7, T, C, Slew	Relocate the enterer's coast/suspend tabular list.

(Table 3-8 continued on page 3- 122)

(Table 3-8 continued from page 3-120)

FUNCTION	MESSAGE FORMAT	PURPOSE
TAB (continued)	F7, T, Enter	Select/inhibit display of the enterer's store tabular list.
	F7, T, Time (4 digits), Enter	Terminate store tracks controlled by the enterer and with ETA/PTD less than the specified time.
	F7, T, Time (4 digits), A, Enter	Terminate all store tracks with ETA/PTD less than time specified.
YSP	F7, Y, Identity (ADS)(2)Δ, Data (1-3 characters), Enter	Enter scratch pad data into the identified Full Data Block.
	F7, Y, Identity (ADS)(2), Enter(5)	Delete scratch pad data from the identified Full Data Block.
ZAB	F7, Z, Enter	Select/inhibit display of assigned beacon codes in enterer's store tabular list.
MAP	F8, Enter	Enable mapping function.
	F8, E, Controller, Enter	Transfer control of the mapping function to the entered controller.
	F8, I, L or H or G, 0 or 1, Enter	Initialize map selected [L = Q2 Select Map (light clutter), H = Q3 Select Map (heavy clutter), G = Ground Clutter Map] to value selected (0 or 1).
	F8, A or B, Enter	Enable description of the selected type of region (type A includes the origin, type B does not). See 3.3.4.2.7.2.26 for details.

(Table 3-8 continued on page 3-122)

(Table 3-8 continued from page 3-121)

FUNCTION	MESSAGE FORMAT	PURPOSE
MAP (continued)	F8, L or H or G, 0 or 1, Enter	Enter described region into map selected [L = Q2 Select Map (light clutter), H = Q3 Select Map (heavy clutter), G = Ground Clutter Map] with selected value (0 or 1).
	F8, T, Enter	Terminate mapping function.
SYN	F9, VEWPS (any or all), Enter	Select display of synthetic video; V = video select, E = enhanced video, W = weather clutter, P = predetection, S = system diagnostic.
	F9, Enter	Inhibit display of synthetic video.

(Table 3-8 continued on page 3-123)

(Table 3-8 continued from page 3-122)

NOTES:

(1) Message Format:

F1-F16 indicates function selection;
commas (not entered) indicate the separation of fields;
Δ represents a space (entered only as a field separator, i.e., not needed after last entered field).

(2) Identity (ADST):

A = Aircraft identity (ACID)
D = Discrete assigned beacon code (discrete ABC)
S = Slew (i.e., trackball)
T = Tabular line identifier (may include controller symbol)

(3) "Enter" may be used only if a discrete ABC or Virgule or Plus is included in the message.

(4) Slew may be used only if the track file is to be given active status; otherwise, "Enter" must be used.

(5) "Enter" will not be used if Slew (S) identity is used.

(6) Upon receipt of Slew (S) identity, the trackball will not be homed if either Multiple Function Mode or F2 (Reposition) is selected.

(7) If the function (F5) is omitted, Controller must also be omitted.

(8) If the function is omitted, then Slew must be entered.

(Table 3-8 continued on page 3-124)

(Table 3-8 continued from page 3-123)

(9) Data is defined:

ACID - 2-7 alphanumerics of which the 1st is alphabetic; not "ALL"; not exactly 2 alphabetics;
ABC - 4 octal digits or virgule or plus;
Controller - 1 alphanumeric;
Entry Fix/Exit Fix - 3 characters * 3 characters, status (OP) or 3 characters *, status (OP) or * 3 characters, status (OP). The status is defined: A = arrival, P = departure, E = overflight
Example: FIX*FIX APT*P
FIX*FIXE *APT
APT* *APTA;
ETA/PTD - 4 numerics followed by E (e.g., 2059E).

(10) Can be legally entered only from a supervisory position.

3.3.4.2.7.1.3 Keyboard Input Word Parity Error.- When the IOP detects a parity error on an input word, the following occurs on the channel which inputs the data:

1) The input buffer is terminated.
2) The input chain is terminated.
3) The input word is stored in memory with bad parity.
4) A channel-oriented interrupt, called an I/O line parity error interrupt, is generated.

The program shall perform the following tasks:

1) Display "PARITY ERR" in line two of each keyboard's preview area (on this scope). This error readout shall be erased upon receipt of the clear or disconnect function character.
2) Printout KEY IN PAR (channel number) on the console typewriter.
3) Abort the keyboard input buffer.
4) Re-initiate this channel's keyboard input chain to input only the remaining words of the four-word input buffer.

3.3.4.2.7.2 Keyboard Input Processing Design.- The keyboard processing functions shall be performed by an external interrupt routine, Keyboard Interrupt Processing (KIP), by an executive subprogram, Keyboard Operational Functions processing (KOF), and by various subroutines as shown in figure 3-32. The KIP routine shall receive control via a channel interrupt on any of the Data Entry and Display Subsystem (DEDS) input channels. The DEDS input chains are initiated by the executive preset program and may remain continuously active (the last chain command of each DEDS input chain may be a jump instruction to the beginning of the chain). Upon detection of an enter or trackball/enter character, the KOF subprogram shall be flagged for processing completed preview messages by executing the appropriate functional processing subroutine (track start, track reposition, multifunction preview, and so forth).

The following sections provide detailed design requirements for the KIP routine and the KOF subprogram.

3.3.4.2.7.2.1 Keyboard Interrupt Processing (KIP).- The KIP routine shall process all DEDS channel interrupts. The main interrupt routine KIP shall be executed from a number of preprocessing interrupt routines (one per DEDS channel). The preprocessing interrupt routines provide KIP with the channel number on which the interrupt was received. The various types of interrupts received on the DEDS channels are:

1) Input chain monitor interrupt
2) Input line parity error interrupt.
3) External interrupt (radar).
4) External interrupt (output parity error).

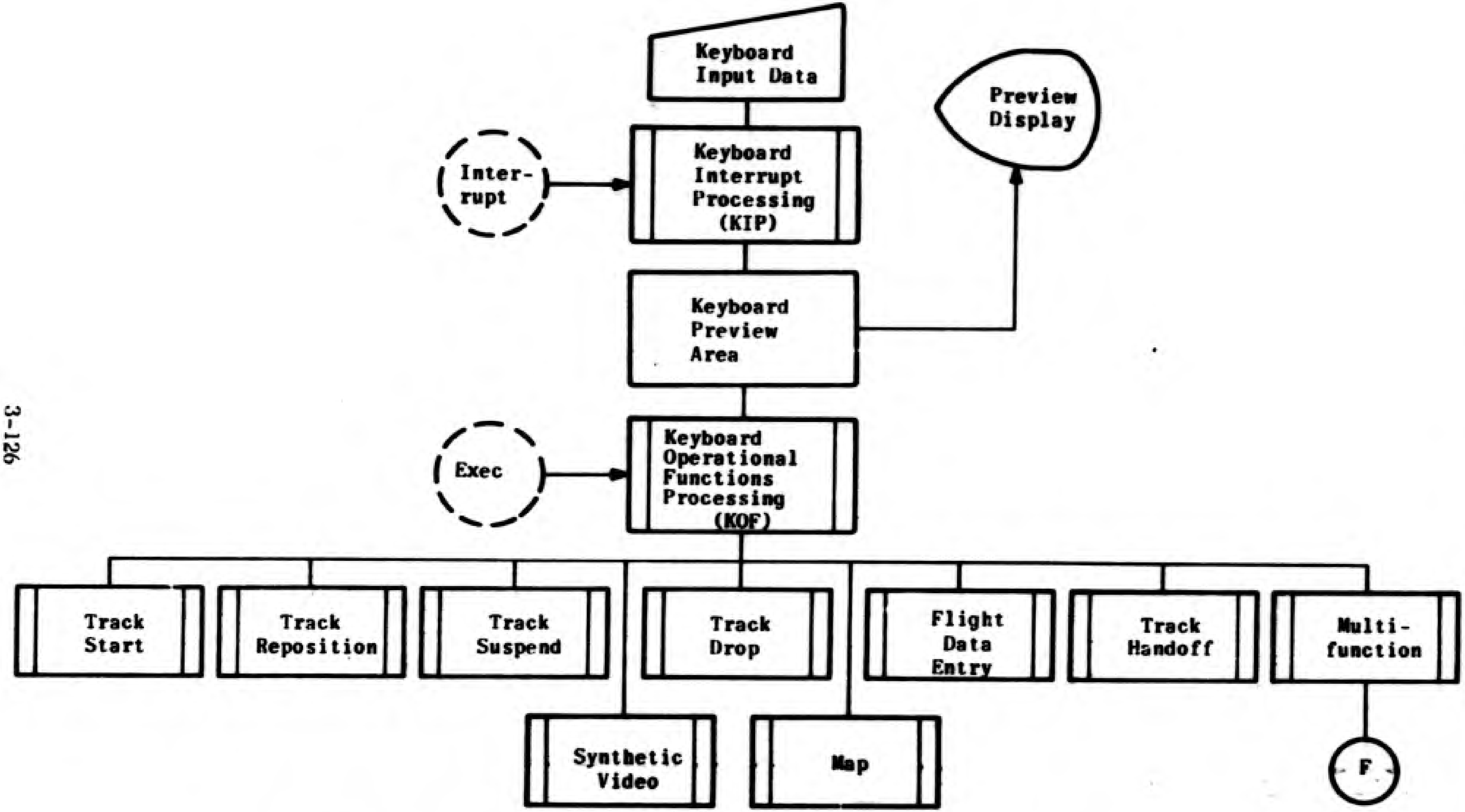


Figure 3-32. Keyboard Input Processing Design Block Diagram (Sheet 1 of 2)

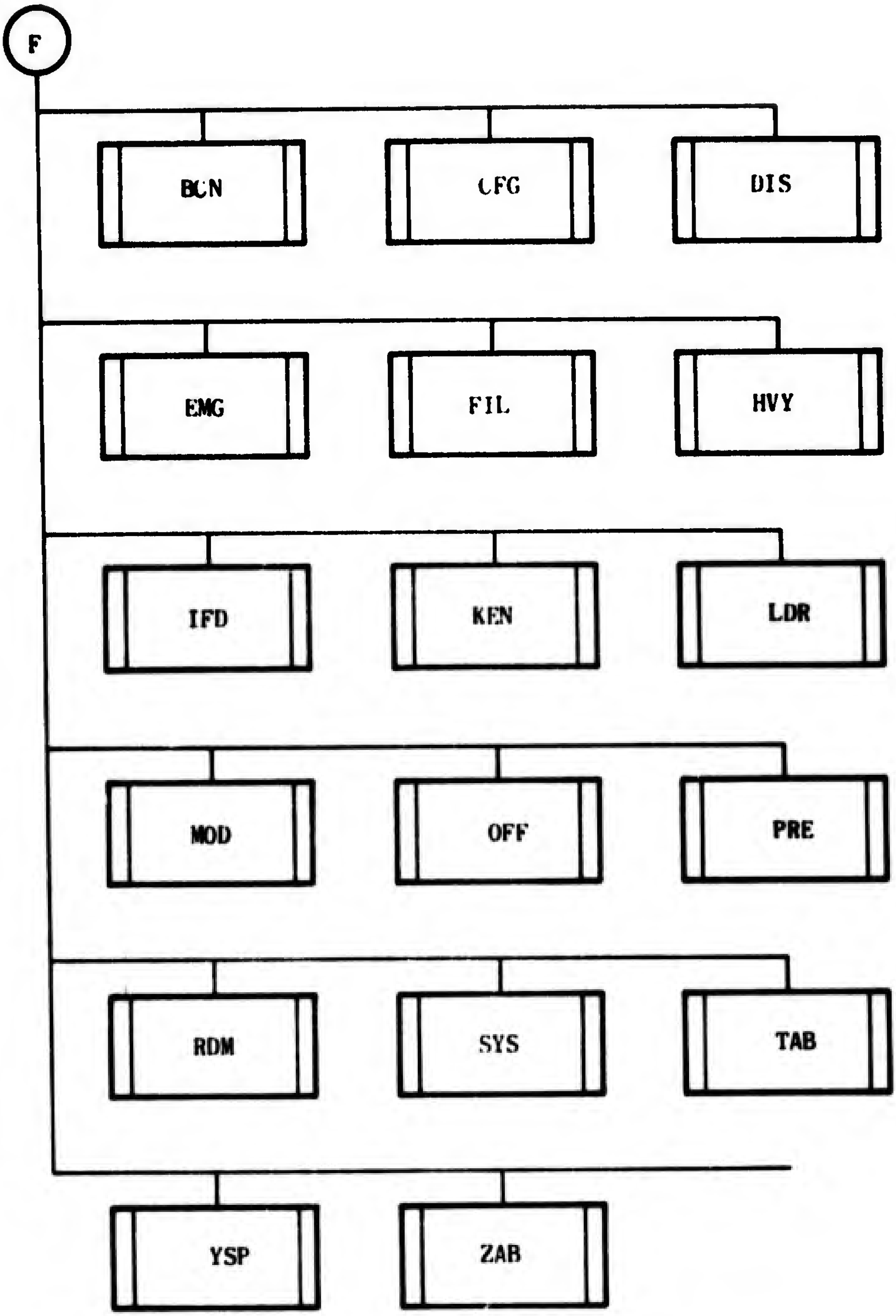


Figure 3-32. Keyboard Input Processing Design Block Diagram (Sheet 2 of 2)

3.3.4.2.7.2.1 (continued)

The interrupt status words shall be pushed into a different push-pull list for each DEDS channel. The KIP routine shall pull the interrupt status words from the appropriate channel's push-pull interrupt status word table. The sections which follow describe the detailed processing requirements of the various types of interrupts.

3.3.4.2.7.2.1.1 Input Chain Monitor Interrupt.-

Upon receipt of an input chain monitor interrupt, the KIP routine shall process the respective DEDS channel's four-word input buffer. Each DEDS input buffer shall consist of one Type I data word and three Type II data words (one Type II word per keyboard). The Type I data word shall contain range and off-centering changes (if any).

The Type II data words shall contain quick look bits, track ball coordinate changes, data/function character codes, and the keyboard identification codes. All keyboard entries shall be reflected in the Type II data words.

The Type I and Type II data words for each display console shall be transmitted to the computer following completion of that display's alphanumeric refresh (approximately every 33 milliseconds). This shall be accomplished by always maintaining an active input chain for each display channel. The DEDS, then, shall transmit the four input words to the computer upon receipt of the end-of-refresh command from the computer.

Since the Type I and Type II display input data words shall be processed in the computer interrupt state, the computer time comsumed by processing this data must be minimized. This shall be accomplished by structuring the logic such that the most frequent type of processing required is accomplished the fastest. For example, the input data words will usually not have changed from the previous cycle. Thus, the logic shall be structured to detect this condition immediately.

The Type II word quick look data shall be stored in the display parameter tables (see 3.3.4.2.14.4.5) for use by the display output processing subprogram. The Type II word track ball change data (if changed) shall be used to update the keyboard's trackball coordinates (see 3.3.4.3.14.4).

The Type II word data/function character (if changed) shall be used to make the appropriate changes to a keyboard's preview message (see 3.3.4.2.14.4.4). The detailed logic of processing the data/function characters is described in 3.3.4.2.7.1.

3.3.4.2.7.2.1.2 Input Line Parity Error Interrupt.- Whenever an input data line parity error interrupt or an external interrupt line parity error interrupt is received, a printout of "KEY IN PAR (channel number)" shall be provided on the console typewriter, and a display of "PARITY ERR" shall be provided in the second line of each keyboard's (on that DEDS channel) preview area.

In addition, for an input data line parity error, the DEDS input buffer shall be re-initiated from where it stopped. It must not be re-initiated from the beginning since this may cause the input data words to be input into the wrong positions in the input buffer (the Type I word must always be input into the first word of the buffer).

3.3.4.2.7.2.1.3 External Interrupt.- The status field of the external interrupt code word shall be interpreted. If the interrupt indicates an output data line parity error, a printout of "DISOUT PAR (channel number)" shall be provided on the console typewriter. All other external interrupts shall be processed as indicated in the following paragraphs.

3.3.4.1.7.2.1.4 Illegal Interrupts.- These DEDS channel interrupts shall be considered illegal: output chain monitor interrupt and external interrupt (except for output data line parity error).

A printout of "KEY ILL INT (channel number)" shall be provided on the console typewriter.

3.3.4.2.7.2.2 Keyboard Operational Functions Processing (KOF).- The keyboard operational functions processing (KOF) task or subprogram shall process all completed preview messages. The preview messages' characters shall be interpreted, the message shall be examined for completeness and for validity, and the required operational processing shall be initiated.

In general, the input messages shall be composed of the following data:

1) Operational function
2) Identity data
3) Associated data
4) Trackball coordinates (slew data).

The operational function shall designate a specific action desired in response to a message entry. Exactly one operational function may be selected for each message.

Certain operational functions (multifunctions) shall be considered "prime". In general, identity data, primarily trackball coordinates, would be the only required controller entry to compose and initiate processing of certain messages. The entry of the specific function character shall not be required.

3.3.4.2.7.2.2 (continued)

The prime functions (multifunctions) are:

1) Track Start - For those controlled tracks that are not actively tracked, the aircraft identity, discrete beacon code, or tabular line identification, together with the slewball entry by the controlling position, would initiate active tracking on the aircraft.
2) Track Reposition - For those controlled tracks that are actively tracked but have lost correct association with their radar/beacon target, the aircraft identification, together with the slewball entry, would position the track data onto the desired target.
3) Track Handoff - For those controlled tracks that are active but not in handoff status, a slewball entry would initiate the handoff of the track to the appropriate controller based on the entering controller. For tracks that are actively tracked and in handoff status, a slewball entry at the receiving controller position would result in the acceptance of the handoff. A slewball entry at the sending controller position would result in the recall of the handoff. An asterisk, together with the slewball entry by the controller position, would disable auto-handoff of the track.
4) BCN (uncontrolled track) - For uncontrolled tracks, a slewball entry would result in a beacon/speed readout (Limited Data Block) on the track.

Identity data refers to the data entered to identify a specific track to the computer. It may consist of any one of the following:

1) AirCraft IDentification (ACID), which shall consist of from two to seven alphanumeric characters, of which the first character is an alphabetic. The following combinations of letters shall be illegal:

   ALL, exactly two characters, both of which are alphabetics. An ACID of blanks may be assigned to a track but may not be used to identify the track. If less than seven ACID characters are entered via a keyboard entry, the program shall automatically assign blank characters to the unused character positions. However, a controller shall not be permitted to enter blank characters in any of the seven character positions of an ACID. This restriction is necessary because of the requirement of a space (blank) character between some data fields in keyboard messages.
2) Line identification (the tabular line identification) shall consist of two characters: the first represents the line identification and the second represents the controller position. If the entering keyboard is the controlling position, the position symbol need not be entered.
3) Discrete beacon code, which shall consist of four octal numerics, except that the last two shall not be zeros.
4) Trackball identification, which shall identify a track as the one which is closest to the entered trackball coordinates and is within ¼ inch (SP) of the entered coordinates.

3.3.4.2.7.2.2 (continued)

The associated data entered in a message may consist of aircraft identification, beacon code, tabular line character, controller character, altimeter setting, beacon altitude limits, time data, entry/exit fix, or other keyboard data characters.

The data characters OK shall be interpreted as meaning that the message enterer need not necessarily be the controller of the track identified in the message. The use of the letters OK shall be used to allow a non-controller of a track to terminate, resume tracking, initiate a hand-off, modify data, or transfer control with respect to that track.

The trackball coordinates associated with a message shall be used to identify a track format (that track which is closest to the entered coordinates) or to specify a position on the display to which tabular data shall be moved. For PRE, TAB, and SYS multi-functions, the trackball shall be entered in display coordinates.

When trackball coordinates associated with a message (e.g., Track Start to activate tracking, or Reposition) are used to position a controlled track onto a particular location, a search of all uncontrolled tracks in CTS shall be made to determine which one is closest to the entered coordinates and is within ¼ inch (SP) of the entered coordinates. If an uncontrolled track is found, its data shall be used to update the controlled track's history data and the uncontrolled track shall be terminated. If no match is found, the controlled track is simply positioned at the entered coordinates and the track's status is set to initial.

The KOF subprogram shall process the keyboard messages by executing a specific subroutine (see figure 3-32) for each operational function. Upon return from the subroutine, KOF shall home the trackball (unless a flag is set saying not to home the trackball) and check for an error condition. If an error condition was detected, KOF shall set the unrecoverable error flag so that KIP will disable all further character entries until a clear or disconnect character is received. The message characters shall not be erased and the preview readout area shall contain an error indication. If no error was detected in the message, the message characters shall be cleared from the preview area (except when in the multiple function mode). If the keyboard is in the multiple function mode, the multiple function shall be displayed in the preview area. The fixed chain list shall be updated to reflect changes in the preview area. Finally, the process preview flag shall be cleared so that the KIP routine may now accept modifications to the preview area.

<u>3.3.4.2.7.2.3 Track Start Operational Function</u>.- This and the following operational function descriptions list the actions which shall be performed in response to the specific entries, the format of the message entries, and the various error conditions which shall be detected.

There are three types of track start messages:

1) Track start new track, which shall be used to initiate a new controlled track file

3.3.4.2.7.2.3 (continued)

2) Track start active, which shall be used to initiate active tracking on an existing controlled track file
3) Track start auto-acquisition, which shall be used to enable auto-acquisition on an existing controlled track file.

The three type of track start message are defined separately in the following three sections.

- Track Start - New Track File

  If an ACID is entered which does not correspond to any file, a new Central Track Store (CTS) file shall be established. If a discrete, unique beacon code is entered, the ACID need not be entered. Blanks shall then be used for the ACID. Beacon code data may be entered as four octal numerics or (if the enterer is not a maintenance position) may be automatically assigned by entering a virgule or a plus (for a discrete code from the Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) list,respectively). Entry of a beacon code, virgule, or plus is optional and, if a beacon code is entered, it may be discrete or nondiscrete. However, if a discrete code is not assigned, trackball data must be entered. A readout of the track file data shall be provided in the entering positions preview area.

- Track Start - Track From Flight Plan Temporary Store

  If an ACID is entered which does not correspond to any CTS file but does correspond to one or more temporary store (TS) file(s), a new CTS file shall be established using the TS data.

- Track Start - Track From Central Track Store

  If identity data (ACID, discrete Assigned Beacon Code (ABC) or tabular line identification) is entered which corresponds to a CTS file, the status of that track file shall be modified. If trackball data was entered, the file shall be placed in active status. If no trackball data was entered, the status shall be adjusted to permit automatic acquisition, that is, from suspend to coast status or from flight plan to store status.

For any of the above track start messages, trackball data may or may not be entered. If entered, a search shall be made of all uncontrolled tracks in the CTS to determine which is closest (within ¼ inch (SP)) to the entered trackball coordinates. If an uncontrolled track is found, its history data shall be transferred to the controlled track and a Full Data Block (FDB) shall replace the uncontrolled track symbology (if any) at the uncontrolled track's reported

3.3.4.2.7.2.3 (continued)

position. If the controlled track has no previously assigned beacon code, the uncontrolled track's beacon code (if one exists) shall be assigned to the controlled track and the uncontrolled track shall be terminated. If no uncontrolled track was found, an FDB shall be displayed at the entered trackball position, the track shall be flagged for initial correlation, and the velocity shall be initialized to zero. In either case, the controlled track shall be placed in active status. If the controlled track was previously in tabular status, the tabular line ID (if any) shall be made available for reassignment.

If no trackball data is entered, the file shall be placed in store status unless the file was previously in suspend status. If identity data corresponds to a flight plan (CTS or TS), the controller shall be determined according to the entry/exit fix data. If unique identity data is entered, the entering position (or the associated position if the entering position is paired) shall be the assigned controller. If the identity data corresponds to more than one CTS file, the non-flight plan file (that is, the store, coast, or suspend) shall be selected. If the identity data corresponds to more than one flight plan in the CTS, the arrival flight plan is selected. If the identity data corresponds to more than one TS file and no CTS files, the TS file with the earliest Estimated Time of Arrival/proposed Time of Departure (ETA/PTD) is selected. If the identity data corresponds to a flight plan, the auto acquire inhibit flag shall be cleared. It shall be set if the flight plan was received from an ARTCC facility.

Format:

Track Start Function, ACID (optional), ABC or virgule or plus (optional), trackball data, or enter (if discrete code assigned)

or

Track Start Function (optional), OK (optional), identity data (ACID, discrete ABC, or the tabular line ID), trackball data, or enter.

The error conditions are those conditions which cause any unacceptable or illegal entry.

Error conditions include the following:

1) A new CTS file must be established and none is available.
2) Extraneous data are entered.
3) A unique identity (no correspondence to existing CTS or TS file) is entered without a discrete code or trackball data.
4) Non unique identity data corresponding to a controlled active or active coast status CTS file are entered.

3.3.4.2.7.2.3 (continued)

5) Δ (delta) is entered without trackball data.
6) An "OK", virgule, or plus is entered by maintenance position.
7) Unique identity data are entered by a position paired with more than one controller.
8) Non unique identity data are entered without "OK" and the enterer is not the controller or paired with the controller.
9) Tabular line identification is used (without controller identifier) by a paired position which is paired with more than one controller.

3.3.4.2.7.2.4 Track Reposition Operational Function.- The track reposition operational function shall be used to move an active track (may be actively coasting) from one location to another. As in the case of Track Start, an attempt is made to associate the entered trackball coordinates with an uncontrolled track and, if an assocation is made, the same action is taken as in Track Start. If no match is found, the entered trackball coordinates shall be stored in the CTS, and, in the common active track buffer, the track shall be considered as an initial track by the tracking function and the velocity shall be initialized to zero.

If the track is in active coast status, the coast flag in the track's CTS file shall be erased and the "CST" shall be deleted from the FDB.

Format:

Track Reposition Function, (optional), OK space (optional), identity data (ACID , discrete beacon code or trackball data), and trackball data

Error conditions include the following:

1) Extraneous data are entered.
2) OK is not entered and the enterer is neither the controller nor paired with the controller.
3) Identity data does not correspond to a track in active track status.
4) No trackball entered.
5) OK is entered by a maintenance position.

3.3.4.2.7.2.5 Suspend Operational Function.- This function shall cause the identified track's aircraft identification to be displayed in the track controller's tabular list, along with the character S. Following the S character a character denoting the type of beacon code assigned to the track (if any) shall be displayed (D for a discrete beacon, N for a non-discrete beacon). A tabular line identifier (if any available) shall be assigned to the track. If an uncontrolled track has a discrete beacon code equal to this track's assigned beacon code, and if the time/distance criteria are met, the track's beacon altitude (if any) shall be displayed following the D in the tabular line of data. In addition, the track's tabular line ID and controller ID shall

3.3.4.2.7.2.5 (continued)

be displayed at the uncontrolled track's position on all consoles. In any case, the suspend function shall cause the erasure of the controlled active track format full data block.

Format:

Track Suspend Function, OK space (optional), and identity data (ACID, discrete ABC, tabular line ID or trackball data), and enter (not used if trackball data is entered)

Error conditions:

1) Extraneous data are entered.
2) OK is not entered and the enterer is neither the controller nor paired with the controller.
3) Identity data does not correspond to a controlled active (may be actively coasting) or store track.
4) The track is in handoff status.
5) Tabular line identification is used (without controller identifier) by a paired position which is paired with more than one controller.
6) OK is entered by a maintenance position.

3.3.4.2.7.2.6 Track Drop Operational Function.- This function shall be used to delete controlled track files. Each identified track file and tabular line identifier (if any) shall be made available for future use. Data related to the track file shall no longer be displayed, and the track file's discrete beacon code (if any) shall become available for reassignment.

Data in the track's Common Active Track Buffer (CATB) shall temporarily remain there to satisfy any active display output chain commands which reference that area. After the display output function has repacked all console output chains, the track's CATB data may be erased.

If the characters ALL are entered, all controlled track files (except flight plans and tracks in handoff status) currently controlled by the message enterer shall be terminated as above. If trackball data is entered, and the keyboard is in the multiple function mode, the trackball shall not be homed.

Format:

Track Drop Function, OK space (optional), and identity data (aircraft identification, discrete beacon code, tabular line identifier, ALL, or trackball data), and enter (not used if trackball data is entered)

Error conditions:

1) Extraneous data are entered.
2) OK is not entered and the enterer is neither the controller nor paired with the controller.
3) Tabular line identifier is used (without controller identifier) by a paired position which is paired with more than one controller.

3.3.4.2.7.2.6 (continued)

4) Identified track in handoff or FP status.
5) Enterer is a paired position (paired with two controllers) and ALL is entered.
6) OK is entered by a maintenance position.
7) Identity data does not correspond to an existing track file.

3.3.4.2.7.2.7 Handoff Initiate/Recall/Accept Operational Function.- This operational function shall initiate, recall, or accept a controlled track handoff. The type of handoff function intended (whether initiate, recall, or accept) shall be deduced by the program based on the current handoff status of the track, a comparison of the track controller with the message enterer, and the controller identification data entered (if any). If the entering keyboard used trackball data and is in the multiple function mode, the trackball shall not be homed.

For each type of handoff function, the message processing may depend on which of the following categories defines the handoff:

1) ARTCC interfacility handoff (a handoff between an ARTS III system and the ARTCC)
2) ARTS III inter-radar handoff (a handoff between radar subsystems within a dual radar ARTS III system)
3) Intra-radar handoff (a handoff within an ARTS III radar subsystem).

Processing for the handoff/initiate function shall cause the track format to be displayed with force and blinking on the receiving controller's scope. If the receiver is an ARTCC controller, an initiate transfer (TI) message shall be sent to the ARTCC. The track shall be placed in handoff status only upon receipt of the acceptance (DA) message from the ARTCC, and track update (TU) messages shall be transmitted to the ARTCC each scan. The handoff receiver's track symbol (a C for ARTCC) shall be displayed in Field 3 of the FDB.

Processing for the handoff/recall function shall result in the elimination of the blinking format on the handoff receiver's scope. For the recall of a track being handed off to the ARTCC, the four second track update messages being sent to the ARTCC shall be discontinued. If a track is in handoff to the ARTCC, an accept transfer message (TA) shall be transferred to the ARTCC, and only upon receipt of an acceptance message from the ARTCC shall the recall be effected. A forced handoff/recall message (controller entry of a recall with "OK") shall be provided to bypass the normal ARTCC communication for a recall when no acceptance message is received.

In processing an handoff/accept function, control of the track file shall be transferred to the handoff receiver and the track symbol shall be changed to

3.3.4.2.7.2.7 (continued)

the new controller's symbol. The FDB format shall be presented on the new controller's display in a normal format with the new controller's initial offset. Where the handoff was initiated by an ARTS III controller, the track shall be presented on the sender's display in a forced and blinking format for three (SP) scans and then automatically dropped. If upon receipt of the handoff/accept message the track is in handoff coast status, the track file shall be retained in the FDB format for three scans (permitting presentation on the sender's display) before transfer to the receiver's tabular list.

For a handoff from the ARTCC, the handoff/accept message shall effect an accept transfer (TA) message to the ARTCC. No further action shall be taken until the acceptance message is received from the ARTCC. At that time the track file shall be changed from handoff status to active status and the format shall be presented in the normal FDB format on the receiver's display. The same procedure shall be followed when the ARTCC handoff is in "Old" status (that is, no track updates are being received for the ARTCC handoff.

To provide for any case where a handoff/accept entry cannot be completed because the acceptance is not received from the ARTCC, a forced handoff/accept shall be provided. This entry shall effect transfer of control without ARTCC communication. The entry may be made by the receiver (or the paired position) by entering "OK" with the normal accept message.

The handoff function shall also enable/disable automatic handoff of tracks controlled by the enterer. A recording printout on the console typewriter shall also be provided in conjunction with this entry.

In addition, the handoff function shall disable automatic handoff of tracks on an individual track basis.

Format:

Handoff Initiate/Recall/Accept Function (optional), OK space (optional), controller space (for handoff initiate only) (optional), identity data (aircraft identification, discrete beacon code, trackball data), and enter (not used if trackball data is entered)

Handoff Function, and enter

Handoff Function (optional), OK space (optional), asterisk, identity data (aircraft identification, discrete beacon code, tabular line ID or trackball data), and enter (not used if trackball data is entered)

Error conditions:

1) Identity data does not correspond to an active track.
2) The handoff function is omitted and trackball data is not entered.

3.3.4.2.7.2.7 (continued)

3) Handoff is initiated to ARTCC controller and interfacility communication is disabled.
4) Handoff is initiated to ARTCC controller, but the FP was not received from ARTCC.
5) Handoff is initiated to ARTCC controller and there is an interfacility message in process on the identified track.
6) A "forced" accept in initiated but the track is not in "OLD" status.
7) OK is entered by maintenance position.
8) OK is not entered and the enterer is neither the controller nor paired with the controller.
9) Handoff is initiated to a paired position or non-existent control position.
10) Handoff is initiated to the controller of the specified track.
11) Extraneous data are entered.

3.3.4.2.7.2.8 Flight Data Entry Operational Function.- This function shall be used to initiate a new track file with the status of flight plan. The entered aircraft identification, beacon code, (if any), controller identification or entry/exit fix (if any), and ETA/PTD (if any) shall be assigned to the track file. If the assigned beacon code is one of the terminal area beacon codes (used for computer assignment following receipt of a virgule or plus character), the code shall be disabled from further assignment.

If entry/exit fix data are entered, the controller shall be determined from the entry/exit fix configuration table. If no controller or entry/exit fix data are entered, the message enterer shall be assigned as the controller.

The entered ETA/PTD data (if any) must be within -15 minutes/+8 hours (SP) of the current time. If no ETA/PTD is entered, the current time shall be used as the ETA/PTD. If the ETA/PTD is within -15 minutes/+ 5 minutes (SP) of the current time, the track file shall be assigned store status.

Finally, the track file data shall be displayed in the preview area in the format described in 3.3.4.2.7.2.19.

Format:

Flight Data Entry Function, ACID (space), ABC or virgule or plus (optional), controller or entry fix * exit fix or entry fix * or * exit fix (optional), and space ETA or PTD "E" (optional), and enter.

Error conditions:

1) Illegal duplicate ACID or no ACID is entered.
2) No controller or entry/exit fix data are entered and the message enterer is a paired position paired with more than one control position.
3) Illegal duplicate beacon code is entered.

3.3.4.2.7.2.8 (continued)

4) Extraneous data are entered.
5) No unused track file is available.
6) No unused terminal area code is available (if virgule or plus entered).
7) Illegal ETA/PTD is entered.
8) Illegal entry/exit fix data are entered.

3.3.4.2.7.2.9 BCN Operational Multifunction.- The BCN (uncontrolled track) multifunction entry shall be used to request a beacon/speed readout on a specific uncontrolled track or to select/inhibit display of special symbology on all uncontrolled tracks reporting a specific two digit code. If trackball coordinates are entered, they shall be used to identify a specific uncontrolled track for a beacon/speed readout which shall be displayed for 3 (SP) scans. If the specified track is correlating on beacon, the readout shall consist of SS (if not inhibited), leader, beacon code, and speed. If the specified track is correlating on radar, the readout shall consist of SS (if not inhibited), leader, and speed. Only one beacon/speed readout may be active at a particular time.

If a two digit beacon code was entered for this message, it shall be known as a selected code request. A maximum of ten codes may be selected per console. The entered beacon code shall be displayed in the enterer's system data display. The selected code shall also be stored for use by the display output subprogram in selecting the corresponding uncontrolled beacon tracks (discrete and non-discrete) for display on the message enterer's console. Symbology for uncontrolled beacon tracks corresponding to a selected code shall be displayed as a □ single symbol (for Mode C targets) or a Δ single symbol (for non-Mode C targets).

If a "selected" beacon code is specified which has already been specified for the entering console, that selected code shall be deleted from the enterer's system data display and the readout request (entering console's selected code request) shall be erased.

Format:

Multifunction, B character, trackball data or selected beacon code (two digits 00 through 75), and enter (not used if trackball data is entered)

Error conditions:

1) Extraneous data are entered.
2) More than ten selected codes are requested.

3.3.4.2.7.2.10 CFG Operational Multifunction.- There are six types of CFG (configuration) messages:

1) CFG consolidation - used to combine control positions
2) CFG deconsolidation - used to decombine control positions (recalling a previous CFG consolidation entry)
3) CFG keyboard status change - used to modify the status of a keyboard
4) CFG resectorization - used to select an alternate table of entry/exit fix controller assignments
5) CFG printout request - used to select a printout of configuration data
6) CFG interfacility select/inhibit - used to select and inhibit the ARTCC interfacility capability.

The six types of CFG entries are defined separately in the following paragraphs. A console typewriter printout shall be provided for each of the CFG entries. It shall reflect the entered change and the entering keyboard; see 3.3.4.2.12.

3.3.4.2.7.2.10.1 CFG Consolidation.- This multifunction entry shall be used to transfer the control of all store tracks and flight plan files from one controller to another controller and, further, to cause assignment of all future flight plans to the new controller. If two controllers' identifications are entered, control of all current store tracks, flight plan files, and future flight plans controlled by the second entered position shall be transferred to the first entered position. If only one controller identification is entered, control of all store tracks and flight plan files controlled by the message enterer shall be transferred to the specified controller. The track symbols of the transferred track files shall be changed to that of the new controller (when the track files become active).

Format:

Multifunction, C character, controller, controller (optional), and enter

Error conditions:

1) One of the specified controllers is a paired or non-existent position.
2) Enterer is a maintenance position.
3) Extraneous data are entered.

3.3.4.2.7.2.10.2 CFG Deconsolidation.- This multifunction entry shall be used to recall a previous CFG consolidation entry. All store tracks and flight plans which normally would have been initiated for the entering controller shall be transferred to the entering controller. In other words, all store tracks and flight plans whose entry/exit fix data corresponds to an entry/exit fix table entry with an associated prime controller equal to the CFG message enterer shall be placed under the control of the message enterer. The previous sentence is applicable only to store tracks and flight plans whose controller was determined by entry/exit fix. Also, all entry/exit fix table entries whose associated prime controllers are equal to the message enterer shall have their associated active controller set to the message enterer. Thus, the entering controller shall now be assigned for all future flight plans and store tracks as specified by the entry/exit fix prime position list.

Format:

Multifunction, C character, and enter

Error conditions:

1) The message enterer is a paired position.
2) Enterer is a maintenance position.
3) Extraneous data are entered.

3.3.4.2.7.2.10.3 CFG Keyboard Status Change.- This multifunction entry shall be used to modify the status of the specified keyboard according to the entered data:

1) M = Maintenance position
2) P = Paired position
3) C = Controller position.

The capabilities and restrictions associated with the keyboard statuses are defined in table 3-9.

The first entered controller in the message shall be the controller whose status is to be changed. The other controllers entered in the message shall be the paired controllers for a paired position entry.

Format:

Multifunction, C character, controller, *, status (M, P, or C), controller (optional), controller (optional), and enter

TABLE 3-9. KEYBOARD (OPERATING POSITION) STATUS

Status	Capability And Restrictions
CONTROLLER	A controller position has the full keyboard entry capability and is defined as a position which may have tracks assigned to it. It cannot modify (or "control") the tracks assigned to another operating position without entering "OK".
PAIRED POSITION	A paired position has the full keyboard entry capability but cannot be assigned tracks. The paired position can modify (control) tracks assigned to other (controller) positions up to two other specified positions. If a paired position is paired with only one controller, the paired position may initiate new tracks, specify tabular tracks with line identification only, and so forth, without specifying the controller. A controller or maintenance position cannot be changed to a paired position if that position either controls tracks, is assigned flight plans, or is eligible to receive flight plans based on the entry/exit fix table. Alltracks must first be transferred to a controller position and the configuration table must be redefined before the status change is made.
MAINTENANCE	The maintenance position has a restricted keyboard entry capability but tracks may be assigned to the maintenance positions. Restrictions: 1) OK cannot be used. 2) Configuration entries (except printout) cannot be entered. 3) Auto-assignment of codes from the discrete beacon code list cannot be done. 4) Flight plan input from magnetic tape cannot be selected or inhibited.

3.3.4.2.7.2.10.3 (continued)

Error conditions:

1) A status of P is specified and no paired controllers are entered.
2) A status of P is specified and the controller whose status is to be changed either controls track files or is eligible for flight plan assignment according to the entry/exit fix table.
3) One or more of the specified controllers are non-existent positions.
4) Extraneous data are entered.
5) A status of P is specified and one of the specified paired controllers is itself a paired position (paired positions may be paired with another paired position).
6) Enterer is a maintenance position.

3.3.4.2.7.2.10.4 CFG Resectorization.- This multifunction entry shall be used to replace the current entry/exit fix configuration table with an alternate table, as specified by the entered numeric. The number of alternate entry/exit fix configuration tables is a system parameter. The controller of each store track and flight plan file shall be redetermined using the new configuration table.

Format:

Multifunction, C character, numeric (1 through 9 (site parameter), and enter

Error conditions:

1) Non-existent configuration is specified.
2) In the specified alternate configuration, at least one of the prime controllers is a paired position.
3) Enterer is not a supervisory position.
4) Enterer is a maintenance position.
5) Extraneous data are entered.

3.3.4.2.7.2.10.5 CFG Printout Request.- This multifunction entry shall be used to request a console typewriter printout of configuration data. If the entered data is "P1", a printout of all keyboards (with associated display channel and keyboard status) shall be provided. If the entered data is "P2", a printout of the current entry/exit fix configuration table is provided. The format of these printouts is described in 3.3.4.2.12.

Format:

Multifunction, C character, printout type (P1 or P2), and enter

3.3.4.2.7.2.10.5 (continued)

Error condition:

1) Extraneous data entered.

3.3.4.2.7.2.10.6 CFG Interfacility Select/Inhibit.- This multifunction entry shall be used to select and inhibit the ARTCC interfacility capability. When inhibited, only test messages are transmitted. All ARTCC handoff keyboard messages shall be illegal. When selected, the interfacility communication shall be allowed in accordance with the prestored parameters defining the interfacility capability, that is, ARTCC tracking capability or flight plan only. A recording printout shall be requested upon receipt of this entry.

Format:

Multifunction, C character, 0, and enter

Error conditions:

1) Enterer is not a supervisory position.
2) Extraneous data entered.
3) Enterer is a maintenance position.

3.3.4.2.7.2.11 DIS Operational Multifunction.- There are two types of DIS (display) messages:

1) DIS FDB - used to select/erase the readout of an active track format
2) DIS track file - used to select display of track file data in the preview area.

The two types of DIS entries are defined separately in the following paragraphs.

3.3.4.2.7.2.11.1 DIS FDB.- This multifunction entry shall be used to select/erase the readout of an active controlled track format. The specified track number of the track shall be stored in the position data tables for use by the display output sub-program in displaying a copy of the FDB of the track at the entering console. If identity data (trackball) is not entered, the enterer's current track format readout shall be erased.

Only one track format request per keyboard shall be allowed. Entry of a second track format readout request shall override the previous request.

Format:

Multifunction, D character, and trackball data or enter

3.3.4.2.7.2.11.1 (continued)

Error conditions:

1) The specified track file is controlled at the entering console.
2) Trackball data do not correspond with an existing track file.

3.3.4.2.7.2.11.2 DIS Track File.- This multifunction entry shall be used to select a display of track file in the enterer's preview area. If only ACID data are entered, the first matching track file encountered (in the ACID search) shall be read out. If ACID and A (arrival) or D (departure) are entered, the matching track file (with respect to ACID) must also have the specified arrival/departure status. The track file data displayed in the preview area shall be the current data in the track file, and this preview shall not be updated if the track file data changes subsequent to the readout request.

If the specified track file is in active, active coast, tabular coast, or suspend status, the following data shall be displayed in the second line of the preview area; ACID, ABC, and controller. If the specified track file is a store track or a flight plan, the following data is displayed: ACID, ABC, controller, entry fix*exit fix (if any), and ETA/PTD.

Format:

Multifunction, D character, identity data (ACID, discrete ABC, or tabular line ID), A or D (optional), and enter

Error conditions:

1) Extraneous data entered.
2) Identity data and A/D status do not correspond to an existing track file.

3.3.4.2.7.2.12 EMG Operational Multifunction.- The EMG (emergency) multifunction entry shall be used to override the display of EM, RF, HJ, or SA in a track format with the ground speed characters of the track. A flag shall be set for the specified track indicating that whenever the firmness of the track is at least as large as a certain value (system parameter), then the ground speed characters shall be displayed, regardless of whether the reported beacon code of the track is a 7600, 7700, 3100, or 1236.

Format:

Multifunction, E character, identity data (ACID, discrete ABC, or trackball data), and enter (not used if trackball data is entered)

3.3.4.2.7.2.12 (continued)

Error conditions:

1) The entered identity data does not correspond to an existing track file.
2) The enterer is not the controller or paired with the controller of the identified track file.
3) Extraneous data are entered.

3.3.4.2.7.2.13 FIL Operational Multifunction.- The FIL (filter) multifunction shall be used to read out or modify the current altitude filter limits of the entering module, or to select/inhibit the display of single symbols for the entering module, or to modify the minimum range at which radar only single symbols shall be displayed. If no data are entered with the message, the current altitude filter limits of the entering module shall be displayed in the preview area of the entering keyboard. If the altitude filter limits are subsequently modified, the modified filter limits will not be reflected in the above mentioned readout.

If the message contains altitude filter limits data (six numerics), the altitude filter limits of the entering console shall be replaced by the entered data. The entered data consists of two altitudes expressed in three numerics each. Each altitude is in hundreds of feet mean sea level. The two altitudes may be entered in either order (either the lower or upper altitude may be specified first). The entered filter limits shall be used to determine which Mode C uncontrolled beacon tracks shall be selected for display.

If the message contains range data, the current minimum range at which radar only (uncontrolled) single symbols are displayed at the entering console shall be replaced by the entered range.

If one of the alphabetic characters, T, M, N or R is entered, the following types of single symbols shall be selected/inhibited for display at the entering console:

T = single symbols of active tracks controlled at other consoles
M = single symbols of uncontrolled Mode C tracks (*)
N = single symbols of uncontrolled non-Mode C tracks (+)
R = single symbols of uncontrolled radar tracks (symbol TBD)

Format:

Multifunction, "F" character, altitude filter limits (six digits; optional), or single symbol data (T or M or N or R; optional), or range limit (optional), and enter.

3.3.4.2.7.2.13 (continued)

Error conditions:

1) Extraneous data entered.

3.3.4.2.7.2.14 Operational Multifunction.- The HVY (heavy jet) multifunction shall select/inhibit display of the heavy jet indicator in an FDB.

Format:

Multifunction "H" character, OK space (optional), identity data (ACID, discrete ABC, tabular line ID, or trackball data), and enter (not used if trackball is entered).

Error conditions:

1) The entered identity data does not correspond to an existing track file.
2) OK is not entered and the enterer is neither the controller nor paired with the controller of the specified track file.
3) Extraneous data are entered.

3.3.4.2.7.2.15 IFD Operational Multifunction.- The IFD (input flight plan data from magnetic tape) multifunction shall be used to select/inhibit the input of flight plan data. The selection entry shall include schedule information (day, entered as code - see table 3-8) and may include time. If time is entered, all flight plans with an earlier ETA/PTD shall be discarded. If time is not entered, current time shall be used. Deselection shall be accomplished using the same multifunction entry without entering day or time.

Format:

Multifunction, I character, day (one octal digit) (optional), time (four digits representing hours and minutes)(optional), and enter.

Error conditions:

1) Extraneous data entered.
2) Illegal day or time is entered.
3) Enterer is a maintenance position.
4) Enterer is not a supervisory position.

3.3.4.2.7.2.16 KEN Operational Multifunction.- The KEN (enable functions) multifunction shall enable the following functions: Auto offset; Display of controlled single symbols; Display of uncontrolled Mode C single symbols; Display of uncontrolled non-Mode C single symbols; Display of uncontrolled radar only single symbols.

3.3.4.2.7.2.16 (continued)

Format:

Multifunction, K character, and enter

Error condtion:

1) Extraneous data are entered.

3.3.4.2.7.2.17 LDR Operational Multifunction.- The LDR (leader direction) multifunction entry shall be used to modify the FDB offset direction of a particular track, or to modify the initial FDB offset direction which is assigned to future active tracks. If identity data are entered, the specified offset direction shall be assigned to the specified track. If no identity data are entered, the specified offset direction shall be assigned to all tracks subsequently going to active status. If the entered offset direction is odd (1, 3, 7, or 9), it shall be taken as an indication of a 45 degree display offset (that is, the formats are displayed at NW, NE, SW, and SE respectively); an even offset (2, 4, 6, or 8) indicates that formats are displayed at N, W, E, or S, respectively. The display offset indication is used by the auto offset program.

Format:

Multifunction, L character, leader direction (1, 2, 3, 4, 6, 7, 8, or 9), identity data (ACID, discrete ABC, or trackball data; optional), and enter (not used if trackball data is entered)

Error conditions:

1) Extraneous data entered.
2) Entered identity data does not correspond to an active track file.
3) The enterer is neither the controller nor paired with the controller of the specified track file.

3.3.4.2.7.2.18 MOD Operational Multifunction.- The MOD (modify) multifunction entry shall be used to modify the aircraft identification, assigned beacon code, controller, entry/exit fix, or ETA/PTD of a track file. The data entered in the message shall define the type of data to be modified for the track file.

For an aircraft identification or beacon code modification, the entered data (if unique) shall be used in place of the previous data assigned to the specified track file. If more than one other track file has the same ACID as that entered, DUP ACID shall be displayed in the preview area with the controller of the active track (if any). If exactly one other track file has the same ACID as that entered, then the two track files (the identified track file and the duplicate file) must have opposite arrival/departure status and, in addition, at least one of the two files must be a flight plan.

3.3.4.2.7.2.18 (continued)

If beacon code data, a virgule, or a plus is entered, and if the previous assigned beacon code is one of the terminal area beacon codes, then that code shall be reenabled (for reassignment following a virgule or plus entry). If a virgule or plus character is entered, the program shall assign a code from the visual flight rules (virgule entered) or instrument flight rules (plus entered) terminal area code list.

For a control identification modification, control of the specified track file shall be transferred to the specified control position. The track symbol shall be changed to the new controller's symbol and the new controller's initial offset shall be used. The active track format (if any) or the tabular line (if any) associated with the track file shall be displayed on the new controller's scope and shall be erased from the previous controller's scope. If the track was in the process of being handed off, the handoff shall be automatically recalled.

For an entry/exit fix modification, the identified track file must be either a flight plan or a store track. The controller shall be re-determined from the entry/exit fix configuration table. For a store track, the new controller's entry/exit fix and arrival departure status shall be saved and the store track tabular line shall be moved to the new controller's tabular list.

For an ETA/PTD modification, the identified track file must be in flight plan or store status. The entered ETA/PTD must be within -15 minutes/+ 8 hours (SP) of the current time. If the entered ETA/PTD is within -15 minutes/+5 minutes (SP) of the current time, the track file's status shall be made that of store track (if not so already). If when attempting to transfer the track file to store status, a duplicate ACID is found, the procedure described in 3.3.4.2.13.2.6 shall apply, except when the FP's duplicate is an active departure. in that case the entry shall be considered illegal and "DUP ACID" shall be displayed. If the entered ETA/PTD is within 5 minutes/+8 hours (SP) of current time, the track file's status shall be made that of flight plan. If the track file was a store track, the tabular line shall be erased and the tabular line identifier shall be made available for system use (shall be de-assigned from the track file).

Finally, the modified track file data shall be displayed in the enterer's preview area in the format described in 3.3.4.2.7.2.11.2.

Format:

Multifunction, M character, OK space (optional), identity data (not entered if trackball used: ACID, discrete ABC, or tabular line ID) space, data (ACID, ABC, controller, entry/exit fix, or ETA/PTD, and enter (not used if trackball data is entered)

Error conditions:

1) The entered identity data does not correspond to an existing track file.

3.3.4.2.7.2.18 (continued)

2) OK is not entered and the enterer is neither the controller nor paired with the controller of the specified track file.
3) The specified track file is in handoff to ARTCC.
4) No data or extraneous data are entered.
5) Entry fix/exit fix data or ETA/PTD data are entered and the specified track file is not in FP or store status.
6) Illegal duplicate ACID is entered.
7) Illegal duplicate discrete beacon code is entered.
8) VFR or IFR beacon code is requested and none is available.
9) Illegal controller data are entered.
10) Illegal entry fix/exit fix data are entered.
11) Illegal ETA/PTD data are entered.

3.3.4.2.7.2.19 OFF Operational Multifunction.- The OFF (auto-offset) multifunction shall be used to select/inhibit the auto-offset function at the entering console. An appropriate flag shall be set to notify the auto-offset subprogram of this entry.

Format:

Multifunction, O character, and enter

Error conditions:

1) Extraneous data are entered.

3.3.4.2.7.2.20 PRE Operational Multifunction.- The PRE (preview) multifunction shall be used to relocate the enterer's preview area. The entered trackball coordinates shall define the new location of enterer's preview area. The preview area location shall be independent of the range scaling and off-centering of the scope.

Format:

Multifunction, P character, trackball data

Error conditions:

1) Extraneous data entered.
2) No trackball entered.

3.3.4.2.7.2.21 RDM Operational Multifunction.- The three types of RDM (read memory) messages are defined separately in the following paragraphs.

1) Memory readout - This multifunction entry shall select/inhibit display of the contents of one or more consecutive memory locations. If a

3.3.4.2.7.2.21 (continued)

number, N, is entered following the specified memory location, then the contents of the following N-1 locations shall also be displayed/deleted. If N is omitted, 1 is assumed. If 0 is entered, N is assumed to be 10.

2) Memory change - This multifunction entry shall change (if skip key 1 is set) the contents of the specified memory location to the entered data. A console typewriter printout shall be provided in conjunction with this entry.
3) Memory readout select/inhibit - This multifunction entry shall select/inhibit display of all of the requested memory locations on the enterer's display.

Format:

Multifunction, R character, address (6 octal digits), space N (one digit 0-9) (optional), and enter

or

Multifunction, R character, address (6 octal digits), space, contents (10 octal digits), and enter

or

Multifunction, R character, and enter.

Error conditions:

1) More than the maximum allowable number of locations are requested.
2) A non-existent location is specified.
3) Extraneous data are entered.

3.3.4.2.7.2.22 SYS Operational Multifunction .- This multifunction shall relocate the system data on the enterer's display, modify the system time, modify the system altimeter setting, or initiate/modify/delete ATIS and GSI data. The SYS Multifunction can only be entered from a supervisory position.

If trackball data are entered, the system data shall be relocated to the specified location.

If a six digit time entry is made, the system time shall be changed to the entered data. Tracks in store status shall not be reconsidered (for transfer to flight plan status) because of a time change.

If a four-digit altimeter setting is entered, the entered data shall replace the current altimeter setting. Future Mode C altitude corrections for barometric pressure shall be made using the new altimeter setting for reported Mode C altitudes which are below the level indicated in the following list (the maximum height to be corrected is a function of the altimeter setting).

3.3.4.2.7.2.22 (continued)

Altimeter Setting	Level Below Which Correction for Altimeter Setting Shall Occur
29.92 and higher	17,700 feet
29.42 to 29.91	18,200
28.92 to 29.41	18,700
28.42 to 28.91	19,200
27.92 to 28.41	19,700
27.42 to 27.91	20,200

For a time or altimeter setting change, the new data shall be reflected in the system data display of all scopes. Also, the new data shall be printed on the console typewriter along with the entering position identification.

If no data are entered, display of ATIS and GSI shall be inhibited.

If one alpha character is entered, display of ATIS shall be selected/modified.

If one alpha character and an asterisk are entered, display of ATIS shall be selected/modified and display of GSI shall be inhibited.

If an asterisk and 1-13 alphanumeric characters are entered, display of GSI shall be selected/modified and display of ATIS shall be inhibited.

If one alpha character and 1-13 alphanumeric characters are entered, display of ATIS and GSI shall be selected/modified.

Format:

Multifunction, S character, time (6 digits) or altimeter setting (4 digits) or trackball data, and enter (not used if trackball data is entered)

or

Multifunction, S character, ATIS (1 alpha character) (optional), asterisk (optional), and enter

or

Multifunction, S character, asterisk, GSI (1-13 alphanumeric characters), and enter

or

Multifunction, S character, ATIS (1 alpha character), GSI (1-13 alphanumeric characters), and enter

3.3.4.2.7.2.22 (continued)

Error conditions:

1) Entered system time is not in the range 000000 to 235959 inclusive.
2) Entered system altimeter setting is not in the range 2700 to 3200 inclusive.
3) Enterer is not a supervisory position.
4) Extraneous data are entered.

3.3.4.2.7.2.23 TAB Operational Multifunction.- This multifunction shall relocate the enterer's store tabular list, relocate the enterer's coast/suspend tabular list, select/inhibit display of the enterer's store tabular list, or flush (terminate) the store tracks from the enterer's list or all store tracks which have an ETA/PTD less than the specified time.

Format:

Multifunction, T character, C (optional), and trackball data

or

Multifunction, T character, Time (4 digits) (optional), A (optional), and enter

Error conditions:

1) Enterer is paired with more than one controller.
2) "A" (all tracks) is specified and enterer is not a supervisory position.
3) Extraneous data are entered.

3.3.4.2.7.2.24 YSP Operational Multifunction.- This multifunction shall enter scratch pad data into/delete scratch pad data from the identified FDB.

Format:

Multifunction, Y character, identity data (ACID, discrete ABC, or trackball data), data (1-3 characters) (optional), and enter (not used if trackball data is entered)

Error conditions:

1) Identity data does not correspond to an active track.
2) Enterer is neither the controller nor paired with the controller of the identified track.
3) Extraneous data are entered.

3.3.4.2.7.2.25 ZAB Operational Multifunction.- This multifunction shall select/inhibit display of the assigned beacon codes in the enterer's store tabular list.

Format:

Multifunction, Z character, and enter

Error conditions:

1) Extraneous data are entered.

3.3.4.2.7.2.26 Area Mapping Operational Function.- Through entries made at any one display console keyboard, an operator can establish and/or modify in any 2 nm by 32 ACP zone the two quantizer slelect maps and the ground clutter map. The actions required of the operator to exercise these options have been minimized while retaining considerable capability to define complex regions.

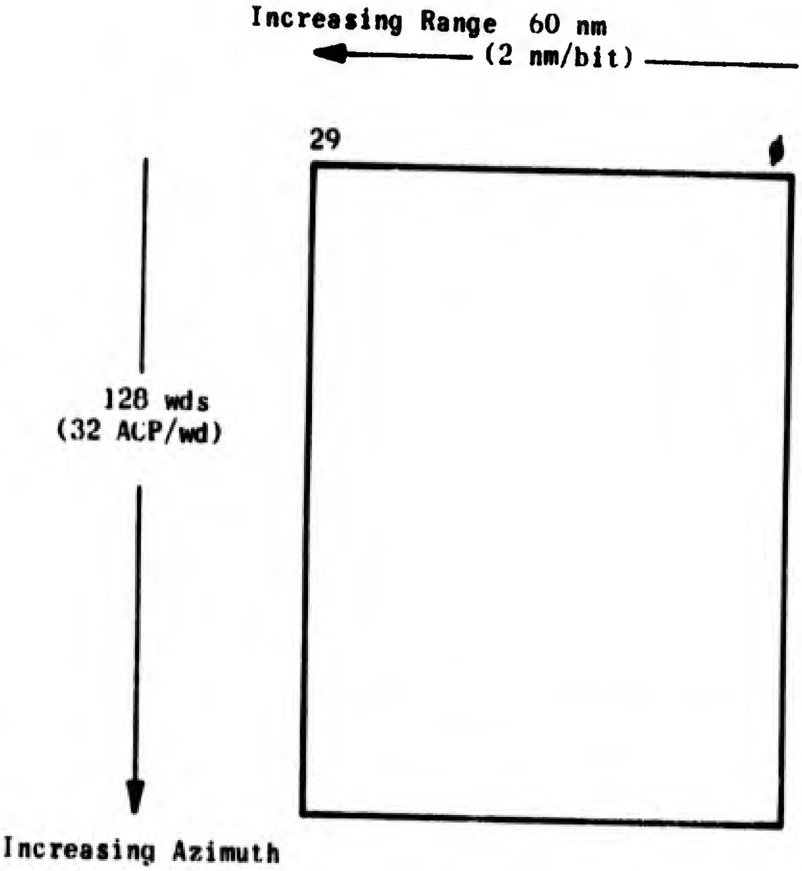
It must be emphasized that the mapping function is not an operational but a maintenance function. It is designed to be employed at a maintenance console. The mapping function in no way affects the raw video which the controllers see on the displays. It only determines which quantizer within the RDAS is used for radar video processing.

The selection shall be performed via a two-stage process. During the first stage, the operator indicates the region in which a change is desired by tracing out this region on the Planned Position Indicator (PPI) using the trackball. During the second stage, the operator indicates which map he desires changed in the area which he has mapped out.

The Q2 select map shall contain data indicating where the normal quantizer Q2 has been selected. The Q3 select map shall contain data indicating where the MTI quantizer Q3 has been selected. The ground clutter map shall be a manually entered map enclosing ground clutter.

The mapping functions shall be accomplished through the use of tabular maps which are stored in the computer (figure 3-33). The Intermediate Area Map (IAM) shall hold data which indicates which zones contain the region which the operator has entered by the use of a trackball and keyboard. This map shall consist of 128 words. Each word represents thirty 2 nm by 32 ACP zones in a 32 ACP sector of the surveillance area. Each bit within a word shall represent one of the 30 zones within the sector represented by the word containing the bit.

The operator's objective during the first stage mapping process will be to identify a region in which a change is desired. Two types of simple regions are defined as Type A (includes the sweep center) and type B (does not include the sweep center).



Design for Intermediate Area Map (IAM), Q2 Select Map, Q3 Select Map, and Ground Clutter Map

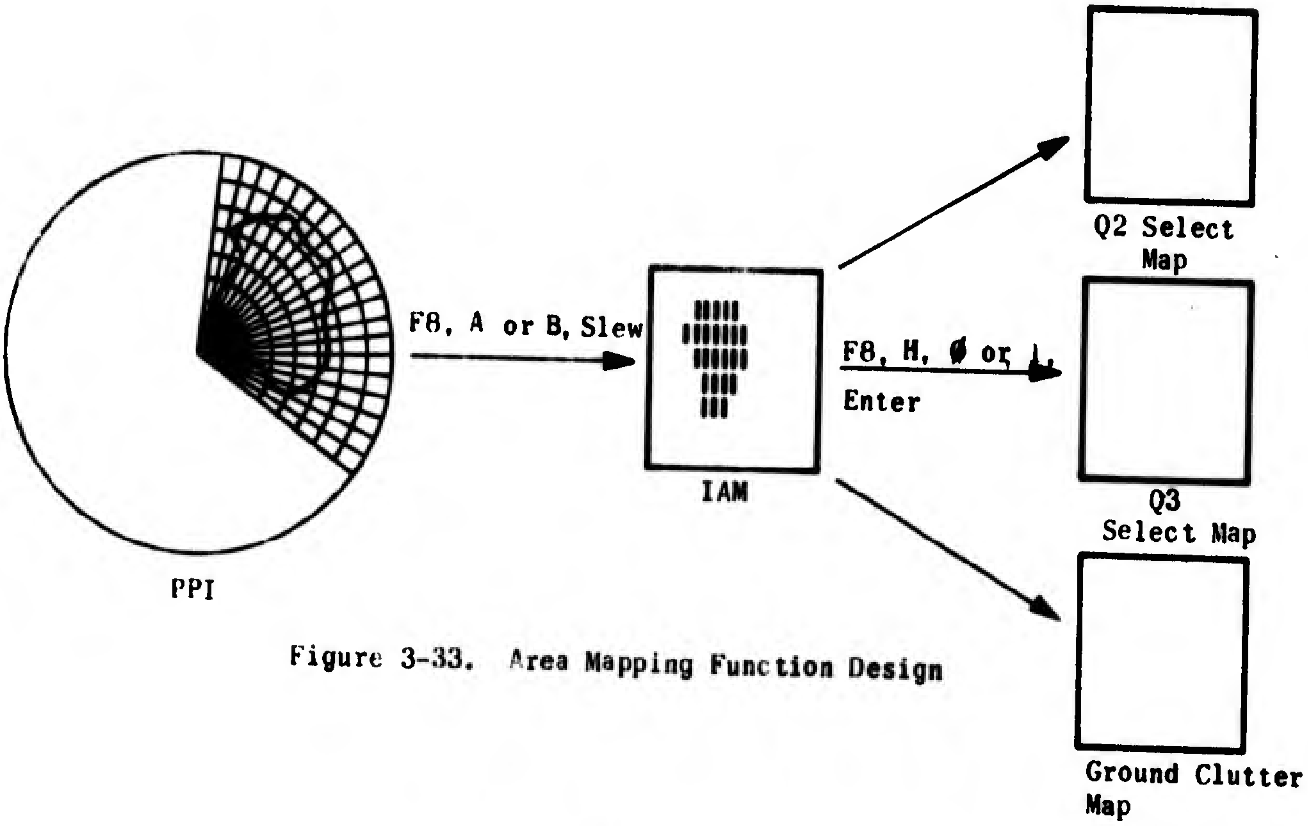


Figure 3-33. Area Mapping Function Design

3.3.4.2.7.2.26 (continued)

The granularity of each region shall be 32 ACPs by 2 miles. A granule shall be denoted by R(r, Θ), and includes the region between Θ and Θ+32 ACPs and between range r and r+2 miles. To every point in R(r, Θ) there shall be associated a pair of non-negative integers, (n,m) which correspond to bit 2^n of word m in table IAM (n = 0, 1 ..., 29; m = 0, 1 ...., 127). Specifically (n,m) shall be defined as a function of the rectangular (x,y) coordinates corresponding to an arbitrary point in R (r, Θ):

$$(n,m) = (\min \{[\sqrt{x^2 + y^2})/2] ,29 \} , (64/ \pi)\tan^{-1}(y/x)),$$

where

$[X]$ = the greatest integer less than or equal to X.

The steps required to map a portion of the total region shall be as follows:

<u>Step 1</u>. If the map is to be a Type A region, home the trackball. If the map is to be a Type B, then slew the trackball until the trackball symbol (balltab) is positioned over a point on the map contour.

<u>Step 2</u>. Select the mapping function by depressing "F8, Enter". The program will respond by:

a) Clearing IAM.
b) Obtaining the current trackball coordinates and setting bit 2^n of word IAM+m, where (n,m) is computed according to the algorithm described above.
c) Establishing table VST as part of the chained output display of the originating console. The format is given in figure 3-34. The buffer is a fixed length data block which is initially set to display space codes at sweep center. The first Type B output data word is set to display the enterer's trackball symbol at the initial coordinates.
d) Flags shall be set to assure exclusive use of this operational function from the enterer's keyboard until terminated by an encounter of any one of the following conditions:

    1) The map is entered into permanent storage by the options described in step 4.
    2) Some operational function, other than F8, is entered from the same keyboard that has exclusive use.
    3) 5 minutes (SP) have elapsed since acquisition of exclusive use.
    4) The option is formally terminated by executing an

        "F8,T,Enter", or an
        "F8,E,Controller, Enter"

    sequence from the originator's keyboard.

Word 1	A Word		
2	y(o)	x(o)	S
3	y(n-3)	x(n-3)	S
4	y(n-2)	x(n-2)	S
5	y(n-1)	x(n-1)	S
6	y(n)	x(n)	S
7	y(n-m+2)	x(n-m+2)	S
	y(n-m+3)	x9n-m+3)	S
• • • •			
m-2	y(n-7)	x(n-7)	S
m-1	y(n-6)	x(n-6)	S
m	y(n-5)	x(n-5)	S
m+1	y(n-4)	x(n-4)	S

Initial trackball position

Last recorded position of trackball

B-Words (Total m)

(S is code for controller's trackball symbol; initially it represents a space code).

Figure 3-34. Video Select History Table, HVST

3.3.4.2.7.2.26 (continued)

Step 3. Using the trackball, trace, slowly and smoothly, the contour of the desired region. An indication of a trackball change at the computer input shall result in the computation of an (n,m) pair corresponding to the new trackball (x,y) coordinates. If (n,m) does not differ from the last recorded pair, nothing more is done. If there is a difference, however, the program shall respond with the following actions:

a) Table VST shall be updated in a circular fashion to point the controller's trackball symbol at the (x,y) position that gave rise to the change in (n,m). This will provide the operator with an indication of the most recent portion of the map contour traced. A sample "history" display is illustrated in figure 3-35.
b) Bit 2^n of word IAM+m shall be set to 1.

Step 4 (optional). If the operator desires, the selected map may be (re)initialized to the "0" state (all bits set to 0) or to the "1" state (all bits set to 1). The format for the (re)initialization entry is as follows:

"F8,I, L or H or G, 0 or 1, Enter".

The program shall respond by (re)initializing the map selected (L = Q2 Select Map (light clutter), H = Q3 Select Map (heavy clutter), G = Ground Clutter Map to the selected value (0 or 1).

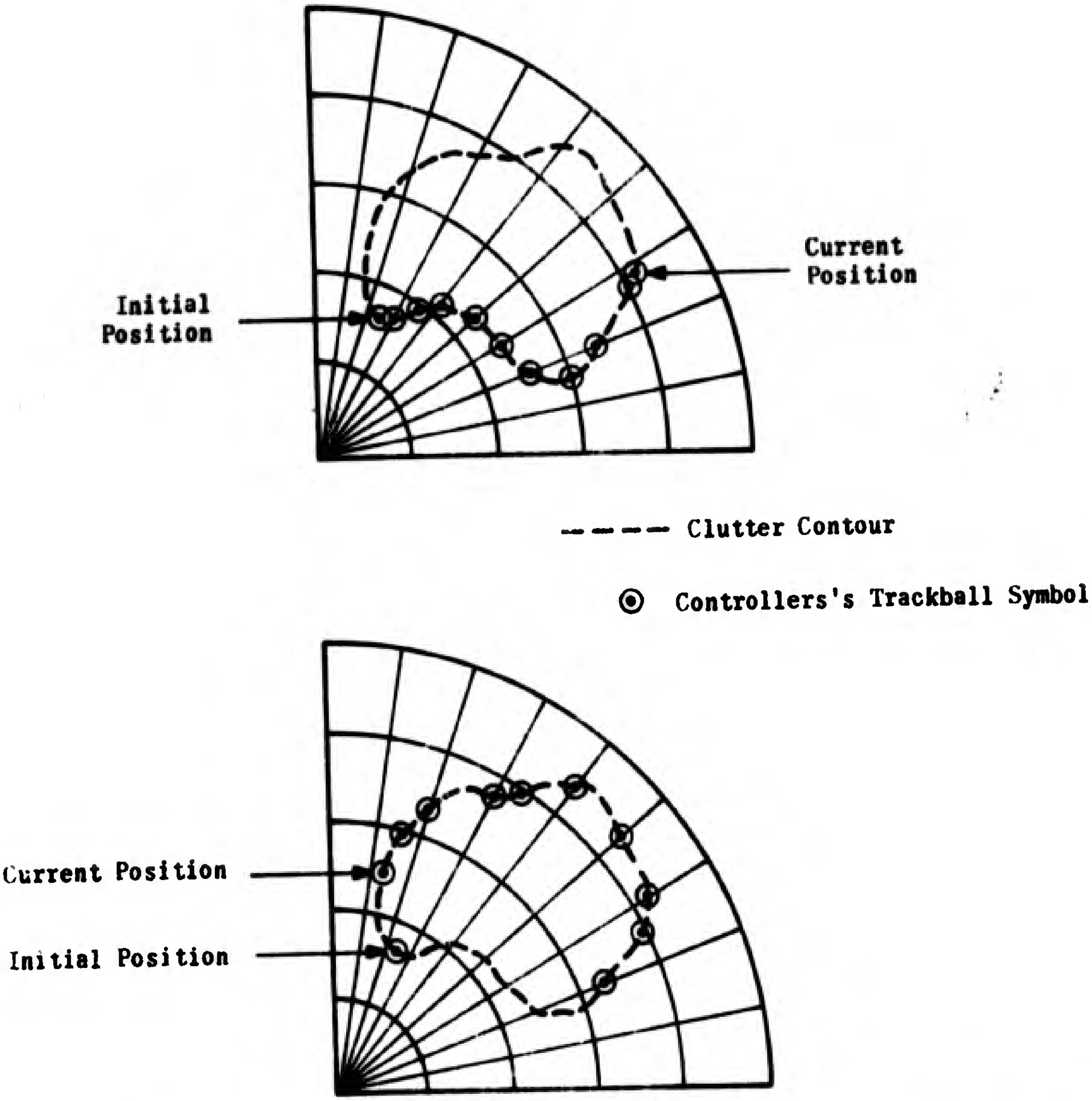
Step 5. Enter map. This entry determines which map will be modified by the described region. The format for the map entry is as follows:

"F8, L or H or G, 0 or 1, Enter".

The program shall respond by modifying the described region in the map selected (L = Q2 Select Map (light clutter), H = Q3 Select Map (heavy clutter), G = Ground Clutter Map with the selected value (0 or 1).

The permanent map can be altered only if the above sequence of steps is followed. Proper modification can be monitored if the display of the video select region is in effect (see description for F9, Display Synthetic Video).

The data entered is summarized in table 3-8.



Upper figure shows map history display near the beginning of the process; the lower shows it near the end. Contour tracing is in a counter-clockwise direction, and the nine most recent points, in addition to the initial and current positions, are displayed. Each annular sector represents 32 ACPs x 2 nm.

Figure 3-35. Clutter Mapping History Display (Example)

3.3.4.2.7.2.26 (continued)

Error conditions:

1) Extraneous data are entered.
2) Illegal characters (codes) are entered.
3) Selected peripheral device is unavailable.
4) I/O errors.
5) Enterer is not a maintenance position.
6) Attempting to interrupt exclusive use of F8 function.

3.3.4.2.7.2.27 Synthetic Video Select Operational Function.- A synthetic video select message shall be initiated by entering the F9 operational function together with associated data characters that define the options which are available. This function shall be restricted to maintenance consoles.

Basically, the operator, hereinafter referred to as the requestor, shall have the option to display for a limited period of time as many as five (SP) types of synthetic video. These are defined as:

Type 1	Video select (MTI/Normal)
Type 2	Enhanced Video
Type 3	System Diagnostic
Type 4	Predetection
Type 5	Weather clutter (Contours 0 and 1)

The system shall be initially set in a nominal state to display the synthetic video identified by the DVS field of the configuration command word and will revert to it upon a legal release by the initiator of the current display, hereinafter referred to as the originator. A legally requested display shall be maintained in the state last requested until legally released. Operator action to exercise the various options and program responses are described in the following paragraphs.

To select the display of synthetic video types, depress the keys indicated:

"F9,xxxxx, ENTER",

where

xxxxx = Between 1 and 5 individual selections from the set of characters (V, E, W, P, S), duplications allowed.

The message "SV xxxxx" shall be displayed in the requestor's preview area. To release the current synthetic video display, depress the keys indicated:

"F9, ENTER".

3.3.4.2.7.2.27 (continued)

Error conditions:

1) Interruption of exclusive use.
2) Extraneous data entered.
3) Illegal display type indicator.
4) Enterer is not a maintenance position.

3.3.4.2.7.3 Keyboard Input Processing Data Base.- The formats of the Type I and Type II data words received from the DEDS are described in figure 3-36.

The following descriptions define the uses of some of the data fields and bits in the controller tables by the KIP and KOF programs.

3.3.4.2.7.3.1 Process Preview Flag: (Bit PP).- The process preview flag shall be set by the KIP routine as a signal to the KOF subprogram that the corresponding preview area of the keyboard should be processed. The process preview flag shall be cleared by the KOF subprogram upon completion of processing the preview area. No additional data/function characters shall be recognized from a keyboard while its PP bit is set.

3.3.4.2.7.3.2 Unrecoverable Error Flag: (Bit UE).- The unrecoverable error flag shall be set for a keyboard whenever an illogical or illegal message is detected by the KOF subprogram. The setting of this flag shall inhibit the recognition of further data/function characters from the corresponding keyboard until a clear or disconnect character is received. When the KIP routine detects the clear or disconnect character, the unrecoverable error flag shall be cleared.

3.3.4.2.7.3.3 Error Flag: (Bit E).- The error flag shall be set by the KIP routine whenever any of the following conditions occurs:

1) Parity error on input data
2) Illegal data/function character entered (not in repertoire)
3) Preview area overflow (too many characters entered).

3.3.4.2.7.3.4 Keyboard System Parameters.- Table 3-10 contains a summary of the keyboard system parameters (SPs) together with their labels and ranges of values.

	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Type I Word	Spare					R	Range					OC	Off Center Y								Off Center X							Spare		0
Type II Word	Quick Look					T	Trackball Y Change							Trackball X Change							C/F	Character or Function						K		1

R = 1: Range did change.

OC = 1: Off center did change.

T = 1: Trackball did change.

C/F = 0: Character.
= 1: Function.

K = Keyboard Number.

Figure 3-36. Display/Keyboard Input Data Words

TABLE 3-10. KEYBOARD INPUT SYSTEM PARAMETERS

ITEM	DESCRIPTION	VALUE RANGE
ASQ	Time, in minutes, prior to ETA when an Arrival or Overflight FP is transferred to store status	0 - 500
BCNTSQ	Number of scans that an identified uncontrolled track readout is displayed	0 - 10
CFIRMQ	Firmness above which speed is displayed by the correction routine	0 - 39
CNTDNQ	Number of scans an FDB in handoff status is presented (forced and blinking) on the sender's console after acceptance by the receiving console	1-5
DSQ	Time, in minutes, prior to PTD when a Departure FP is transferred to store status	0 - 500
MAPQ	Time, in minutes, allowed exclusive use of the mapping function	0 - 10
SYNVDQ	The number of types of synthetic video which may be displayed	1 - 5
TBBSQ	The maximum distance, in inches, from trackball coordinates considered for track identification	1/16 - 1/2
LLKQ	Time, in minutes, prior to current time beyond which ETA/PTD is considered illegal	0 - 500
ULKQ	Time, in minutes, in advance of current time beyond which ETA/PTD is considered illegal	0 - 500
FLUSQ	Time, in minutes, subtracted from entered time to form the lower limit beyond which store tracks, as a result of a tabular flush entry, will not be terminated	0 - 1440

3.3.4.2.8. Interfacility Input/Output Processing.-

3.3.4.2.8.1 Interfacility-General Requirements.- The purpose of the interfacility program is to 1) process all data received from ARTCC, and 2) pack and send necessary messages to ARTCC.

3.3.4.2.8.1.1 Interfacility Message Formats.- The format of input and output messages is so similar that they will be described with differences noted where they occur. Data characters will be given in EBCDIC code (Extended Binary Coded Decimal Interchange Code) unless otherwise specified. Each message consists of several fields which are separated by an EBCDIC space (except the LRC field). Each field consists of 8 bit bytes where each byte is an EBCDIC character unless otherwise specified. Table 3-11 shows the fields, in the order they appear in the message, for each message type. Table 3-12 defines each field.

3.3.4.2.8.1.2 Flight Plan Message (FP).- Flight plan messages are transmitted from ARTCC to ARTS III for the purpose of reserving a track file and recording certain data for an aircraft that will enter the terminal area at some future time. If the coordination time does not fall within the interval -15 minutes/+8 hours (SP) of current time, the message will be discarded and acknowledged with a DR. If the coordination time falls within the interval -15 minutes/+5 minutes (SP) of current time, the track will be placed in store status. A Primary Controller, Active Controller, Radar Subsystem, and Arrival/Departure/Overflight Status are retrieved from the configuration table in accordance with the Entry or Departure Point/Exit Fix or Entry/Destination Fix. The Arrival/Departure/Overflight Status retrieved must agree with that given in the FP message.

If, when attempting to place an FP in store status, a duplicate ACID is found, the procedure described in 3.3.4.2.13.2.6 shall apply. If the FP is to be retained in FP status, a duplicate ACID will be accepted only if the duplicate (only one) is assigned the opposite arrival/departure status. A duplicate beacon code check will not be made until the track file is eligible to enter store status.

If the message passes all validity checks, the following information is stored in CTS: Flight Identification, Beacon Code, Coordination Time, Arrival/Departure/Overflight Status, Entry or Departure Point/Exit Fix or Entry/Destination Fix, Radar Subsystem, Primary and Active Controllers, and Heavy Jet Indicator.

TABLE 3-11. SUMMARY OF ARTCC/ARTS III COMMUNICATION

Message Contents \ Message	Flight Plan	Amendment(2)	Cancellation	Departure	Initiate Transfer	Track Update(3)	Accept Transfer	Acceptance	Retransmit	Rejection	Test Data	Data Test	Beacon Terminate
ARTCC to ARTS III	X	X	X		X	X	X	X	X	X	X	X	
ARTS III to ARTCC				X	X	X	X	X	X	X	X	X	X
Data Field --													
Source ID	X	X	X	X	X	X	X	X	X	XX	X	X	X
LRC	X	X	X	X	X	X	X	X	X	X	X	X	X
Message Type	FP	AM	CX	DM	TI	TU	TA	DA	DX	DR	TR	DT	TB
Output Routing					X	X	X				X		
Flight Identification(1)	A	T	T	E	EorT	EorT	EorT	TorE					E
A/C Data (or Departure Point)	X												
Beacon Code	X												
Coordination Fix	X												
Prefix and Coordination Time	X												
Assigned or Requested Altitude	X												
Route	X												
Referent Msg. Source I.D.								X	X	X		X	
Field Reference Number		X											
Amendment Data		X											
Coordinates & Velocity					X	X							
Remark											X	X	
Progress Report Data				X									
LRC	X	X	X	X	X	X	X	X	X	X	X	X	X
EOM	X	X	X	X	X	X	X	X	X	X	X	X	X

Note: (1) Flight Identification may be ACID (A), TCID (T), or ECID (E).
(2) Field Ref. No. and Amendment Data fields may be repeated up to 5 times.
(3) Identity and Coordinates may be repeated up to 6 times.

TABLE 3-12. INTERFACILITY MESSAGE FIELDS

Source ID: Consists of ten bytes, the first three of which are alphas specifying the sending facility's identification. There will be a unique combination of alphas for each ARTS III site. The next four bytes are GMT, in hours and minutes. The last three bytes are the message number. All ARTS III input and output messages require this field.

LRC: Consists of the LRC prepare character (263_8) followed by the LRC Register. The LRC Register is added by the ICA on output and removed by the ICA on input. The LRC field is not followed by an EBCDIC space. All ARTS III input and output messages require this field.

Message Type: Consists of two bytes which are alphas specifying the message type. The two alphas are defined for each message type in table 3-11. All ARTS III input and output messages require this field.

Output Routing: Consists of three bytes defined as follows: for an ARTS III to ARTCC TI message, three alphas specifying the ARTCC controller to which the handoff is directed; for an ARTS III to ARTCC TR message, three alphas specifying the ARTCC Site ID; for all other messages that require this field, three alphas specifying the ARTS III Site ID. ARTS III output messages that require this field are TI and TR. ARTS III input messages that require this field are TI, TU, TA, and TR.

Flight Identification: May be any of the following:

(1) ECID (Enroute Computer ID): consists of three bytes (numeric, numeric, alphanumeric) specifying the ARTCC internal track number.

(2) TCID (Terminal Computer ID): consists of three bytes, all numerics, specifying the ARTS III internal track number.

(3) ACID (Aircraft ID): consists of from five to ten bytes. The first three bytes specify the ECID (see (1) above) and the remaining bytes specify ACID. The first byte following the ECID must be an alpha and the remaining bytes alphanumeric. However, exactly two alphas or "ALL" are not allowed.

ARTS III output messages that require this field are DM, TI, TU, TA, DA, and TB.

ARTS III input messages that require this field are FP, AM, CX, TI, TU, TA, and DA.

A/C Data or (Departure Point): For a Departure FP, this field consists of three bytes, alphanumerics, specifying the departure airport and one byte, alpha, specifying A/C category (for heavy jet indicator). For an Arrival or Overflight FP, this is a two byte field specifying the number of aircraft in the flight (first byte, numeric) and the A/C category (second byte, alpha). The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

(Table 3-12 continued on page 3-167)

(Table 3-12 continued from page 3-166)

Beacon Code: Consists of four bytes (all octal numerics) specifying a discrete or non-discrete assigned code. The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

Coordination Fix: Consists of three bytes (all alphanumerics) specifying the Entry fix for an Arrival or Overflight FP and Exit fix for a Departure FP. The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

Prefix and Coordination Time: Consists of five bytes (1 alpha followed by 4 numerics). For an Arrival FP, the first byte is an "A" followed by four bytes of GMT specifying ETA in hours and minutes. For an Overflight FP, the first byte is an "E" followed by four bytes of GMT specifying ETA in hours and minutes. For a Departure FP, the first byte is a "P" followed by four bytes of GMT specifying PTD in hours and minutes. The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

Assigned or Requested Altitude: Consists of three bytes (all numerics) specifying assigned or requested altitude in hundreds of feet. The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

Route: Consists of three bytes (all alphanumerics) specifying the destination airport for an Arrival FP, the Exit fix for an Overflight FP. This field is absent for a Departure FP. The only ARTS III input message that requires this field is FP. This field is not required on any ARTS III output messages.

Referent Message Source ID: Consists of ten bytes specifying the Source ID (see item 1 in this table) of the message being acknowledged. ARTS III output messages that require this field are DA, DX, DR, and DT. ARTS III input messages that require this field are DA, DX, DR, and DT.

Field Reference Number: Consists of two bytes (both numerics) specifying the number of the field to be amended. The only ARTS III input message that requires this field is AM. This field is not required on any ARTS III output messages. Acceptable values for this field are:

01	Message Type
02	Flight Identification
03	A/C Data or (Departure Point)
04	Beacon Code
06	Coordination Fix
07	Prefix and Coordination Time
08	Assigned Altitude
09	Requested Altitude
10	Route
11	Remarks
12	Field Reference Number
16	Output Routing
17	Amendment Data
18	Progress Report Data
23	Track Coordinates and Velocity
25	Referent Message Source ID

(Table 3-12 continued on page 3-168)

(Table 3-12 continued from page 3-167)

Amendment Data: The format of this field is consistent with the format of the field to be amended. The only ARTS III input message that requires this field is AM. This field is not required on any ARTS III output messages.

Coordinates and Velocity: Consists of eight bytes (all numerics) as shown below. In dual beacon ARTS III systems, coordinates are transferred relative to one (predefined) radar subsystem.

Bit 7 6 5 4 3 2 1 0

Byte 1	S	X Coordinate (upper)
2	X Coordinate (lower) LSB = 1/8 nm	0
3	S	Y Coordinate (lower)
4	Y Coordinate (lower LSB = 1/8 nm	0
5	S	X Velocity Component (upper)
6	X Velocity Component (lower) LSB = 1 Knot	0
7	S	Y Velocity Component (upper)
8	Y Velocity Component (lower) LSB = 1 knot	0

S = sign

0 = positive

1 = negative

ARTS III output messages that require this field are TI and TU. ARTS III input messages that require this field are TI and TU.

Remarks: Consists of five bytes (the clear weather symbol followed by "TEST"). The field in the TR message, as received, will be used as the Remarks field for the corresponding DT message. ARTS III output messages that require this field are TR and DT. ARTS III input messages that require this field are TR and DT.

Progress Report Data: Consists of four bytes (all numerics) of GMT specifying actual departure time in hours and minutes. The only ARTS III output message that requires this field is DM. This field is not required on any ARTS III input message.

EOM: Consists of only one byte, the EOM character (261_8). This field is required on all ARTS III input and output messages.

3.3.4.2.8.1.3 Amendment Message (AM).- Once a Flight Plan message has been received from ARTCC, that message may be amended via an Amendment Message (AM). A new coordination time must fall within the interval -15 minutes/+8 hours (SP) of current time. When the new time falls in the interval -15 minutes/ +5 minutes (SP) of current time, and the track file was in Flight Plan status, the track file shall be placed in store status. If the FP has a duplicate ACID, the procedure described in 3.3.4.2.13.2.6 shall apply. A change in the ACID which would make the new ACID an illegal duplicate is illegal. Up to five field changes to a common flight plan may be chained together in one AM message. The change must apply to a track file in either Flight Plan or Store Status and an FP message must have previously been received from ARTCC on this track file. If the same field is amended more than once in the same AM message, only the last one received will be used.

3.3.4.2.8.1.4 Cancellation Message (X).- Once an FP message has been received from ARTCC, the track file will be discarded upon receipt of a CX message from ARTCC, provided the track file is still in FP or Store status.

3.3.4.2.8.1.5 Initiate Transfer Message (TI).- These messages will be sent interfacility in either direction for the purpose of transferring control of a track from one facility to another.

When a TI message is received from the ARTCC, the track file shall be placed in handoff status and the FDB format will blink on the receiver's scope. The track symbol will be "C" and the receiver's symbol will be placed in Field 3 of the FDB format.

A TI message will be sent to ARTCC upon request via keyboard action. A bit will be set in CTS by keyboard input to signal ENROUT to send the message. ENROUT will send the TI message and, upon receipt of the acceptance message, ENROUT will place a "C" in Field 3 of the track format and start sending TUs on this track once per scan. If no acceptance is received from ARTCC in five seconds (SP), the TI is sent again but with current coordinates and velocity. If no acceptance is received on this TI for five seconds (SP), the message IF NO ACKNOL (ACID) will be printed on the console typewriter and the TI request will be cancelled. This same design will be used in processing a TA message request.

The following keyboard entries will be illegal for a track being handed off to ARTCC: A second Handoff Initiate, Suspend, Drop, Modify ACID, and Modify Beacon Code.

A TI message from ARTCC on a departure Flight Plan status track file will be illegal and will be acknowledged with a DR. Automatic acquisition is inhibited on arrival and overflight flight plans received from ARTCC. A Track Start keyboard entry with no slew coordinates will allow automatic acquisition on the track.

3.3.4.2.8.1.6 Track Update Message (TU).- Once a TI message has been sent and acknowledged, the coordinates of this track are updated via a TU message at an interval of once per ARTS III scan for messages to ARTCC and twice per ARTCC scan for messages from ARTCC. To conserve on the amount of data sent interfacility, there may be up to six of these TU messages chained together. The message will contain ECID or TCID, depending upon whether it is going to or from the ARTCC, respectively. Predicted coordinates will be sent to ARTCC. If TUs are not received from ARTCC at least once every 15 seconds (SP), an alarm printout (IF NO UPDATE (ACID)) will be requested and "OLD" will be displayed in Field 4 of the FDB format.

When TUs are again received, they will be used to update the track file and "OLD" will be replaced by the speed. Speed in tens of knots shall be displayed in Field 4 of the FDB format.

While "OLD" is being presented in FDB format on a track file in handoff from the ARTCC, only the Handoff/Accept Keyboard entry shall be permitted. The Handoff/Accept shall be processed the same as if TUs had been received. If the Handoff/Accept cannot be completed because the acceptance (DA) is not received from the ARTCC, a Forced Handoff/Accept shall be provided. The Forced Accept shall transfer control of the file to the handoff receiver without ARTCC communication (see 3.3.4.2.7.2.7).

3.3.4.2.8.1.7 Accept Transfer Message(TA).- Acceptance of a transfer track action is done via a TA message. When a TA is sent to ARTCC and is acknowledged with a DA, the FDB track symbol will change to the receiver's position symbol. His symbol will be erased from Field 3 of the FDB and the FDB format will stop blinking. When a TA is received from ARTCC, it will be acknowledged with a DA, the track symbol will change to a C, and it will blink for three (SP) scans before it will be dropped from the sender's scope.

If ARTCC sends a TA on a track which is already in handoff status from ARTCC, (a Handoff Recall), the track will be placed in store status. It can then be placed in Flight Plan status via controller keyboard entry if desired. Similarly, ARTS III can recall a handoff to ARTCC by sending a TA on that track. In this case, the track would be taken out of handoff status. The C would be removed from Field 3 of the FDB and the TU transmissions to ARTCC for this track will terminate.

If an ARTS III controller is unable to recall a track in handoff to the ARTCC because the acceptance (DA) was not received, a Forced Handoff/Recall shall be provided. The Forced Recall is a keyboard message removing the track from Handoff status without ARTCC communication. (See 3.3.4.2.7.2.7).

3.3.4.2.8.1.8 Departure Message (DM).- A departure message will be sent to ARTCC for all departure tracks which were established by an ARTCC flight plan message. The DM will be generated when the track file changes from FP or Store Status to Active Status (manual or automatic acquisition).

3.3.4.2.8.1.9 Acknowledge Message (DA, DR, DX). - All FP, AM, CX, DM, TB, TI, and TA messages sent interfacility will be acknowledged by one of three types of acknowledge messages defined below.

DA - No errors detected
DX - Hardware error detected - retransmit
DR - Logic error detected - do not transmit

3.3.4.2.8.1.10 Test Data Message (TR) & Data Test Message (DT).- Capability will be provided for each site to test the interfacility communications.

Whenever a TR message is received from ARTCC, ARTS III will respond with a DT message. ARTS III will insure that a message is sent to ARTCC and a good reponse received at least once every 60 seconds (SP). When an ARTS III/ARTCC TI-DA, TA-DA or DM-DA exchange does not occur in this time interval, the test will be made via a TR-DT exchange. If the DT is not received properly from the ARTCC, an alarm printout (IF TEST FAIL) will occur.

3.3.4.2.8.1.11 Terminate Beacon Message (TB).- A Terminate Beacon message will be sent to ARTCC for all tracks which were established by an ARTCC FP message. The message will be generated when the track file is terminated (manually or automatically) so that the track's beacon code can be made available for reassignment by the ARTCC program.

3.3.4.2.8.1.12 Flight Identification Field in Messages.- Whenever a message (except DX, DR, TR, and DT) is sent interfacility, the Flight Identification field contains either an ACID, TCID, or ECID to tell the receiver which track is being referenced. The following diagrams give the content of this field for the various types of message exchanges.

For an FP, AM or CX:

```
ARTS III        ARTCC

     ←——FP-ACID
     DA-TCID——→
     ←——AM-TCID
     DA-TCID——→
     ←——CX-TCID
     DA-TCID——→
```

For a Handoff on a track for which ARTS III received a Flight Plan from ARTCC:

```
ARTS III        ARTCC

     ←——TI-TCID
     DA-TCID——→
     ←——TU-TCID
```

3.3.4.2.8.1.12 (continued)

TA-ECID →
← DA-ECID
TI-ECID →
← DA-ECID
TU-ECID →
← TA-TCID
DA-TCID →

For an DM or TB:

ARTS III ARTCC

DM-ECID →
← DA-ECID
TB-ECID →
← DA-ECID

3.3.4.2.8.1.13 Interfacility Inhibit.- There will be a keyboard entry to inhibit and resume interfacility communication. The inhibit and resume entry will affect all interfacility communication except test messages.

All TI, TA, and TU messages generated by an ARTS III will be inhibited for those sites for which the ARTCC does not have radar tracking capability.

3.3.4.2.8.2 Interfacility Design.- The interfacility program consists of three parts. The Enroute Input Processor (ENRIN) processes all incoming data. The Enroute Output Processor (ENROUT) packs and sends all necessary messages to ARTCC. The Enroute Interrupt Routine (ENCHIN) processes all interrupts on the interfacility channel.

3.3.4.2.8.2.1 ENRIN Design.- Upon receipt of an End of Message (EOM) character on an input message, the Interfacility Communications Adapter (ICA) will interrupt the IOP. The interrupt routine (ENCHIN) will set ENRIN's executive flag and establish input into the alternate input buffer. ENRIN will process the message and pack any necessary acknowledge message in an acknowledge buffer. If the alternate input buffer is ready to process when ENRIN has completed processing the first buffer, ENRIN will also process the alternate input buffer prior to returning control to the executive program.

All errors encountered in a message prior to and including the message type will cause ENRIN to discard the entire message without any acknowledgement. All format errors encountered after this point will be acknowledged by a DR unless otherwise specified. DA, DX, DR and DT messages will not be acknowledged even if they are erroneous.

3.3.4.2.8.2.2 ENROUT Design.- Unlike ENRIN, ENROUT will be hit periodically from the executive program. If the interfacility output channel is active, it will exit. Otherwise it will scan the CTS for any TI, TA, TU, DM, or TB message to send. It will pack and send only one message per execution. If it finds a TI, TA, DM or TB message to send while it is packing a TU chain, it will save the index of this message to use as a start search index the next time it is executed.

ENROUT determines what function it is to perform on a track file by examining the ENROUT status. These statuses and the required functions to be performed are listed below:

Status 0 - No processing

Status 1 - If the ENROUTE time field is non zero, set it to zero and send a TU message to ARTCC.

Status 2 - Send a TI message to ARTCC; store current clock time in ENROUT time field and change status to 3.

Status 3 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, send a TI message to ARTCC. Store current clock time in ENROUT time field and change status to 4.

Status 4 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, request an IF NO ACKNOL alarm printout, change status to 0.

Status 5 - Send a TA message to ARTCC. Store current clock time in ENROUT time field and change status to 6.

Status 6 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, send a TA message to ARTCC. Store current clock time in ENROUT time field and change status to 7.

Status 7 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, request an IF NO ACKNOL printout and change status to 0.

Status 8 - Send a DM message to ARTCC. Store current clock time in ENROUT time field and change status to 9.

Status 9 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, send a DM message to ARTCC. Store current clock time in ENROUT time field and change status to 10.

Status 10 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, request an IF NO ACKNOL alarm printout and change the status to 0.

3.3.4.2.8.2.2 (continued)

Status 11 - If ENROUT time field indicates 15 seconds (SP) have not elapsed, ignore this track; otherwise, place this track in "OLD" status.

Status 12 - Send a TB message to ARTCC. Store current clock time in ENROUT time field and change status to 13.

Status 13 - If ENROUT time field indicates 5 seconds (SP) have not elapsed,ignore this track; otherwise, send a TB message to ARTCC. Store current clock time in ENROUT time field and change status to 14.

Status 14 - If ENROUT time field indicates 5 seconds (SP) have not elapsed, ignore this track; otherwise, request an IF NO ACKNOL printout and change status to 0.

3.3.4.2.8.2.3 ENCHIN Design.- ENCHIN will process the following types of interrupts:

1) External Interrupt Line Parity Error - This interrupt indicates that there has been a parity error on the interrupt status word. Since it is not known what interrupt the error occurred on, the status interrupt word is processed as if there were no error.

2) Input Data Line Parity Error - This is an internal interrupt generated by the IOP and indicates that a parity error occurred somewhere between the ICA and the IOP. When this happens, an external function "Not Received" must be sent to the ICA to shut off input and therefore eliminate the input timing errors which would otherwise follow this interrupt. From this point the interrupt is processed like Interrupt 3.

3) Input Lateral Parity Error - This interrupt indicates that a lateral parity error was detected by the ICA on data entering from the modem. when this happens, the following will occur:

   a) The ICA stops sending data to the IOP
   b) The interrupt is generated to the IOP
   c) The ICA puts itself into the receive disable mode
   d) The ICA puts itself into the receive enable mode and therefore will search for a synch code. All other data that it encounters at this point will be discarded.

When this happens, the interrupt routine will determine if the error occurred on or before the 13th word of the buffer. If it has, it will reinitiate input into the same buffer. Otherwise, it will set the DX flag telling ENRIN to respond to this message with a DX, provided the message itself is not a DA, DR, DX, TR, DT, or TU.

3.3.4.2.8.2.3 (continued)

4) LRC Parity Error - This interrupt is generated by the ICA whenever the LRC in a message does not agree with the ICA computed checksum. The error is processed the same as Error 3.

5) Input Timing Error - The ICA shall generate this interrupt whenever the IOP fails to accept character data from the ICA at a rate sufficient to avoid loss of input data from the modem. It is processed the same as Error 3.

6) Input Monitor Interrupt - The IOP is notified of the end of a buffer via the EOM interrupt and therefore does not do input with monitor. Hence this interrupt should never occur. If it does, it is merely typed out and ignored.

7) EOM Interrupt - This interrupt is generated by the ICA whenever it detects an EOM character in the input data. The ICA behaves as in steps a) through d) in Interrupt 3). ENRIN's Exec Flag is set to process this message. Input is then established into the alternate buffer. If this buffer is not available, a data loss message is typed on the console typewriter.

8) Output Lateral Parity Error - This interrupt is generated by the ICA whenever a lateral parity error exists in character data transferred from the IOP to the ICA. The ICA will then automatically disable the send mode. The IOP then enables the send mode and reinitiates the same output buffer. A synch code will be generated by the ICA when send mode is enabled.

9) Output Timing Error - This interrupt is generated by the ICA whenever the IOP fails to send character data to the ICA at a rate sufficient to maintain a continuous serial data train for transfer to the modem. It is processed the same as the output lateral parity error.

10) Output Monitor Interrupt - This is an I/O chain interrupt generated upon request by the operational program when an output buffer terminates. The buffer just output is made available for new data. If an acknowledge buffer is ready to be sent to ARTCC, the output of this buffer is then initiated. The ICA is put into the Not Send mode upon receipt of this interrupt. The sending of the acknowledge buffer is preceded by putting the ICA in the Send mode, which wil. cause the ICA to automatically generate a synch code.

3.3.4.2.8.3 Interfacility I/O Data Base.- Data from ARTCC will enter the IOP via two alternate 53 word input buffers. There will be one message per buffer. Data going to ARTCC will be packed in either a 51 word output buffer or one of three 17 word acknowledge buffers. The 51 word buffer will be used to output TI, TU, and DT messages. All other output message types (DM, TR, TA, DA, DR,

3.3.4.2.8.3 (continued)

DX, and TB) will be packed in one of the acknowledge buffers. Within the computer, the bytes are stored 2 per word: that is, one will be stored in bits 0-7 and the following one will be stored in bits 15-22 of the same word. The next byte would be stored in bits 0-7 of the following word and so on.

3.3.4.2.8.4 Interfacility System Parameters.- Table 3-13 contains a summary of the Interfacility System Parameters (SP) together with their labels and ranges of values.

3.3.4.2.9 Tracking.-

3.3.4.2.9.1 General Requirements.- The purpose of the tracking subprogram shall be to maintain the correct association between target reports and their corresponding alphanumeric data blocks. This association shall be maintained for both controlled and uncontrolled beacon and radar targets. Controlled targets are those tracks that have specific flight plan or controller entered identity data associated with them (e.g., ACID, ABC etc.). Uncontrolled targets are those unused reports that are automatically initiated and tracked and not necessarily associated with a controlled track. It should be noted that tracked aircraft consist of both uncontrolled tracks and controlled tracks and controlled active or inactive tracks that are controlled by the ARTS III system, or that have just been handed off from the ARTS III system. Those tracks just handed off shall continue to occupy active track files in CTS and shall continue to be tracked by the ARTCC. Then they shall be automatically terminated from the ARTS III system. Another type of track that will occupy a track file in CTS is an aircraft in handoff status from the ARTCC to the ARTS III system. These pseudo-tracks shall be tracked and updated by the ARTCC.

To enhance the tracking correlation algorithm, all targets shall be tracked. This shall be accomplished through an automatic initiation and termination process for all unused reports.

A tracking control subprogram shall be required to maintain a priority of processing for the various tracking functions. Inherent in the priority scheme is a determination by sector (11¼ degrees of antenna rotation) of the time at which a particular tracking function is to be performed, based on the current position of the radar antenna. The current sector shall be determined by the radar and beacon input processing subprograms.

A cross referencing scheme shall be required to maintain an association between specific types of tracks and radar/beacon targets. This shall minimize the probability of track swapping and shall detect ambiguous situations that arise when correlating a track..

TABLE 3-13. INTERFACILITY SYSTEM PARAMETERS

ITEM	DESCRIPTION	VALUE RANGE
ASQ	Time, in minutes, prior to ETA when an Arrival or Overflight FP is transferred to store status	0-500
DSQ	Time, in minutes, prior to PTD when a Departure FP is transferred to store status	0-500
LLAQ	Time, in minutes, prior to current time beyond which ETA/PTD is considered illegal	0-500
ULAQ	Time, in minutes, in advance of current time beyond which ETA/PTD is considered illegal	0-500
IAIQ	Time, in seconds, waited for acknowledge before retransmission of the message or declaring a failure	0-31
ITUIQ	Time, in seconds, waited between track updates before placing a handoff from ARTCC in "OLD" status	0-31
IMMEFQ	Minimum ARTS III/ARTCC exchange frequency in seconds	0-64000

3.3.4.2.9.1 (continued)

The tracking function shall be broken down into tasks, and these tasks shall be executed by a group of separate subroutines which are controlled by the tracking control subprogram. The subroutine to process all unused reports in a particular sector shall not be referenced until all tracks in the CTS table, falling into or preceding this sector, have been processed by the correlation tasks.

3.3.4.2.9.2 Beacon Radar Tracking Design.- In addition to tracking control, the major tasks of the tracking function are the correlation subroutines (primary/secondary, initial, and turning), track prediction, and processing of unused reports.

The major functions of the subroutine shall be track acquisition, track reacquisition, search mode, and normal tracking. The classes of tracks associated with the functions shall be initial, turning trial and parent trial and deviation trial, turning and parent, and normal, respectively.

The executive shall reference the tracking control subprogram approximately once every 125 milliseconds per beacon subsystem. All of the correlation subroutines shall be referenced on a sector number basis. A Track Number Pointer (TNP) table and associated Track Sector Summary Store (TSSS) table shall be used to determine the track numbers in a particular sector. All normal, parent, and parent trial tracks in sector n-5 (n-6 for second pass) shall be processed by primary/secondary correlation; the initial tracks in sector n-7 shall be processed by initial correlation; and the turning trial tracks in sector n-7 shall be processed by turning correlation. In addition, the preparation for the cross referencing of all normal, parent and parent trial tracks shall be processed by primary/secondary correlation. All unused reports that fall in sector n-8 shall be processed, followed by the prediction of all tracks in sector n-9. (Sector n shall be determined by radar and beacon input processing).

All tracks shall go through a start-up (or initialization) sequence which requires m correlations in n scans for initiation. The smoothing performed on the positional and velocity data during this initialization state is accomplished by using radar oriented α , β values assuming a straight-line track. After initialization has been performed, the track shall be maintained using track-oriented smoothing, the use of separate α , β values applied across and along the track direction. The reason for orienting the smoothing operations to the estimated track direction is the fact that aircraft normally maneuver in such a manner that transverse accelerations are larger than longitudinal accelerations. Eventually the track shall reach a steady-state condition where continued successful correlation results in no increase in the track's firmness, i.e., a constant α , β tracker. The firmness is an index and is used to determine the choice of smoothing and bin size parameters. (Table 3-14 shows the firmness table). The left column corresponds to the track's current firmness, which in turn determines the firmness values to be used for retrieving the longitudinal and transverse α , β values. This scheme is necessary since the maximum firmness (steady-state) is different in the two directions, longitudinal and trans-

TABLE 3-14. FIRMNESS LIMIT TABLE

INTEGER INDEX	LONGITUDINAL	TRANSVERSE
0	36	21
1	37	22
2	40	23
3	41	24
4	42	25
5	43	26
6	44	27
7	45	30
10	46	31
11	47	32

(All values are octal)

verse, where each measure has its different limit. The limit on the longitudinal firmness is higher than on the transverse firmness. The result of the lower transverse firmness limit is a tracker that is more responsive to track maneuvers.

To increase the tracker's response to data changes, a form of deviation controlled smoothing shall be used. This results in the immediate establishment of a trial track when it is determined that a report lying in the track's secondary bin is the report associated with the track. This allows for a faster response in tracking on turns. It should be noted that this immediate response results only in the establishment of a trial mode and will not affect the parent track's history data until the trial track has successfully correlated for two consecutive scans. Where the immediate detection of a possible turn cannot be made, turning tracks shall be created to establish a search mode in an attempt to maintain tracking through turns.

3.3.4.2.9.2.1 Primary/Secondary Correlation.- The combined primary/secondary (P/S) correlation routine shall process all controlled and uncontrolled tracks that have successfully passed the initialization sequence. This shall include all normal, parent, and parent trial tracks in an area defined as two sectors on either side of and including the sector to be processed by P/S, i.e., sectors n-3 through n-7. Initially, all tracks in sector n-3 shall be cross-referenced by placing their associated reports in the Report Address Table (RAT) together with an index (track number) of all tracks that correlated with each report in RAT. In addition, each track-report association shall be assigned a qualifying score, which will be stored in RAT for future use in resolving ambiguities between tracks. The cross-referencing and the qualifying scores, together with a two-pass system, shall be used in an attempt to successfully correlate a track. The first pass, which is performed five sectors behind the antenna, shall attempt to select the correct report from the RAT table based on the qualifying score only. If on the first pass the score alone cannot resolve an ambiguous situation (e.g., two valid reports in the track's bin with equal scores), the track shall be flagged for second pass processing. This will result in allowing a second attempt to correlate the track in sector n-6. Thus, between passes, an attempt to correlate all tracks in the sector processed shall have been made. In this way, the possibility exists that a track processed before the one marked for second pass processing may indirectly resolve the ambiguous situation by using one of the reports, based on qualifying score, which causes the ambiguous situation. In some cases, when qualifying score alone cannot resolve an ambiguous situation, deviation scoring shall be used to select the correct report. The deviation score is the distance (computed by a minimum variance estimate) between the track's predicted position and the reported position of the beacon and/or radar report. The use of the qualifying score, two-pass processing, and deviation scoring, together with the cross-referencing scheme, is intended to reduce the probability of "track swapping" and increase the number of successful correlations, i.e., reduce the number of coasts. The P/S routine shall also update the 3-bit radar report history field in the Central Track Store (CTS) for normal, parent, and parent trial

3.3.4.2.9.2.1 (continued)

tracks (both controlled and uncontrolled) in sector n-5 (n-6 for tracks flagged for second pass processing). The radar report history field shall provide a measure of the quality of the radar reports being correlated to a given track.

The P/S routine is logically divided into three sections. The first part shall consist of the cross-referencing and qualifying scoring of those tracks in sector n-3. The Track Number Pointer table (TNP) is referenced for all tracks in sector n-3 that qualify, i.e., are not initial, turning, or trial tracks. If the track is not a suspend track, a primary and secondary bin shall be built around the current (last predicted) position of the track. The target report store shall then be searched to determine those targets that fall within the primary or secondary bin. This task shall be performed by target selection. Those reports found by target selection shall be flagged, appropriately, as secondary or primary reports. Each report shall be scored (qualifying score) to reflect its relationship to the track. This score, together with an index to the target report store, a track number index, the number of tracks correlated to the report, and a designation as to whether or not the report was found in the primary or secondary bin of the track, shall be stored in the RAT (see 3.3.4.2.9.3.5). Each track contains a word in CTS (the TNT word) which shall include an index to RAT for the track and the number of reports found in the track's bins. To maintain the count of and cross-reference to all tracks associated with each report, a search shall be made of RAT (that part of RAT which contains data for sectors n-3 through n-7) for each report found in the bin of the track. If a match is found, i.e., that report is in the bin of another track, the track count shall be increased for the report and a thread of the track numbers associated with the report shall be maintained. Whether or not a match is found, the report and associated data shall be added to RAT. After the first report in the bin is indexed from TNT, the data on each additional target report found in the bin shall be stored successively in RAT.

The second major function of P/S shall be to attempt to determine the track's correct associated report using the information obtained from cross-referencing together with a two pass system. The first pass is performed five sectors behind the antenna. All tracks in sector n-5 (sector n-6 for second pass) shall be processed in the manner discussed below.

The first check made shall be to determine if any reports fell in the track's primary or secondary bin. If no reports did, the track's radar report history field in CTS shall be updated using the following formula:

$$Q_u = (1 - \alpha)\ Q_p,$$

where

Q_u = updated radar report history

$\alpha = \frac{1}{2}$ (SP)

Q_p = previous radar report history.

Furthermore, if the track has coasted for a designated number of scans, specific action is taken affecting the display of the track format (see 3.3.4.2.10).

3.3.4.2.9.2.1 (continued)

If no reports fell into the secondary bin of the track (controlled or uncontrolled), and if the active track has not coasted for the required number of consecutive scans, a check shall be made on the class of the active track. A parent or parent trial track shall simply be coasted; that is, its firmness shall be decreased, the coast status shall be set in CTS, and the counter maintained in CTS to determine the number of consecutive scans of coasting which will be incremented. A normal track whose firmness is above 20 shall result in the establishment of two turning tracks. The position of each of the turning tracks shall be approximated by using the last predicted X, Y position of the normal track as found in CTS, together with its computed heading and normal turn rate. This is accomplished by using the following expression:

$$(X_t)_n = K\left[V \sin(\Theta \pm KR) - \dot{X}_c\right] + X_p,$$

where:

$(X_t)_n$ = estimated position of the turning track

X_p = predicted position of the normal track

V = speed of the normal track

Θ = current heading of the normal track where $\Theta = \tan^{-1} \frac{\dot{X}}{\dot{Y}}$

R = rate of turn, where $R = 1\frac{1}{2}^{\circ}/\text{sec}$ if the speed of the track > 220 knots; $R = 3^{\circ}/\text{sec}$ if the speed of the track $\leq$ 220 knots

N = time since the last correction

n = current scan

$\dot{X}_c$ = last corrected velocity of the normal track

K = N + SCANMQ (parameter of back scan time), time at which the turn is assumed to have started.

It should be noted, as pointed out in the above expression, that the last predicted position of the normal track and the associated time of its last corrected position, which is in CTS as a result of the last successful correlation, are used to approximate the current position of the turning track. Inherent in the approximation is the last corrected position of the normal track, which can be computed as follows:

$$(X)_{n-m} = X_p - K(\dot{X}_c),$$

3.3.4.2.9.2.1 (continued)

where

$(X)_{n-m}$ = normal, last corrected position of the track

$K, \dot{X}_c$ = as defined above.

Therefore, the original form of equation (1) is

$$(X_t)_n = (X)_{n-m} + KV \sin (\theta \pm RN)$$

$$= X_p - K(\dot{X}_c) + KV \sin (\theta \pm RN),$$

which, simplfied, is

$$(X_t)_n = K \left[V \sin (\theta \pm KR) - \dot{X}_c \right] + X_p.$$

Turning correlation shall process these turning tracks. Each turning track shall be flagged as a right or left turning track in CTS.

It should be noted that the turning tracks that are created shall be internal to the computer only. Their data shall not be displayed. However, they shall be predicted through a turn by the prediction routine.

If no reports are found in the primary bin but exactly one is found in the secondary bin which, through qualifying score, is determined to be the correct report, a trial track shall be created using deviation control smoothing (e.g. $\alpha = 0.5$, $\beta = 0.25$). This trial track shall be processed in turning correlation and shall require two consecutive scans of successful correlation. If a selection cannot be made from those reports in the secondary bin, two turning tracks shall be created as previously mentioned and flagged for processing on the current scan by turning correlation. This deviation trial track differs from turning or turning trial tracks in that straight-line prediction is performed on the deviation trial.

The first step in the second part of P/S is a determination of the best reports from the RAT table. In determining the best report(s), an attempt is made to find a radar reinforcement for those beacon only reports in RAT. This is accomplished by establishing a radar search position between the track's predicted position and the beacon only report's position. A bin is then established around this search position and a check is made on the radar only reports in RAT to determine if any fall within the search bin. If one is found, it is used to reinforce the beacon only report (see 3.3.4.2.9.2.6).

3.3.4.2.9.2.1 (continued)

If, after determining the best report for the track being processed, exactly one is found in the primary bin that is not associated with another track (as determined from the cross-referencing data) or, if associated to another track, has a better qualifying score, that report shall be used for correction (see 3.3.4.2.9.2.6). If more than one best report (none of which is associated with other tracks) is found, deviation scoring shall be performed between the track's predicted position and each of the reports' positions. The one with the lowest score is then used for correction. Deviation scoring is performed using a form of minimum variance estimation as follows:

$$DS = \frac{\sigma_\rho^2 \sigma_{AA}^2}{(\sigma_\rho^2 + \sigma_A^2)} \left(\frac{D_\rho}{\sigma_\rho^2} + \frac{D_\theta}{\sigma_A^2} \right) .$$

where

DS = deviation score
D_ρ = $|R_p - R_R|$ = deviation in range, in nm
D_θ = $(|\theta - \theta_R|)R_p$ = deviation in azimuth, in nm
σ_A = $\sigma_\theta R_p$ = standard deviation of azimuth sensor error, in nm
σ_ρ = standard deviation of range sensor error, in nm
σ_θ = standard deviation of azimuth sensor error, in radians
$R\rho$ = track's predicted range, in nm
θ_ρ = track's predicted azimuth, in radians
R_R = reported range, in nm
θ_R = reported azimuth, in radians.

If the track being processed is a parent track and is successfully correlated, its class shall be changed to a parent trial. A parent trial shall then require PRTNMQ (SP) consecutive scans of successful correlations before becoming a normal track. However, the required number of scans may be set to zero, thus allowing the first successful correlation of a parent track to enable the class of the track to become normal. After any successful correlation, a track shall be flagged in its TNT word in CTS as processed, and the report(s) used for correction shall be flagged RAT.

Deviation scoring will be employed in an attempt to resolve certain types of ambiguities which may still exist after second pass. In particular, if a track which has undergone second pass still contains more than one report with equal qualifying scores in its primary bin and if none of these reports is associated with another track, deviation scoring shall be performed in an attempt to resolve the ambiguity. The report with the lowest deviation score will be used for correlation.

3.3.4.2.9.2.1 (continued)

If after second pass a track either is or is not included in the special case described above, but the lowest deviation scores were equal, the track will be coasted. If the ambiguity has been caused by a case wherein more than one report with equal qualifying scores has been continued in the primary bin, and if at least one of these reports is associated with another track, the firmness of the track will not be allowed to decrease as rapidly as the other cases wherein tracks are coasted. This will result in a more rapid resolution of the ambiguity on subsequent scans.

Whenever a track is successfully correlated, track oriented smoothing shall be performed on the track. This smoothing, together with the updating of its other history data, is performed by the correction routine (see 3.3.4.2.9.2.6).

Whenever a merged beacon/radar or radar only report is selected to be used for correction of a track, the track's radar report history field in CTS shall be updated using the following formula:

$$Q_u = Q_p + \alpha(Q_r - Q_p),$$

where

Q_u = updated radar report history

Q_p = previous radar report history

α = ½ (SP)

Q_r = radar report quality of the report chosen for correlation.

An indication of the correlation performance on each track shall be maintained through the use of two 10-bit fields in CTS. These fields, one each for beacon and radar, shall be used as sliding windows and shall indicate the success of correlation on each track over the past ten scans. When correlation is successful, a bit(s) in the sliding window(s) shall be set to represent what type of target the track correlated with, i.e., beacon, radar, or both (radar-reinforced beacon).

The third part of P/S involves the final processing of uncontrolled tracks. The final processing involves an attempt to associate a discrete coded uncontrolled track with a controlled track for the purpose of updating discrete suspend tracks or auto-acquiring discrete coast (tabular and handoff) and store tracks.

The criteria for final processing shall be the quality indicator, the Mode 3/A validity (Va), the Mode C validity (Vc), and the radar reinforcement of the target with which the uncontrolled track correlated.

3.3.4.2.9.2.1 (continued)

An attempt is made either to update the altitude of a controlled beacon normal track in suspend status or automatically acquire a track in store, tab coast, or handoff coast status which has a discrete ABC. If the uncontrolled track being processed has a discrete RBC which is equal to the ABC of the suspend track, and if the time and distance criteria are met, the uncontrolled track shall be flagged for the display of special symbology; and in addition, if the uncontrolled track has a Mode C altitude with a good Vc validity, the suspend track shall be flagged for the display of the altitude in its tabular area (see 3.3.4.2.10).

If a match is found between the uncontrolled track and a controlled track in store, tabular coast, or handoff coast status, the track shall be considered for automatic acquisition (transferring the uncontrolled track's data to the controlled track's CTS file, changing its status to active, and terminating the uncontrolled track). A system parameter shall be used to determine if automatic acquisition of the arrival flight plans from ARTCC should be inhibited. Only controlled beacon tracks shall be considered for automatic acquisition. The first check made shall be to determine if the time criteria have been met since the last code match. This time criteria, together with a distance check which will be considered later, shall be used to eliminate the possibility of acquiring a reflection. Thus, a flip-flop condition shall exist until the reflection disappears (until there exists one, and only one, associated uncontrolled track during the radar scan).

After the reflection problem has been resolved, automatic acquisition shall only be considered after two (SP not greater than seven) consecutive scans of code quality have been met. Additional checks shall be made on both the controlled track being considered for automatic acquisition and the uncontrolled track being processed. If the uncontrolled track is in the automatic termination area, based on the arrival/departure information of the controlled track, or if the uncontrolled position is not within five nautical miles (SP) of the last uncontrolled position as saved in CTS, the position of the uncontrolled track and the current time shall be stored in the controlled track's CTS file and the consecutive scan counter shall be updated.

If the above criteria (time, distance, and area checks) are met and if the uncontrolled track falls within the automatic acquisition area as defined by the arrival/departure information of the controlled track, the status of the controlled track shall be changed to active, the history data from the uncontrolled track shall be used to update the controlled track file, and the uncontrolled track shall be terminated. In addition, the offset of the controlled track in the A-word of CATB shall be set to initial. From this point on active tracking on a scan to scan correlation basis shall commence for the controlled track.

3.3.4.2.9.2.2 Initial Correlation.- Initial correlation shall process both controlled and uncontrolled tracks which have not completed the initialization phase. The controlled tracks shall consist of those manually entered (track, start, slew) tracks for which a match, based on the entered slew coordinates, to an uncontrolled track could not be found. The uncontrolled tracks consist of those radar reinforced beacon targets which have been automatically initiated by the process unused reports program (see 3.3.4.2.9.2.4). The purpose of initial correlation is to insure that these tracks go through an initialization phase, i.e., perform 100 percent α, β smoothing, to establish a good initial velocity and position before making the transition to track-oriented smoothing in P/S correlation.

Initial correlation shall perform seven sectors behind the antenna. The firmness of an active track shall be initially set to a value of three, and the track shall be considered an initial track for a minimum of two scans based on the firmness of the track. One result of initial correlation shall be to determine the Mode C status of the track. Based on the limited amount of history data available for correlation, the track shall be designated as Mode C or non-Mode C; i.e., if the report with which the track correlates has Mode C, a flag in CTS shall be set to denote the track as Mode C. This information shall be used in P/S correlation in determining the qualifying score for a track-report combination.

The first task performed in initial correlation shall be that of target selection. If no reports are found, the track shall be coasted. This involves decreasing the track's firmness and setting the coast status in CTS. For a controlled track, if the firmness has reached zero or if the track has coasted for 10 (SP not greater than 16) consecutive scans, the status of the track shall be changed to tabular coast or handoff coast if the track is in handoff status. An uncontrolled track that has coasted for m (SP) consecutive scans shall be automatically terminated.

If exactly one report is found whose RBC is equal to the ABC (or LGC, i.e., last reported code) of the active beacon normal track or whose RBC is 7700, 7600, or 3100, the report shall be used for correction of all or a portion of the track file. If this is the first correlation for the track, no velocity shall be computed. It shall take a minimum of two scans, i.e., two data points before a velocity is computed for the track.

If exactly one beacon report is found and the track has no ABC or LGC, the report shall be used to correct the track's history data, and the report's RBC, if present, shall be stored in CTS as the track's last reported code (LGC).

If only one report is found and the report is radar only, the report shall be used to correct the track's history data. For a radar or a beacon track, only the range and azimuth of the report shall be used to correct the history data of the track.

3.3.4.2.9.2.3 Turning Correlation.- Turning correlation shall process those turning, turning trial, and deviation trial tracks that are seven sectors behind the antenna. A deviation trial track shall not be processed by turning correlation on the same scan in which it was created. The initial processing of the deviation trial, i.e., its establishment by P/S correlation, was performed on the current scan using a report that was found in its associated parent track's secondary bin. Therefore, the search mode is bypassed and the reacquire (or trial) mode is entered immediately, since it was determined that a possible turn is in progress and the track's current position in the turn is known. If on the subsequent scan it is determined, through target selection, that exactly one report is found in the deviation trial's bin, or, if more than one, exactly one is found whose RBC is equal to the trial's ABC or whose code is garbled, that report shall be used to update the trial's history data. The trial's data, in turn, shall be transferred to its associated parent track, whose status shall be changed to normal, and the deviation trial shall be terminated. If no reports are found in the bin, the deviation trial is simply terminated, and, if on subsequent scans the parent track still fails to correlate, truning track mechanism shall be used.

A turning trial track is processed similarly to a deviation trial. Target selection shall first be performed to determine the reports that fall in the trial track's bin. The reports shall then be scored to determine if one good report (e.g., RBC = ABC with Mode C agreement) is found. If one is found and the turning trial has successfully correlated for 2 (SP) consecutive scans, the turning trial track's data shall be used to update its associated parent track, whose status shall be changed to normal, and the turning trial track shall be terminated. If no reports or more than one report of equal score are found, the turning trial track will simply be terminated.

Since the location of the parent track determines the reference sector for its turning tracks, both shall be processed simultaneously. Target selection shall first be performed on both tracks to determine the target reports that fall in each bin. The reports shall then be scored, and the best score associated with each track, together with the number of reports with that score, shall be saved. If no reports were found in the track's bins or if the best score for each track is the same, both turning tracks shall be coasted. This also shall be the case if one track has a better score but there is more than one report with that score. Turning tracks shall be retained for a maximum of ten (SP not greater than 16) scans, at which time they shall be terminated.

If one turning track has a better score that is associated with only one report, that report shall be used for correction of the turning track, and its status shall be changed to turning trial. The other turning tracks shall be terminated.

3.3.4.2.9.2.3 (continued)

In turning correlation, only those scores that reflect reports that are radar only or beacon reports that have Mode C agreement with the track and whose RBC is garbled or equal to the track's ABC shall be considered. If the track is radar only and correlates with a beacon report, the report shall remain eligible for automatic acquisition (i.e., shall not be erased from the target report store).

It should be noted that on the first successful correlation of a turning track, i.e., when it becomes a turning trial track, only the position shall be corrected. No further smoothing shall be done on the turning trial track. However, any unsuccessful correlation of a turning trial shall result in its termination.

On a particular scan, then, the net result of the secondary path through P/S correlation for a normal track shall be the establishment of one of the following:

a) Parent track and a deviation trial track
b) Parent track and two turning tracks
c) Parent track and a turning trial track.

<u>3.3.4.2.9.2.4 Process Unused Reports</u>.- The Process Unused Reports (PUR) routine shall process all beacon and radar reports that have not been used after all correlation routines have been executed. Only those reports in the target report store that fall eight sectors behind the antenna shall be processed. The two main tasks of PUR are:

a) Active track correlation
b) Automatic initiation.

The criteria used to perform the tasks are the target report's quality indicator, Mode 3/A validity (Va), Mode C validity (Vc), and radar reinforcement.

Each unused target is first checked to determine if it has been flagged by the correlation routines to not be considered by PUR. The reason for flagging the target is to insure that a new track is not automatically initiated on a target that was not used by correlation because of an ambiguous situation. If, in fact, the target is new to the system, i.e., not simply the result of a split target or an unresolved ambiguous situation, it shall eventually be automatically initiated when the ambiguity is resolved.

If the unused target being processed is a discrete beacon with validity greater than one (SP), an attempt shall be made to determine if its position is within five nautical miles (SP) of an active beacon track whose ABC is equal to the target's RBC. (A track will be determined to be an active beacon track on the basis of the type of report which correlated to the track on the previous scan.)

3.3.4.2.9.2.4 (continued)

If an active track is found and has not been correlated this scan or has been correlated with a radar only report or a beacon report whose RBC did not equal the track's ABC, and the distance criteria are met, the report shall be used to correct the track's history data. When correction is performed on the track, all associated turning or trial tracks shall be terminated.

If the unused report is a non-discrete beacon or a discrete beacon not eligible for correlation with an active track, it shall be considered for automatic initiation. If the beacon report is radar reinforced, it shall be immediately automatically initiated. This involves creating an uncontrolled track slot in CTS by using the next available (unused) track slot. The report's RBC is stored in CTS as the uncontrolled track's ABC. In addition, the report's positional data and Mode C status are stored in CTS, and the track's firmness is set to three. The track is then eligible to be processed by initial correlation.

If the beacon report is not radar reinforced, a bin shall be built around the reported position. The BOT shall then be searched to determine if any entries in the table fall within the bin and have code agreement with the report. If none is found, a new BOT file will be established for the report and its correlation count will be set to 2 (SP). If only one is found, its correlation count will be incremented by 2 (SP). Its time (since last correlation) field will be subtracted from current time to determine the number of scans since the last correlation. The current time will then be stored in the time field. The number of scans since last correlation will be multiplied by the counter decrement of 1 (SP), and this value will be subtracted from the correlation count. If the resultant count value is less than or equal to 0, the BOT file will be eliminated. If the value is greater than 0, the report shall be used to correct, i.e., smooth, the file's position and velocity. If the correlation count is greater than 0 but less than 4 (SP), the file will be straight line predicted for possible correlation on the next scan. If the correlation count is greater than 2, and the smoothed velocity is between 50 and 600 kts (SP), an uncontrolled track file shall automatically be created, as was done for a radar reinforced beacon, and the BOT file shall be terminated. If the file does not pass the velocity check, it will be terminated. Unlike the radar reinforced beacon, the beacon only uncontrolled track shall have its firmness set to a non-initial value.

If more than one track is in the beacon report bin and has code agreement with the report, the deviation scores of each are computed from their ρ, θ positions and the report's ρ, θ position. The report with the lowest deviation score will be used for correlation and the same steps will be followed for this report as were done for the case when only one report with matching code fell into the bin.

3.3.4.2.9.2.4 (continued)

As the BOT files are being checked for correlation with the first beacon report in the sector being processed, a check of the time since last correlation will be made to determine whether 3 (SP) scans have elapsed. If 3 scans have elapsed since the last correlation, the BOT file will be terminated. After all BOT files have been checked in this manner, a flag will be set which will inhibit the time check when subsequent reports in the sector are processed. The flag will be cleared immediately prior to exiting the PUR routine.

After the last beacon report has been processed, straight line prediction shall be performed on those tracks whose correlation count is greater than 2 (SP), using the smoothed position and velocity.

If the unused report being processed is radar only, a check will be made to determine whether the report is within an auto drop area. If it is in such an area, it will not be eligible for automatic initiation. If the report is not within an auto drop area, it will be considered for automatic initiation.

The automatic initiation process will be similar to the procedure used for beacon initiation, with several exceptions. First, the track files will be held in the Radar Only Track Table (ROT) instead of the BOT, which is used for beacon track files exclusively. (See 3.3.4.2.9.3.7 for a description of ROT). Secondly, the threshold which the correlation count is required to reach for radar track auto initiation will not be the same for the entire surveillance area. The threshold will be chosen from among three thresholds: one for the clear environment, one for the weather clutter environment, and one for areas of MTI breakthrough from ground clutter. The choice of threshold will be determined by using the clutter map (QS2 select map) which is maintained by the radar input processing routine, a manually defined ground clutter map, and five range azimuth gates which define the regions of MTI breakthrough from ground clutter. These maps and regions will be used in the following manner to select radar track auto initiation thresholds:

1) MTI Breakthrough Area Threshold - The MTI breakthrough areas will be five site-dependent range azimuth gates, each of which is defined by a start and stop range and a start and stop azimuth. These areas will be within the area covered by the manual ground clutter map. Prior to auto initiating an ROT file, a check will be made to determine whether the track is in an area covered by the ground clutter map. If it is, further check will be made to determine whether the track is in one of the five MTI breakthrough areas. A threshold of 8 (SP) will be required prior to initiation of radar tracks which are within MTI breakthrough areas.

2) Weather Clutter Threshold - If the track in ROT is not within the ground clutter area, the QS2 select map will be checked to determine whether the track is in a weather clutter region. If it is, a threshold of 6 (SP) will be required prior to initiation. In addition, if the radar report's quality is less than 4 (SP), it will not be used for auto initiation.

3.3.4.2.9.2.4 (continued)

3) Clear Environment Threshold - If the track within ROT is not in either an MTI breakthrough area or a weather clutter area, a clear environment threshold of 4 (SP) will be used for auto initiation.

After each unused report is processed, it shall be erased from the target report store.

3.3.4.2.9.2.5 Prediction.- Track prediction shall be performed nine sectors behind the antenna after process unused reports has been executed. Six major tasks shall be handled by this subprogram. These tasks are as follows:

1) Initialization of the track presence map and the radar detection map
2) Updating output tables for active coast tracks
3) Positional next scan prediction
4) Determination if active or active coast track's predicted position falls in an automatic drop area or automatic handoff area
5) Updating of the track presence map and the radar detection map
6) Performing a velocity check on all uncontrolled tracks.

The prediction routine shall begin by clearing to zero all bits in the Track Presence Map (TPM) and Radar Detection Map (RDM) which correspond to the 2 nm by 32 ACP zones in Sector n-3.

All normal, parent, parent trial, turning, turning trial, and deviation trial tracks that fall in the sector being processed shall be considered. All active tracks shall have their predicted X, Y coordinates placed in CATB. It should be noted that the predicted X, Y coordinates used for an active track are for the next scan.

All normal, parent, parent trial, and deviation trial tracks that fall in the sector being processed shall be straight-line predicted from their current position to their expected position at the time of the next radar scan, using the following expression:

$$(X_p)_{n+1} = (X_m)_n + (\dot{X}_c)_n T_n$$

where

$$T_n = \frac{T_{n-1} + T_{n'}}{2}$$

X_p = the predicted position of the track

X_m = the corrected position of the track if correlation was successful on the current scan, or the currently predicted position of the track if correlation was unsuccessful

3.3.4.2.9.2.5 (continued)

$\dot{X}_c$ = the last corrected velocity of the track

$T_{n'}$ = the time of the last radar scan

$T_{n-1} = T_n$ computed last scan

n = the current scan.

The equation for the Y coordinate is similar.

Since the first approximation of the predicted position may result in a change of the azimuth of the track, a second approximation may be needed to adjust the predicted position to the time at which the radar next crosses the track, a time which will normally approximate but not necessarily equal T_n. Therefore, a modification for T_n is computed as follows:

$$\Delta T = \left((A_p)_{n+1} - A_p\right) \quad T_n,$$

where

$(A_p)_{n+1}$ = the azimuth in BAMS, obtained by converting $(X_p, Y_p)_{n+1}$ from the preceding equation

(A_p) = the last azimuth, in BAMS.

If the absolute value of ΔT is equal to or greater than ¼ second, the predicted position is revised using the following correction:

$$(X'_p)_{n+1} = (X_p)_{N+1} + (\dot{X}_c)_n \quad \Delta T .$$

The correction for the Y coordinate is similar.

For a discussion of those controlled tracks that are predicted into an automatic track drop or handoff area, see 3.3.4.2.13.

If the predicted position does not fall in an automatic drop or handoff area, a check shall be made to determine if this active or active coast track is in handoff to the ARTCC. If it is, a counter in CTS is incremented to inform the interfacility I/O processing routine that a track update should be sent to the ARTCC. See 3.3.4.2.8.

All turning and turning trial tracks that fall in the sector being processed shall be predicted along a turn from their current position to their expected position at the time of the next radar scan using the following expression:

$$(X_t)_{n+1} = (X_m)_n + V \sin(\Theta \pm RT_n) \quad T_n,$$

3.3.4.2.9.2.5 (continued)

where

$(X_t)_{n+1}$ = predicted position

$(X_m)_n$ = current position

V = speed

θ = current heading

R = rate of turn, where $R=1\frac{1}{2}^{\circ}$/sec. if the speed of the track >220 knots, $R = 3^{\circ}$/sec. if the speed of the track ≤220 knots

T_n = the last computed radar scan time.

After it is determined that the predicted position of an active track is not in an automatic drop area, this position shall be used to update the track presence (TPM) and radar detection (RDM) maps. If the firmness of the track is greater than 14 (SP), the TPM shall be updated by setting to one all bits in the map which correspond to zones containing the track's primary bin. If in addition to its firmness being greater than 14 (SP), the track's 3-bit radar report history field equals 0, 1, 2, 3, or 4, the bits in the RDM which correspond to zones containing the track's primary bin will be set to one.

The final task of the prediction routine is to perform a velocity check on uncontrolled tracks. If the track being processed is uncontrolled and if its velocity is less than 50 Kts (SP) or greater than 600 Kts (SP), the prediction routine will terminate the track.

3.3.4.2.9.2.6 Beacon Radar Tracking Support Routines.- The three major support routines mentioned throughout the beacon radar tracking subprogram levels are correction, target selection, and report scoring. Since these routines shall be used by the correlation programs, they shall be discussed in detail at this point.

3.3.4.2.9.2.6.1 Correction.- Track correction shall be performed only on tracks (controlled or uncontrolled) that have successfully correlated. In correcting the position and velocity of a track, its predicted position and the associated position of the target (beacon, radar, or combined beacon/radar) shall be smoothed using longitudinal and transverse parameters. (The smoothing parameters are listed in table 3-15). The smoothing technique used, track oriented smoothing, to compute the track's corrected position involves orienting the smoothing operations to the estimated track direction. The reason for doing this is that aircraft normally maneuver in such a way that transverse accelerations are larger than longitudinal accelerations.

TABLE 3-15. SMOOTHING PARAMETER TABLE

FIRMNESS (in octal)	ALPHA (in 64ths)	BETA (in 64ths)
0		
1	64	0
2	64	0
3	64	0
4	64	64
5	64	64
6	64	64
7	64	64
10	52	0
11	52	0
12	52	0
13	not used	not used
14	64	64
15	60	57
16	57	50
17	54	43
20	51	36
21	48	30
22	44	24
23	41	20
24	38	16
25	36	14
26	34	12
27	32	10
30	30	9
31	29	8
32	27	7
33	26	6
34	24	6
35	23	5
36	22	5
37	21	4
40	20	4
41	19	3
42	18	3
43	17	3
44	16	2
45	15	2
46	14	2
47	13	2

3.3.4.2.9.2.6.1 (continued)

Track oriented smoothing basically involves smoothing in a rotated system while preserving the use of ordinary X, Y coordinates for its implementation.. The corrected position shall be calculated using the following expressions:

$$(X_c)_n = (X_p)_n + \alpha_T \frac{U(\dot{X}_c)_{n-1}}{S^2} + \alpha_T \frac{V(\dot{Y}_c)_{n-1}}{S^2}$$

$$(Y_c)_n = (Y_p)_n + \alpha_L \frac{U(\dot{Y}_c)_{n-1}}{S^2} + \alpha_T \frac{V(\dot{X}_c)_{n-1}}{S^2},$$

where

$$U = (X_p - X_R)_n(\dot{X}_c)_{n-1} + (Y_p - Y_R)_n(\dot{Y}_c)_{n-1}$$

$$V = (X_p - X_R)_n(\dot{Y}_c)_{n-1} - (Y_p - Y_R)_n(\dot{X}_c)_{n-1}$$

$$S^2 = (\dot{X}_c)_n^2 + (\dot{Y}_c)_n^2$$

X_c, Y_c = corrected position of the track

X_p, Y_p = predicted position of the track

X_R, Y_R = position of the report

$\dot{X}_c, \dot{Y}_c$ = X, Y components of velocity

α_L = longitudinal (along track) position smoothing parameter

α_T = transverse (across track) position smoothing parameter

n = current scan.

The corrected velocity shall be calculated using the same track oriented smoothing technique as follows:

$$(\dot{X}_c)_n = (\dot{X}_c)_{n-1} + \frac{\beta_L}{t} \cdot \frac{U(\dot{X}_c)_{n-1}}{S^2} + \frac{\beta_T}{t} \cdot \frac{V(\dot{Y}_c)_{n-1}}{S^2}$$

$$(\dot{Y}_c)_n = (\dot{Y}_c)_{n-1} + \frac{\beta_L}{t} \cdot \frac{U(\dot{Y}_c)_{n-1}}{S^2} - \frac{\beta_T}{t} \cdot \frac{V(\dot{X}_c)_{n-1}}{S^2},$$

where

$\dot{X}_c, \dot{Y}_c$ = corrected X, Y velocity components

3.3.4.2.9.2.6.1 (continued)

t = time since last correlation

U = as defined previously

V = as defined previously

S^2 = as defined previously

β_L = longitudinal velocity smoothing parameter

β_T = transverse velocity smoothing parameter

n = current scan.

The reported position (X_R, Y_R), in the case where a separate beacon and separate radar report were found and associated in the track's bin, is the result of the merging of the two reports using the minimum variance estimation as described in 3.3.4.2.4.

The values of α_L, α_T, β_L, β_T, are determined from the parameter table using the track's current firmness index or the firmness based on the upper firmness limit computation, whichever is smaller. The limit computation takes into account the effect of the data error distribution which is skew to the track direction. This effect is approximately introduced by computing the variance of the data noise errors along the track's longitudinal and transverse directions separately, using the current position and heading in the following expression:

$$C_L{}^2 = C_\theta^2 \ \sin^2 (\phi - \theta) + C_\rho^2 \cos^2 (\phi - \theta)$$

$$C_T^2 = C_\theta^2 \ \cos^2 (\phi - \theta) + C_\rho^2 \sin^2 \ (\phi - \theta),$$

where

θ = track's azimuth

ϕ = track's heading

C_θ^2 = variance in position in tangential deviation (varies with track range)

C_ρ^2 = variance in range (constant).

Since these computations result in varying ranges of values, a normalization factor is applied to the above computations. The normalization results in a set of integer indexes (0-9) used to reference table 3-14, which contains the appropriate upper firmness limit. In applying the normalization factor for computing the integer indexes, the computations take the following forms:

3.3.4.2.9.2.6.1 (continued)

$$L = \sqrt{\frac{C_L^2}{C_o^2}}$$

$$T = \sqrt{\frac{C_T^2}{C_o^2}} \quad .$$

where C_o^2 is an assumed nominal value of data noise variance ($C_o^2 = 0.0009$).

Then:

$$L = \frac{\sqrt{C_L^2}}{.03} + .5\text{(for rounding)}$$

$$T = \frac{\sqrt{C_T^2}}{.03} + .5\text{(for rounding)}$$

L and T are then integer indexes to the table which contains the limit firmness. The limit firmness referenced by the integer L is compared against the longitudinal firmness retrieved from the α, β firmness step table (table 3-16). The smaller of the two firmnesses is then used to reference the longitudinal α, β smoothing parameter values in Table 3-15. The transverse α, β smoothing parameter values are obtained similarly from the integer, T.

The corrected X, Y and $\dot{X}$, $\dot{Y}$ values shall be stored in CTS with the updated formness. Also, the correlate flag of the track shall be set, and its coast counter shall be cleared.

The initial values of smoothing parameters shall be designed to allow an approximate least-squares straight line fit of a succession of reports, i.e., a simple α, β tracker. This is accomplished by setting $\alpha_L = \alpha_T$ and $\beta_L = \beta_T$ for the initial firmness values as shown in table 3-15. An initial track with a firmness of one, two or three shall only have its position smoothed. Smoothing of 100 percent is used here to simply lock-on to the proper target. The position only of a turning track is corrected since a tangential change to the track's current direction is used to predict the turn of the aircraft.

The corrected and updated history data of an active track (controlled or uncontrolled) is stored in CTS and CATB, and the use of the data for siplay purposes is described in 3.3.4.2.10.

When a beacon target is used for correction and the track has no Assigned Beacon Code (ABC), attempt shall be made to automatically assign the Reported Beacon Code (RBC) to the track. Originally a Tentative Assigned Beacon Code (TABC) equal to the RBC is given to the track, and when another match is found (TABC = RBC), the track's ABC is set equal to the TABC.

After correction has been performed on the track, the target report used to correct the track shall be labeled as used in the target report store. This shall inhibit processing of a report used by correction as an unused report in PUR.

TABLE 3-16. FIRMNESS TABLE (in octal)

Previous Longitudinal Firmness	Consecutive Correlations				
	Successful Correlation		Unsuccessful Correlation		
	1	2	1	2	3
0	3	3	0	0	0
1	5	5	0	0	0
2	6	6	1	1	1
3	7	7	2	2	2
4	15	15	0	0	0
5	16	16	4	4	4
6	17	17	5	5	5
7	20	20	6	6	6
10	13	13	10	10	10
11	13	13	10	10	10
12	13	13	11	10	10
13	25	25	13	13	13
14	16	24	14	14	14
15	17	25	14	14	14
16	20	26	15	14	14
17	21	27	16	14	14
20	22	30	17	14	14
21	23	31	20	14	14
22	24	32	21	16	14
23	25	33	22	17	15
24	26	34	23	20	16
25	27	35	24	21	17
26	30	36	25	22	20
27	31	37	26	23	21
30	32	40	27	24	22
31	33	41	30	25	23
32	34	42	31	26	24
33	35	43	32	27	25
34	36	44	33	30	26
35	37	45	34	31	27
36	40	46	35	32	30
37	41	47	36	33	31
40	42	47	37	34	32
41	43	47	40	35	33
42	44	47	41	36	34
43	45	47	42	37	35
44	46	47	43	40	36
45	47	47	44	41	37
46	47	47	45	42	42
47	47	47	46	43	43

α, β Step Firmness	
Long.	Trans.
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
20	20
21	12
22	22
23	23
24	24
25	24
26	25
27	25
30	25
31	25
32	26
33	26
34	26
35	26
36	26
37	26
40	27
41	27
42	27
43	27
44	27
45	27
46	27
47	27

3.3.4.2.9.2.6.2 Target Selection.- The first major task of the correlation routines shall be target selection. A primary and a secondary bin shall be built around the predicted position (range, azimuth) of the track using the expressions which follow:

$R \pm E_R$ and $A \pm E_A$ (for the primary bin)

$R \pm KE_R$ and $A \pm LE_A$ (for the secondary bin),

where

$$E_R = BRE + C'_1 = C_1$$

$$E_A = C_2 + \frac{C_3}{R}$$

K and L = multiple parameters.

The maximum value for E_A shall be 15½ degrees (SP). C_2 is a constant ½ degree, while C_1 and C_3 are parameters which are a function of the firmness of the track. Table 3-17 contains the primary bin size parameters. In both expressions, two types of errors are reflected. The first term in each expression, BRE in E_R and C_2 in E_A, represent the error in the radar. C'_1 and $\frac{C_3}{R}$ represent the predicted error. BRE is a constant (1/16 nm) but shall be combined with the C'_1 term and stored as one term $(C_1)_2$ in the primary bin size parameter tables.

The bin sizes are designed to be large enough to ensure proper correlation and small enough to reduce the probability of incorrect correlation.

The size of the correlation bins is based on the outcome of studies and evaluations performed during the ARTS Enhancement effort coupled with empirical information and feedback from the ARTS III operational system.

The routine shall determine the left and right sectors across which the primary and secondary bins are built, and then the number of reports in those sectors. Each report not used shall be checked to see if it falls in the bin or bins. For each report that falls in a primary bin, an index to the target report store shall be put into a word in the RAT table. If they fall in the secondary bin, bit 28 of reports in the bins are found in the upper and lower half of a stored word.

3.3.4.2.9.2.6.3 Report Scoring.- After target selection has been performed, its output table, i.e., those targets that were found in the track's bin, shall be examined, and each target shall be assigned a qualifying score based upon its RBC, code and altitude validity, report quality, and relationship to the track's history data. For example, if a beacon report has good code validity (Va), good Mode C validity (Vc), Mode C agreement with the track, and its RBC is equal to the track's ABC, that report shall be assigned a qualifying score of zero (see 3.3.4.2.9.3.4).

TABLE 3-17. PRIMARY ERROR PARAMETER TABLE

FIRMNESS (in octal)	C1 (feet)	C3 (degree nm)
0		
1	13680	136.3
2	9630	87.5
3	5575	48.8
4	7600	67.2
5	6460	57.3
6	5510	48.3
7	4655	40.3
10	2370	18.8
11	2180	17.0
12	2000	15.3
13	2120	16.3
14	9020	81.7
15	7100	63.2
16	5980	52.8
17	4980	44.2
20	4230	36.2
21	3560	29.8
22	3230	26.7
23	2990	24.5
24	2770	22.5
25	2600	21.0
26	2480	19.8
27	2370	18.7
30	2260	17.7
31	2180	17.0
32	2120	16.3
33	2080	16.0
34	2050	15.7
35	2025	15.5
36	2010	15.4
37	2000	15.3
40	2000	15.3
41	2000	15.3
42	2000	15.3
43	2000	15.3
44	2000	15.3
45	2000	15.3
46	2000	15.3
47	2000	15.3

3.3.4.2.9.2.6.3 (continued)

Each score is stored in the report table, and the lowest score and the number of reports with that score is stored separately. This data is then used by the correlation routines to determine which report shall be used to correct and update the track's history data.

3.3.4.2.9.3 Tracking Data Base.- The firmness, smoothing, primary error, and qualifying score parameter tables, together with the report address table, the beacon only table, and the radar only table, described in this section are referenced only by the tracking subprogram. All other tables and buffers referenced by tracking are described in 3.3.4.2.14.

3.3.4.2.9.3.1 Firmness Table.- The firmness of the track is both an indication of its history and, more importantly, an index to various parameter tables. As can be seen from the table (table 3-16), its flexibility allows for adjustments to the current firmness based on the consecutive number of successful or unsuccessful correlations. This flexibility permits stepping up or down through the table in larger increments based upon current (last few scans) performance of the track. For example, if the track's current firmness is 30 and if correlation has been unsuccessful for three consecutive scans, its new firmness shall be set to 22. In track oriented smoothing, the firmness of the track is represented by the longitudinal firmness.

Additional flexibility exists in retrieving the firmnesses to be used for obtaining the smoothing parameters. As shown in the α, β step firmness position of the table (3-16), the track's current firmness is used as an index to retrieve separate firmness (index) values for obtaining both the longitudinal and transverse smoothing parameters. These separate firmness values, however, are used only after the upper firmness limit computations, described in correction, have been made.

Initial tracks shall have firmness from 0-7. Turning tracks shall have firmnesses from 10-12 (octal). Normal tracks shall have firmnesses of 14 to 47 (octal). The firmness of 13 (octal) shall be used for turning trial tracks to determine the C_1 and C_3 values when establishing the bin. No alpha, beta smoothing shall be done for turning trial tracks.

An active initial track reaching a firmness of zero shall be automatically placed in a tabular coast status.

3.3.4.2.9.3.2 Smoothing Parameter Table.- This is a 47 (octal) word vertical table which is referenced by the current (longitudinal) firmness of the track and its corresponding transverse firmness. Four smoothing parameters - alpha 1, beta 1 and alpha 2, beta 2 - shall be represented at each level of track firmness. All shall be scaled +6, and the maximum value of each is one (1) (zero smoothing). The parameters, alpha 1 and beta 1, are used to smooth, respectively, the position and velocity along the track (longitudinal smoothing). The parameters, alpha 2 and beta 2, are used to smooth, respectively,

3.3.4.2.9.3.2 (continued)

the position and velocity across the track (transverse smoothing). The values, in 64ths, used in the smoothing parameter table are shown in table 3-15.

3.3.4.2.9.3.3 Primary Error Parameter Table.- This is a 47 (octal) word vertical table which is referenced by the current (longitudinal) firmness of the track. Two error parameters, C_1 and C_3, shall be represented at each level of firmness. These two parameters shall be used to create a primary bin around the predicted range and azimuth position of the track. The bin shall be used to determine what reports, if any, fall near the track in position.

C_1 is the range error factor in nautical miles scaled +9. C_3 is the azimuth error in BAM nautical miles. The values used in the primary error parameter table are shown in table 3-17.

3.3.4.2.9.3.4 Qualifying Score Parameter Table.- This is a 10 (octal) word vertical table which is referenced by a report's classification. Words 1 through 6 define classes of beacon reports which may be found in a beacon track's bin. For a given class, the qualifying score of the report will depend on its validity and whether there is Mode C agreement with the track. Word 7 is used for determining the qualifying score of a beacon report falling in the bin of a radar track. Its score depends upon the report's validity. Word 8 contains the qualifying score for a radar only report. The score is dependent upon the radar report quality.

A beacon report with radar reinforcement will have its qualifying score decremented by one. The qualifying scores are then used to determine "best reports" for a given track. The values used in the qualifying score parameter table are shown in table 3-18.

3.3.4.2.9.3.5 Report Address Table (RAT).- The RAT (figure 3-37) is a revolving, threaded table used in conjunction with a track's TNT word in CTS (see 3.3.4.2.14) which shall contain the addresses of all reports associated with the track and an index with each entry pointing back to its associated track number. Also associated with RAT is a one-word index pointing back to its associated track number, and also a one-word index pointing to the next available slot in RAT.

For each track processed in sector n-3 by P/S correlation, those reports found in the track's bin shall be listed in RAT (2 words per entry). As a report is listed for the track being processed, a check is made on other entries in RAT to determine if the report is associated with any other tracks. If it is associated to another track(s), a field in RAT shall be updated to reflect the number of tracks associated with the report.

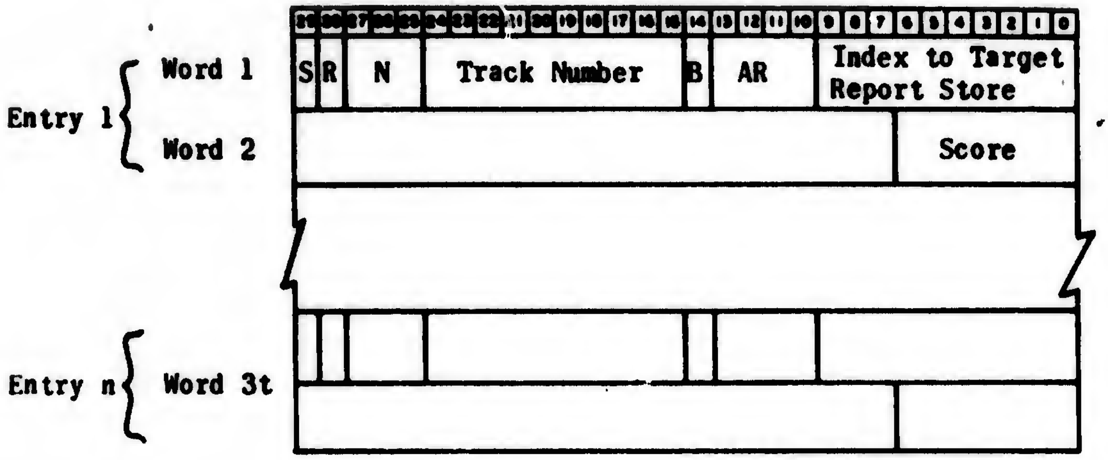
An additional field is maintained for use as an index to reflect the radar only report to be used for radar reinforcement of a beacon only report.

TABLE 3-18. QUALIFYING SCORE PARAMETER TABLE

		Validity < n		Validity ≥ n	
	Report Classification	Mode C Disagree	Mode C Agree	Mode C Disagree	Mode C Agree
Word 1	RBC = garbled code	21	12	----	----
Word 2	RBC = Discrete ABC	3	1	3	1
Word 3	RBC = ABC	16	1	3	1
Word 4	RBC = last reported code	20	5	18	5
Word 5	RBC = 7600/7700	24	8	22	8
Word 6	RBC = new code	31	26	28	26

		Validity < n	Validity ≥ n
Word 7	Beacon in Radar Track's Bin	39	34

		0 ≤ Report Quality < 4	4 ≤ Report Quality ≤ 7
Word 8	Radar Only Report	40	29



S : Report in track's secondary bin
R : Radar only report
N : Number of tracks correlated to report
B : Beacon only report
AR : Index to associated report in beacon/radar combination
Score : Qualifying score for this report/track association

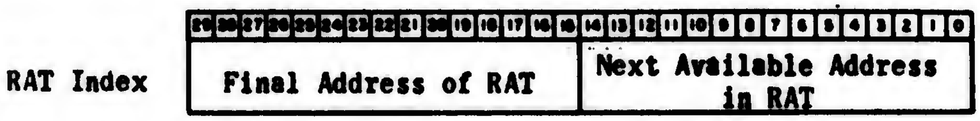


Figure 3-37. Report Address Table and Index

3.3.4.2.9.3.5 (continued)

The size of RAT is 3t, where t is the number of tracks in the system.

3.3.4.2.9.3.6 Beacon Only Track Table (BOT).- The BOT (figure 3-38) is a vertical table containing temporary files of beacon only unused reports. These files (five words per file) are used to perform the initialization phase for beacon only tracks before they are automatically initiated as uncontrolled tracks. When a new beacon only unused report is processed by the PUR subprogram, it is placed in an unused BOT file. On a successive scan, when it is processed as an unused report, a search of the BOT file is made to find a match. If a match is found, the correlation count will be first incremented by a parametric count and then decremented by the number of scans since the last correlation. If at this point the correlation count is equal to or greater than a threshold, and if certain velocity checks are passed, the file is transferred to CTS as an uncontrolled track. When this is done, the BOT file shall be terminated.

Those BOT files that fail to correlate for a parametric number of scans shall be terminated. In this way, intermittent reflections may be filtered out and not entered into the system as uncontrolled tracks.

The size of BOT is 100 words, i.e., 25 track files.

3.3.4.2.9.3.7 Radar Only Track Table (ROT).- The ROT (figure 3-38) is a vertical table containing temporary files of radar only unused reports. These files (four words per file) are used to perform the initialization phase for radar only tracks before they are automatically initiated as uncontrolled tracks. When a new radar only unused report is processed by the PUR subprogram, it is placed in an unused ROT file. On a successive scan, when it is processed as an unused report, a search of the ROT file is made to find a match.

If a match is found, the correlation count will be first incremented by a parametric count and then decremented by the number of scans since the last correlation time. If at this point the correlation count is equal to or greater than a threshold chosen on the basis of the environment and if certain velocity criteria are satisifed, the file is transferred to CTS as an uncontrolled track. When this is done, the ROT file shall be terminated.

Those ROT files that fail to correlate on successive scans shall be terminated. In this way, clutter may be filtered out and not be entered into the system as uncontrolled tracks.

The size of ROT is 150 words, i.e., 50 track files.

<table>
<tr><th></th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th><th></th></tr>
<tr><td rowspan="4">ROT</td><td colspan="15">Azimuth (BAMS)</td><td colspan="15">Range (nm) 1/512</td><td rowspan="5">BOT</td></tr>
<tr><td colspan="15">± Y (nm) 1/256</td><td colspan="15">± X (nm) 1/256</td></tr>
<tr><td colspan="15">± $\dot{Y}$ (nm/sec.) (Bit 28 = 450 Kts)</td><td colspan="15">± $\dot{X}$ (nm/sec) (Bit 13 - 450 Kts)</td></tr>
<tr><td colspan="2">Not Used</td><td colspan="3">Radar Report History</td><td colspan="6">Firmness</td><td colspan="4">Correlation Count</td><td colspan="15">Time (Sc + 6)</td></tr>
<tr><td></td><td>NU</td><td colspan="2">Va</td><td colspan="12">Beacon Code</td><td>NU</td><td colspan="2">Vc</td><td colspan="12">Altitude (BCD)</td></tr>
</table>

Va = Mode 3/A Validity
Vc = Mode C Validity
NU = Not Used

NOTE: The BOT and ROT are identical tables with the exception of Word 5, which is contained in the BOT but not in the ROT.

Figure 3-38. Beacon Only Table (BOT) and Radar Only Table (ROT)

3.3.4.2.9.3.8 Tracking System Parameters.- Table 3-19 contains a summary of the Tracking System parameters (SP), together with their labels and value ranges.

3.3.4.2.10 Display Output Processing.-

3.3.4.2.10.1 General Requirements.- The display output processing function involves the preparation of all data for presentation on the controller's radar scope, the preparation of all data transfer commands (the output command chain lists), and the maintenance of the output transfer (the display refresh). These tasks shall be divided into separate subroutines in order to effectively handle the variety of data to be presented and to meet the individual update frequencies required for the various data.

The data to be transferred to each display may be divided into six separate categories:

1) Active controlled aircraft
2) Inactive controlled (tabular) aircraft
3) Uncontrolled aircraft
4) System data
5) Keyboard (preview) data
6) Trackball position.

3.3.4.2.10.1.1 Active Controlled Aircraft.- Active tracks shall be presented on the controlling console at the reported position of the target. The presentation shall consist of the controller's discrete symbol, a leader, and two lines (of up to seven characters each) of alphanumeric data. The first line (Field 1) shall contain the AirCraft IDentification (ACID). The ACID shall be two to seven characters, the first of which must be alphabetic, or, if no ACID is available, there shall be seven blank characters. The ACID shall be right-justified if the format is offset to the S, SW, W, or NW. The second line shall contain the corrected Mode C altitude in the first three characters (Field 2), followed by a space (Field 3). If correlation was unsuccessful, CST shall be displayed in Field 2. If correlation was successful but no altitude was reported, Field 2 shall be left blank. The last three characters (Field 4) shall normally contain the aircraft's ground speed (in tens of knots) followed by a space or an "H" to indicate heavy jet for those aircraft identified as heavy jets through flight plan data received from the ARTCC or through keyboard modification of the flight plan data. When an "H" appears, the FDB shall be transferred with field select override (forced). An example of the active track full data block (FDB) format is:

TABLE 3-19. TRACKING SYSTEM PARAMETERS

ITEM	DESCRIPTION	VALUE RANGE
CFIRMQ	Firmness value above which speed is displayed by the correction routine	$0-47_8$
PRTNMQ	Number of successful correlations required before declaring a parent trial track a normal track	$0-17_8$
TCNQ	Number of scans a turning track will be coasted before being terminated	$0-17_8$
TTCNQ	Number of successive correlations required before declaring a turning trial track a normal track	$0-17_8$
CCNTQ	Number of scans of coast allowed before track is put in tabular coast	$0-17_8$
FIRM1Q	Firmness limit for tracking feedback	$0-47_8$
RRHQ	Alpha value for report quality calculations	0-1
ACNTQ	Number of consecutive scans of code match for auto acquisition	0-7
RQUALQ	Radar report quality below which radar report is not used for auto initiation in Weather Clutter	0-7
DIS2Q	Distance of unused beacon report from uncontrolled track for auto acquisition	0-36 7/8 nm
USPEEDQ	Upper velocity limit for auto acquire	0-900 Kts
LSPEEDQ	Lower velocity limit for auto acquire	0-900 Kts
VAQ	Value used for good code validity	0-3
VCQ	Value used for good altitude validity	0-3
CCIBQ	Correlation count increment in BOT	0-7
CCDBQ	Correlation Count Decrement in BOT	0-7
CCTBQ	Correlation Count Threshold for uncontrolled track start for BOT	0-15

(Table 3-19 continued on page 3-210)

(Table 3-19 continued from page 3-209)

ITEM	DESCRIPTION	VALUE RANGE
CCIRQ	Correlation Count Increment in ROT	0-7
CCDRQ	Correlation Count Decrement in ROT	0-7
CTIMBQ	Maximum time allowed since last correlation in BOT	0-20 Sec.
CTIMRQ	Maximum time allowed since last correlation in ROT	0-20 Sec.
CCTRCQ	Correlation count threshold for uncontrolled track start in ROT (clear area)	0-15
CCTRMQ	Correlation count threshold for uncontrolled track start in ROT (MTI breakthrough)	0-15
CCTRWQ	Correlation count threshold for uncontrolled track start in ROT (weather clutter)	0-15

3.3.4.2.10.1.1 (continued)

If the aircraft reports a code of 7700 (emergency), 7600 (radio failure), 3100 (hijack), or 1236 (suspect aircraft), the ground speed in Field 4 shall be replaced with an EM, RF, HJ, or SA, respectively. The alphanumeric format shall be transferred to the controlling console with field select override (forced), and the EM, RF, HJ, or SA characters shall blink. The format shall be transferred in this manner until the EM, RF, HJ, or SA code is no longer being transmitted by the aircraft, or until receipt of a keyboard entry (MULtifunction, E) from the controller. An example of the emergency code format is:

```
   A307B
 081 EM \
         \
          \
           S
```

If the beacon and radar report for a target which has been actively tracked is lost for 1 (SP) scan, it shall become an active coast track before being placed in the coast/suspend list after 5 (SP) such consecutive scans. Such tracks are identified by the letters "CST" in Field 2 of the track's FDB.

3.3.4.2.10.1.1 (continued)

If the aircraft transmits SPI, the characters "ID" shall be displayed in Field 4 in the same manner as EM, RF, HJ, or SA (that is, format forced with "ID" blinking). If the SPI is received with an EM, RF, HJ, or SA code, the "ID" characters shall be time shared in field 4 with EM, RF, HJ, or SA.

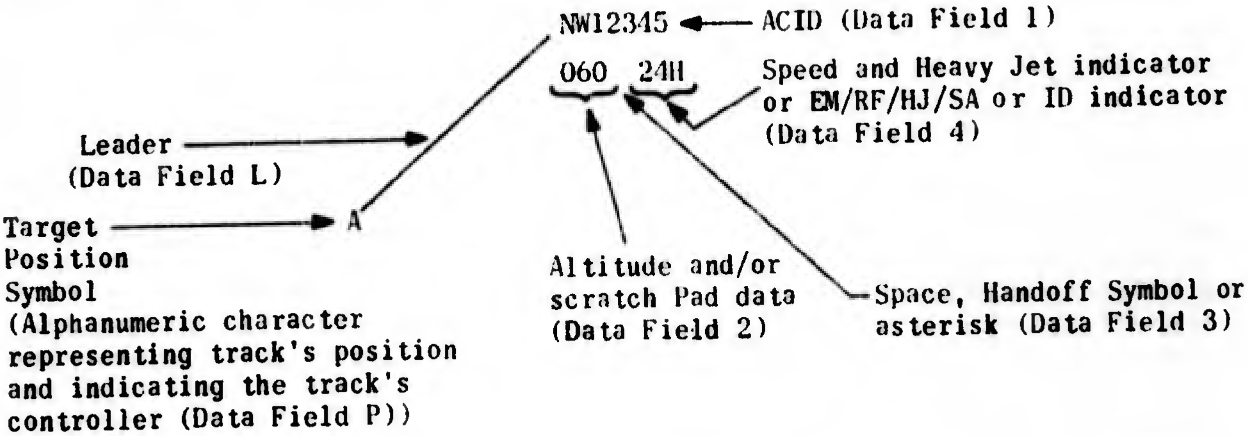
Active tracks controlled by positions at other displays shall be presented as a single symbol (SS) at the reported position of the target. The SS shall be the discrete symbol of the controlling position. These SS may be inhibited by keyboard entry (MULtifunction, F). The complete FDB format of these tracks may be obtained by requesting a specific track readout by keyboard entry (MULtifunction, D, slew), or through selection and activation of a quick look switch. The selected track, or the active tracks of the selected position (if quick look was used), shall be presented in the same format as on the controlling console, that is, controller's discrete symbol, same offset; and if the format contains EM/RF/HJ/SA, it shall be forced and the characters shall be blinking.

Active aircraft in a handoff status shall be presented in the normal FDB format with the handoff receiver's discrete position symbol in Field 3. The format shall also be transferred forced and blinking to the receiver's console. Upon acceptance of the handoff (keyboard entry track handoff), the track symbol shall be changed to the receiver's discrete position symbol, the offset shall be changed to the receiver's initial offset, and the receiver's symbol shall be deleted from Field 3. The format shall be transferred in the normal manner to the receiver (new controller) and shall be transferred to the sender in a forced and blinking format for three (SP) scans. After three scans, the sender's format shall be automatically dropped.

Handoffs between the ARTCC and ARTS III shall be presented in the same manner; however, a discrete track symbol (C) shall be used for ARTCC controlled tracks, a C shall be displayed in Field 3 for handoffs pending to the ARTCC, and a C shall be used as the track symbol after an acceptance of a handoff to the ARTCC. Should any track in handoff status fail to correlate for 5 (SP) scans, the track shall not be transferred to the tabular list (coast status) but shall be left in the active track format, frozen at the last predicted position. The same format shall be presented on the receiver's console (forced and blinking). In all other respects the track shall be regarded as a track in tabular coast status; that is, no position symbol shall be presented on other consoles and, if the track is assigned a discrete beacon code, the track shall be eligible for automatic reacquisition. The track shall retain the active track format for three (SP) scans after acceptance, to allow the sender's format to blink for that time. After the three scans, and if the tabular coast status has not been corrected, the track shall be transferred to the (new) controller's tabular list and dropped from the sender's display. The tabular coast status for the track in handoff may be corrected by autoreacquisition or by the track reposition keyboard entry.

3.3.4.2.10.1.1 (continued)

Field 2 may contain controller keyboard (MULtifunction, Y) entered data of general nature. This "scratch pad" data shall consist of up to three special alphanumeric characters left justified in Field 2. The data shall be designated as "scratch pad" by the display of a computer generated asterisk in Field 3. The scratch pad data shall be presented on a time-shared 1 : 1 display ratio with Mode C altitude data. The scratch pad data shall be displayed for approximately 8 seconds and the Mode C altitude data (if present) displayed for approximately 8 seconds (SP) in each time-shared cycle. If either information element does not contain data, the remaining element shall be displayed all the time. Also, the asterisk in Field 3 shall be time-shared in the same manner with the controller position symbol when a handoff is initiated. When in the time-shared mode, the FDB shall be transferred to the display with field select override (forced). The general format of an FDB is:



3.3.4.2.10.1.2 Inactive Controlled Aircraft.- Inactive controlled aircraft shall include those track files in flight plan, store, tabular coast, and suspend status. Track files initiated by keyboard entry, by an ARTCC flight plan message, or by magnetic tape input of flight plan data, shall be assigned Flight Plan (FP) status. Track files in FP status are not presented to the controller unless specifically requested for readout in the preview area (keyboard entry multifunction, display). Track files in FP status shall be automatically transferred to store status when the ETA/PTD of the file is within five (SP) minutes of current time. When transferring a track file to store status, an alphabetic line identity shall be assigned. If no line identify is available, the file shall retain its store status but shall not be displayed until a line ID can be assigned.

Track files in store status with a line ID shall be presented on the controller's display in a tabular format. The tabular format shall consist of up to 26 lines (one line per store track) with each line including the line ID, the ACID, and four numeric characters of the track's discrete assigned beacon code or a D, dependent upon keyboard entry (MULtifunction Z). If the track's assigned

3.3.4.2.10.1.2 (continued)

beacon code is non-discrete, an N or the first two characters of the beacon code shall be presented, dependent on the same keyboard entry. The store list shall be ordered alphabetically by ACID. Ths lists shall be capable of selection/deselection and relocation through keyboard entry.

Active tracks which fail to correlate for 5 (SP) consecutive scans shall be automatically transferred to tabular coast status. Active tracks which are manually suspended from active status shall be placed in suspend status. Both coast and suspend tracks shall be presented in a tabular format. The presentation shall consist of a numeric (one digit) line ID, the ACID, and symbology indicating the status and the code assignment -- a C or S for coast or suspend and a D or N for discrete or nondiscrete code. If the discrete code of the suspend track corresponds to the reported code of an uncontrolled track, the corrected Mode C altitude of the uncontrolled track (if any) shall be presented following the "SD". Should more than ten tracks be assigned to coast or suspend status at one position, those in excess of ten (up to a maximum of 32 total) shall be presented without a line ID. The coast/suspend list shall be presented in alphabetical order by ACID and shall be relocatable by keyboard entry.

Below are examples of the store (arrival/departure) and coast/suspend tabular lists, respectively:

(Store List)

G	AA12	0412
B	AA120	
L	AA12B	
D	RO241	
A	UA140	04
C	W10	
E	WA78	

(Coast/Suspend List)

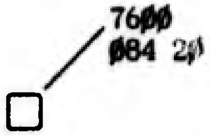
4	NC201	SN
0	NW130	CD
3	RO123	C
7	UA222	SD103
2	WA86	SD

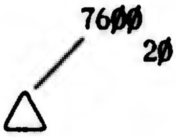
3.3.4.2.10.1.3 Uncontrolled Aircraft.- All uncontrolled tracks (those tracked beacon and radar reports that are not associated with or controlled by a specific controller) shall be considered for presentation on all controllers' radar scopes. All uncontrolled tracks shall be presented at their reported positions. If a Limited Data Block (LDB) is used, the format offset shall be 0 (either north or northeast, depending on the console offset selection). Uncontrolled track single symbols and/or LDBs for Mode C beacon tracks (*), non-Mode C beacon tracks (+), or radar tracks (unique symbol to be specified at contract award) may be selected or inhibited by keyboard entry (MULtifunction F). If the position of the track is outside the display's area (based on the display's range and off-centering), symbology for the track shall not be transferred to that display.

3.3.4.2.10.1.3 (continued)

All uncontrolled tracks shall qualify for presentation on each console in one of the formats discussed below.

Emergency, radio failure, hijack, and suspect aircraft codes (7700, 7600, 3100, and 1236 respectively) shall be displayed in an LDB format, forced and blinking on all consoles. Two examples of a radio failure format are shown below:

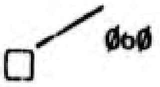
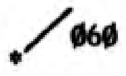




The symbols (□ and △) represent selected codes. Emergency, radio failure, hijack codes, and suspect aircraft shall be considered as selected codes at all consoles. The square shall indicate a Mode C selected code and the triangle shall indicate a non-Mode C selected code. Both LDBs shall contain the speed (in tens of knots) in Field 4.

If the uncontrolled track has a Mode C altitude whose validity (Vc) is greater than two (SP), it shall be checked to determine if the altitude is within the altitude filter limits for each display. If it is within these limits, the indicators in CTS for the display being processed shall be set to affect the display of an LDB with shall consist of a three-character altitude. If the altitude is not within filter limits and Mode C single symbols (SS) have not been deselected by keyboard entry (MULtifunction, F) for the display, the uncontrolled track shall be flagged in CTS for SS display. If the uncontrolled track does not have a Mode C altitude, i.e., it is radar only or non-Mode C beacon, additional checks shall be made to determine if the track should be flagged in CTS as an LDB or SS. The LDB would contain only the track's speed.

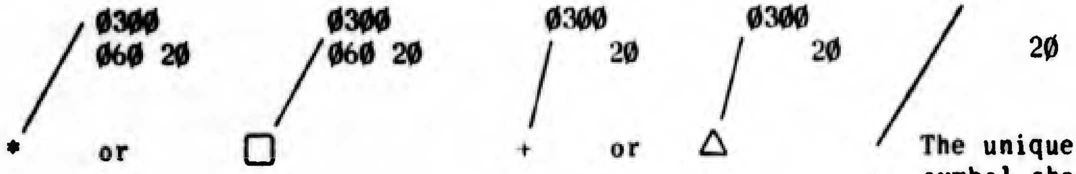
Uncontrolled tracks reporting a discrete code corresponding to the assigned code of a controlled track in suspend status shall be represented on all consoles as two characters. The first character shall be the suspend track's tabular line identifier and the second character shall be the controller's discrete position symbol. All uncontrolled tracks shall be presented as shown below:

Track	Symbology	
Radar only	The unique radar symbol shall be specified at the time of contract award	
	Selected Code	Non-selected Code
Mode C beacon within filter limits		
Mode C beacon outside filter limits	□	*
Non-Mode C beacon	△	+

3.3.4.2.10.1.3 (continued)

For selected codes, the symbol (□or△) shall blink when the target reports SPI.

Uncontrolled tracks which have been identified for a beacon/speed readout (MULtifunction, B, slew) shall be presented on the requesting console in an LDB format. An identified uncontrolled track readout shall be presented for 3 (SP) scans and then automatically dropped. The LDB format shall correspond to those LDB formats previously discussed, but will additionally include the beacon code in Field 1 of the format and the speed (in tens of knots) in Field 4 of the format. The identified track format is shown below for Mode C and non-Mode C beacon tracks and radar only track.



The unique radar symbol shall be specified at the time of contract award

3.3.4.2.10.1.4 System Data.- A system data presentation, in a tabular type format, shall be provided at each display. The system data shall be relocatable (MULtifunction, S, slew), and shall consist of the following information:

Current Time - in hours, minutes and seconds, separated by virgules. The time will be updated each second and shall be initially entered and/or modified by the MULtifunction, S, keyboard entry.

Altimeter Setting - in inches of mercury, to hundredths of inches, separated by a period. The altimeter setting shall be entered by the MULtifunction, S, entry. In the dual radar system, any entry of time or altimeter setting shall update both radar subsystem.

General Systems Information - the Automatic Terminal Information Service (ATIS) designator and general information (GI), such as runway in use, etc., shall be entered by the MULtifunction, S, entry. The ATIS designator is displayed as an alpha character. The GI is displayed as up to 13 alpha-numeric characters. No special characters except a space are allowed in the GI area.

Selected Codes - all codes (two digit non-discrete codes) selected by any keyboard at that display shall be listed in numerical order. Codes are selected by the MULtifunction, B, entry. A maximum of ten selected codes per display are permitted.

3.3.4.2.10.1.4 (continued)

Emergency/Radio Failure/Hijack/Suspect Aircraft Indication - EM and/or RF and/or HJ and/or SA shall be presented with the system data whenever a 7700, 7600, 3100 or 1236 aircraft is detected. This shall be in addition to the LDB format described previously and shall ensure the emergency does not go undetected because of range scale and off centering.

Memory Readout - the contents of memory shall be displayed with the system data upon operator request (MULtifunction, R). Both the address and the contents (up to ten/system) shall be presented in octal numerics.

An example of a system data presentation is shown below:

13/44/31 29.89	System time and altimeter setting
A RUNWAY 4	ATIS and GI
03 04 06 07 10 11 12	Selected codes, this display, in numerical order, ten maximum
EM RF HJ SA	Emergency, radio failure, hijack, and suspect aircraft indication
001325 00000 07420 001326 14000 00001 014256 00000 00027	Memory readouts Maximum ten/system

3.3.4.2.10.1.5 Keyboard (Preview) Data.- Each keyboard shall have a relocatable (MULtifunction, P, slew) area consisting of keyboard input message characters and readout messages. The preview data shall be prepared and maintained by the keyboard input processing subprogram (see 3.3.4.2.7). An example of the preview display is shown below:

FORMAT HD	error readout
C TWA123	message characters

3.3.4.2.10.1.6 Trackball Data.- The trackball (slew) position for each keyboard shall be presented as a symbol (parameter for each keyboard) at a position defined by radar coordinates except when MULtifunctions: PREview, TABular or SYStem keyboard entries are made. For these multifunctions, the trackball symbol position (and "home" position) shall be in display coordinates presented at the display center and updated from that position (in display coordinates) until the message is processed.

The trackball shall be updated each refresh and shall be relocated to the "home" position after completions of message processing, except for the Track Reposition function, which allows two slew entries, and for the Track Drop and Track Handoff functions when in the Multiple Function mode (see 3.3.4.2.7.2.2). The "home" position shall be the display center, in radar coordinates. If the display center is not addressable in radar coordinates (because of display off-centering), the trackball shall be presented at that (addressable) radar

3.3.4.2.10.1.6 (continued)

position nearest the display center. The display of the trackball symbol shall be inhibited at the "home" position and shall appear upon detection of movement of the trackball.

3.3.4.2.10.2 Display Output Processing Design.- The display output processing task may be divided into two separate functions: buffer preparation and output chain list preparation. The subprograms employed to perform these functions are designed to meet all functional requirements while satisfying the timing restriction of the IOP and the system time delay imposed by the FAA-TD/S-120-801 specification. The specification states that a total system delay of 1.2 seconds from receipt of video to display of alphanumerics shall be the maximum for tracked aircraft; two (2) seconds shall be the maximum for uncontrolled aircraft.

The above requirement may be taken as a time from target declaration to time of alphanumeric presentation (since target length is not defined) for tracked targets. No requirement was specified for the time delay associated with keyboard messages. This is defined in the following paragraph.

For all messages pertaining to tracked aircraft (for example, track start, modify, handoff, and so forth) the maximum delay shall be 1.2 seconds; for preview data (message characters), the maximum delay shall be 0.2 seconds; for readout data (contained in the preview) tabular and preview location, and for system data (time, altimeter setting, and so forth), the maximum delay shall be 0.5 seconds; and for messages pertaining to uncontrolled targets (for example, filter limits, selected code symbology, and so forth), the entry will effect only new data. Therefore, the initial response shall be within 1.2 seconds and the complete response (for the full 360 degress of data) shall be within 5.2 seconds.

The display output programs shall interface with all radar subsystem (ASR-4 and ASR-7) and shall be used in both dual and single radar systems.

3.3.4.2.10.2.1 Display Output Buffer Preparation.- Two major buffer areas shall contain display output data: the Common Active Track Buffer (CATB) and the Track Chain List (TCL). All other output data shall be contained in the display parameter tables and the common system data buffer (time and altimeter setting and memory readout data).

The CATB shall contain all track data: active control track FDB and single symbols (SS), quick look, handoff, active track readout formats, emergency and radio failure formats, and tabular line data. TCL shall contain uncontrolled target data: emergency, radio failure, hijack and suspect aircraft LDBs, unfiltered altitude LDB readouts, selected and unselected Mode C SS, selected and unselected non-Mode C SS, radar target SS, and identified uncontrolled track readouts (maximum of one per keyboard) - together with the chain commands for both the controlled and uncontrolled data. Preview data (including error and controller-requested readouts), trackball symbols, and the system display data shall be contained in and transferred from the display parameter tables.

3.3.4.2.10.2.1 (continued)

The display parameter tables shall be maintained by the keyboard input processing subprogram. The output chain commands for this data shall be contained in a Fixed Chain List (FCL) (one per display), and the chain commands shall also be maintained by the keyboard input processing subprogram. In this way, the buffer area and the chain commands shall be updated only when a change occurs, and the time-to-update shall be minimum.

The tracked target data in CATB (controlled and uncontrolled) shall be maintained by various subprograms including tracking, keyboard input processing, auto-offset, and interfacility input processing. In the dual radar systems, two CATBs (one per subsystem) shall be maintained. The output chain commands for tracked target data shall be prepared and maintained by the display output Chain Preparation Subprogram (CPS). The commands for the tracked data shall be contained in a single area of memory. That area shall include the commands for each data block (CATB), the controlled and uncontrolled track SS data, and the tabular data for each display, plus sufficient memory to repack the list of one display. Each list shall be variable in length and shall be relocated within the output chain area that each list updates. TCL of the display shall be referenced from the FCL and shall return control to the FCL. Figure 3-39 shows the tracked chain list, and the fixed chain list is described in 3.3.4.2.14. Table 3-20 lists the display output buffers used.

<u>3.3.4.2.10.2.2 Display Output Chain Preparation (CPS)</u>.- The CPS shall be referenced from the executive once per second per display. Upon entry, the CPS shall completely repack the TCL for one display. This approach will insure that the TCL of each display is updated at a frequency satisfying the system time delay, and that the chain list maintains a structure which most efficiently utilizes the display capability and memory. Effective utilization of the display capability requires that a minimum of alphanumeric write times (radar dead times) are wasted. This shall be accomplished by storing the alphanumeric write time available (AWT - a value less than dead time and dependent on radar PRF), and also storing the write time required for FDBs, LDBs and SS formats. The CPS shall retain a counter for each display indicating the available time and,,as each chain command is packed, the counter shall be decremented. When an insufficient AWT is available, a command shall be packed to transfer the "Do Not Process" (DNP) A-word. When transferring FDBs, the DNP A-word shall be followed by the next FDB's B-word; that is two successive A-words shall not be transferred.

The end TCL of each display shall contain a jump command to transfer I/O control back to the FCL of that display. The jump in the FCL (transferring control to the TCL) shall be modified upon completion of the TCL. After approximately 30 milliseconds, the old TCL of the display shall represent available memory for repacking the TCL of the next display.

In preparing the TCL for one display, the CPS shall search the CTS. Each controlled active track shall be considered to determine if it is:

1) Controlled by any position associated with that display
2) In handoff status to a position at that display

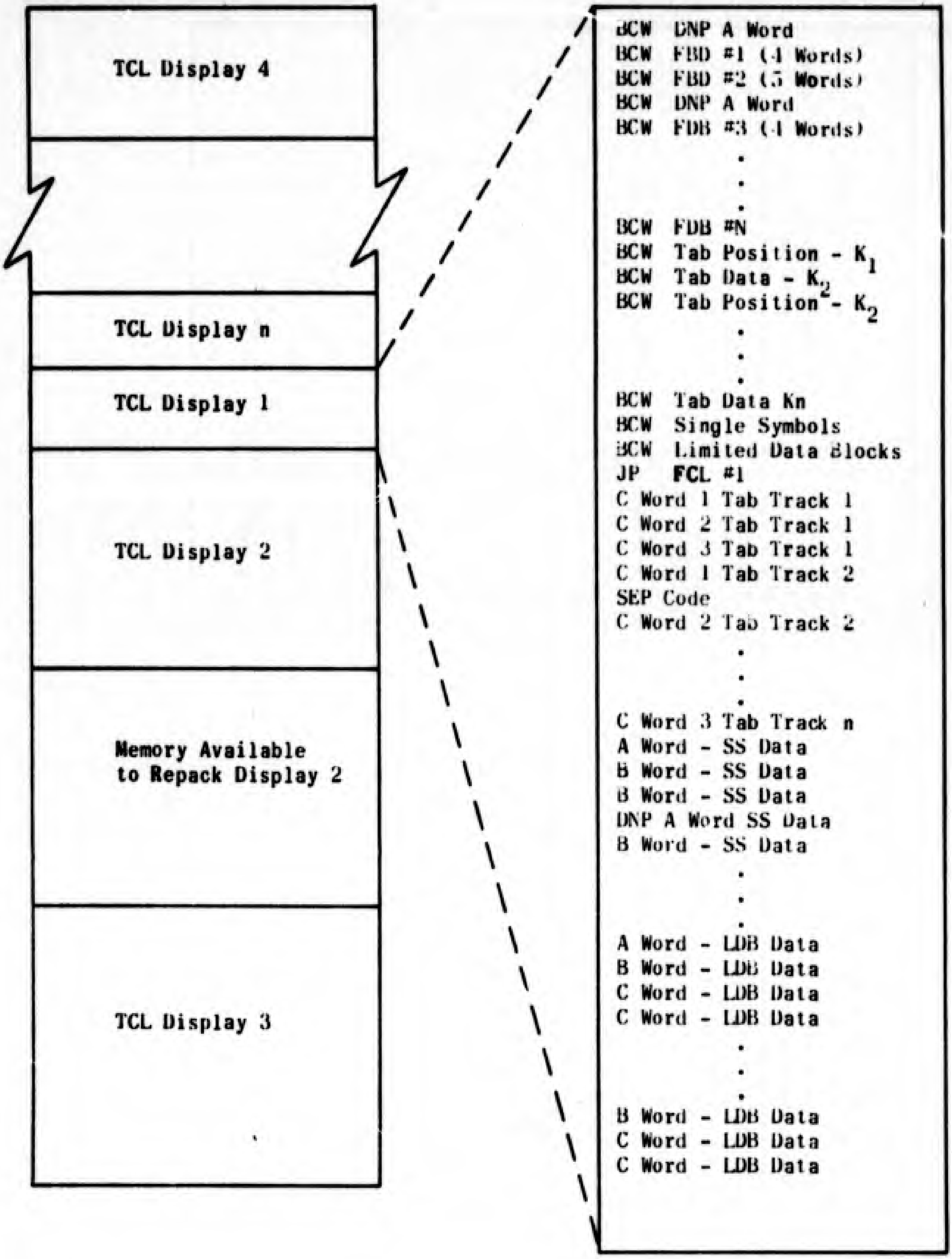


Figure 3-39. Tracked Command Chain List (TCL)

TABLE 3-20. DISPLAY OUTPUT BUFFERS

Display Output Data	Buffer	
Controlled Tracks		
Active controlled track formats	CATB	Keyboard Input, Tracking, Auto Offset, Interfacility Input
Tracks in handoff to display	CATB	
Tracks just accepted from display	CATB	
Tracks quick looked by display	CATB	
Tracks in selective QL (readout)	CATB	
SS of all other active tracks	CATB	
Tracks in handoff coast to display	CATB	
Tracks in handoff coast accepted from display	CATB	
Tabular tracks - each keyboard at display	CATB	
Uncontrolled Beacon Tracks		
Emergency and radio failure target formats	TCL	Tracking
Mode C (selected and unselected) within alt. limits	TCL	
Mode C (selected and unselected) outside alt. limits	TCL	
Non-Mode C (selected and unselected) SS formats	TCL	
Target symbology for suspend tracks	TCL	
Identified beacon code readout formats	TCL	
Uncontrolled Radar Tracks	TCL	
System Data		
Time, altimeter setting, general systems information, emergency & memory readouts	COMMON	Keyboard Input
Selected code list	DISPLAY	
Keyboard (Preview) Data	KEYBOARD	
Trackball Data	KEYBOARD	

3.3.4.2.10.2.2 (continued)

3) A track handoff from a position at that display and still in a readout status on that display
4) Controlled by a position being quick looked by any position at that display
5) A track selected for readout by any position at that display.

If none of the above criteria is met, the position of the active controlled track shall be considered to determine if SS presentation is required; that is, X, Y, filtering is performed. If the position falls within the range and off-centering of the display, that track shall be flagged (in the CATB) for SS symbology.

The search of the CTS shall follow the controlled track threaded ACID order (that is, the first track file considered shall be the first in alphabetical order). Then, the controlled track files in tabular status will be found in their alphabetical order, facilitating preparation of the tabular data.

Tracks found to be in tabular status (coast, suspend or store) shall be checked to determine if they are controlled by a position associated with the display being processed. If the tabular track has no assigned line identity, an attempt shall be made to assign a line ID. The TN of all coast and suspend track files and all store tracks with a line ID shall then be placed in the TABular Index Table (TABIT) and the associated index shall be incremented. Upon completion of the active track commands, the TABIT shall be used to develop the tabular commands and the tabular buffer data. Both the output commands and the buffer data for all tabular lists shall be contained in the TCL.

After the tabular data commands have been completed, the SS data for controlled aircraft shall be prepared. The B-words for all controlled tracks flagged in the CATB shall be transferred to the TCL. The necessary A-words to control the AWT will also be transferred to the TCL together with the chain command to transfer the SS data.

The uncontrolled tracks shall be processed next. The search of the CTS shall follow the uncontrolled track thread. All uncontrolled tracks shall be flagged in CTS for appropriate presentation on each display through prefiltering. If the uncontrolled track's position is outside the area of the display (based on the range of the display and off-centering), its display indicators in CTS, for the display being processed, shall be cleared to indicate that no display presentation should be made for this uncontrolled track. To determine whether or not the uncontrolled track is on a particular display, a check shall be made on the X, Y coordinates of the track versus the X, Y coordinates representing coverage on the display by referencing the display parameter table. Those tracks flagged as SS shall be transferred to the TCL along with the necessary A-words to control the AWT and with the chain command to transfer the SS data.

After the uncontrolled track SS data commands have been completed, the LDB data for uncontrolled aircraft shall be prepared. All uncontrolled tracks

3.3.4.2.10.2.2 (continued)

flagged in CTS for LDB formats through prefiltering shall be formatted as appropriate LDBs (e.g., altitude readouts, emergency code presentations, etc.) are transferred to the TCL together with the necessary A-words to control the AWT. A chain command shall then be stored to transfer those LDB words. Finally, the jump command shall be stored to return control to the FCL, and the jump command in the FCL shall be changed for reference of the new TCL. Control shall then be returned to the executive.

In preparing the TCL, checks shall be made to insure that enough area is available to contain the next format (BCW, tab list buffers, SS buffer, or LDB buffer). If sufficient area is not available, an alarm printout shall be requested. The data lost shall be uncontrolled track data first, then controlled track SS data, then tabular data, then FDBs. A chain list for one display may also progress from the end of the TCL to the beginning. In providing for this, words may be wasted (last words in TCL may not be used). However, the number of words wasted shall not exceed that required for an LDB buffer or an SS buffer or the tabular lists.

When interfacing with the ASR-7 (staggered pulse periods), two AWT values shall be used. The two (alternating) values shall provide added write time; however, additional DNP A-words must be used to maintain synchronization when the chain list transfers from the FCL to the TCL. With a non-staggered radar subsystem, only one AWT value shall be used and all resynchronization checks shall be bypassed to prevent wasting DTs. The available write time may be approximated by the following equation:

$$AWT = 56 + DT/2$$

where

DT = total DT of a display with a 55 nm range. The DTs for ASR-7 subsystem shall be 953 and 833 microseconds.

3.3.4.2.10.3 Display Output Data Base.- The tracked Command Chain List (TCL) and the TABular Index Table (TABIT) described on the following pages are those tables used by the chain preparation subprogram only. Tables and buffers used by CPS and other subprograms are described in 3.3.4.2.14 and are listed below:

1) Central Track Store (CTS)
2) Fixed Chain List (FCL)
3) Display parameter tables
4) Common Active Track Buffer (CATB).

3.3.4.2.10.3.1 Tracked Command Chain List (TCL).- The TCL shall contain all display output commands for active controlled tracks, tabular tracks, SS data, and uncontrolled tracks data, as well as the buffer areas for tabular, SS and uncontrolled LDB data. The commands and buffers shall be contained separately within the TCL. The area used for commands and buffers of any display shall be

3.3.4.2.10.3.1 (continued)

variable in length and shall rotate within the TCL as the area of each display is periodically repacked. The SS data includes single symbols representing aircraft controlled at other displays and not presented as FDBs on the display, together with single symbols of all uncontrolled aircraft not eligible for LDB presentation. The LDB data includes LDBs for all uncontrolled aircraft that fall within the coverage of each display. Further, no SS or LDB data need be prepared if they are inhibited by keyboard message request filtering.

The storage required for the TCL shall provide for worst case (all tracks uncontrolled).

The equation for memory required is:

$$3T\ (D+1)\ +\ 100$$

where

D = number of displays defined for each system

T = number of tracks defined for each system.

In a dual radar system, a TCL shall be associated with each radar system. The TCL is shown in figure 3-39.

3.3.4.2.10.3.2 TABular Index Table (TABIT).- The TABIT is an internal temporary table prepared by the CPS to aid in development of the tabular buffers and output commands. The TABIT shall require 99 words of memory, one index word and 32 words of storage for up to three keyboards at one display. The 32 storage words shall retain the internal track numbers of the keyboard's tabular tracks--store tracks in the lower, coast/suspend tracks in the upper half word. The index word retains the number of tabular tracks. Because the tabular tracks are found by following the threaded (alphabetically) CTS list, the track numbers in TABIT will be in their proper alphabetical order. The TABIT is shown in figure 3-40.

3.3.4.2.10.3.3 Display Output System Parameters.- Table 3-21 contains a list of the system parameters used by Display Output Processing, togehter with their discription and value range.

3.3.4.2.11 Automatic Offset.- The following paragraphs describe the general requirements, design, and data base of automatic offset.

3.3.4.2.11.1 General Requirements.- The automatic offset function (selectable at each display by keyboard entry) shall attempt to minimize alphanumeric format overlapping at each display. The active controlled track formats at each display shall be periodically checked to determine if format overlap exists.

Word 1	No. of Coast/Suspend	No. of Store	Keyboard 1
2	TN	TN	
.	.	.	
.	.	.	
.	.	.	
33			
34	No. of Coast/Suspend	No. of Store	Keyboard 2
35	TN	TN	
.	.	.	
.	.	.	
.	.	.	
66			
67	No. of Coast/Suspend	No. of Store	Keyboard 3
68	TN	TN	
.	.	.	
.	.	.	
.	.	.	
99			

Figure 3-40. Tabular Index Table (TABIT)

TABLE 3-21. DISPLAY OUTPUT SYSTEM PARAMETERS

ITEM	DESCRIPTION	VALUE RANGE
CCNTQ	Number of scans of coast allowed before track is placed in tabular coast list	$0-17_8$
CNTDNQ	Number of scans on FDB in handoff status is presented (forced and blinking) on the sender's console after acceptance of the handoff by the receiving console	1-5
ASQ	Time, in minutes, prior to ETA when a flight plan is transferred to store status	0-500
DSQ	Time, in minutes, prior to PTD when a flight plan is transferred to store status	0-500
SCRQ	Time to display scratch pad data	$0-17_8$
VCQ	Value used for good altitude validity	0-3
BCNTSQ	Number of scans that an identified uncontrolled track readout is displayed	$0-12_8$
DTFDQ	FDB alphanumeric write time, in microseconds	64-S1D1Q
S1DT1Q	Usable alphanumeric write time (radar dead time), in microseconds, based on radar PRF	132-265
MXCT1Q	Altitude C-word write time, in microseconds	15-25
MXCT4Q	Speed C-word write time, in microseconds	8-25
AADTQ	A-word write time, in microseconds	.33
DBBQ	Data block B-word write time, in microseconds	16-19
SSBQ	Single symbol B-word write time, in microseconds	13-16
TBBQ	Tabular B-word write time, in microseconds	10-13

3.3.4.2.11.1 (continued)

If overlap is detected, the offset of one of the formats shall be changed. Only the active tracks controlled by the position or positions at one display shall be considered. No attempt shall be made to prohibit an active track format from overlapping with untracked target readouts, quick looked tracks, handoff tracks, tabular lists, preview data, or single symbols (representing other controlled aircraft or untracked aircraft). Also, no attempt shall be made to prohibit crossing leaders. Format offsetting off the display scope shall be prohibited.

3.3.4.2.11.2 Automatic Offset Design.- One subprogram shall perform the auto offset function. This subprogram shall be referenced from the executive once every six seconds per display. On each reference, one display shall be considered and all necessary offset changes shall be made. Track format offset shall be stored in the CATB (the buffer area which shall be transferred directly to the displays). The automatic offset subprogram shall use the position data table to determine the display offset (north or northeast), display range, and off centering. Alphanumeric size and leader length shall be prestored parameters.

The automatic offset subprogram shall employ a 120-word map table which depicts the display scope. The map table may be viewed as a 60 by 60 matrix where each element of the matrix corresponds to a bit in memory and also represents a portion of the display scope. A set bit shall represent an alphanumeric character(s) on the scope or an unviewable portion of the scope.

Initially, bits shall be set to represent the perimeter of the scope. The CTS shall then be searched for all active track formats controlled at that scope. When one is found, the position and format offset is determined from the CATB. Bits shall then be set in the map table to represent the alphanumeric tag. If these bits are already set, an overlap shall be declared. The number of conflicting bits required for declaring an overlap condition shall be a parameter. Once overlap is declared for an active track format, the next (clockwise) offset shall be considered. If no overlap is detected at the next offset position, the new offset shall be stored in the CATB, the corresponding bits shall be set in the map table, and the next active controlled track shall be considered. If overlap is found at all offsets, no offset change shall be made.

If the format offset is changed from a one to a two (01 to 10) or from a three to a zero (11 to 00), the ACID shall also be changed in CATB from left to right-justification or from right to left-justification, respectively. The offset direction and offset value (bits 6 and 7 of the A word) are shown in figure 3-41.

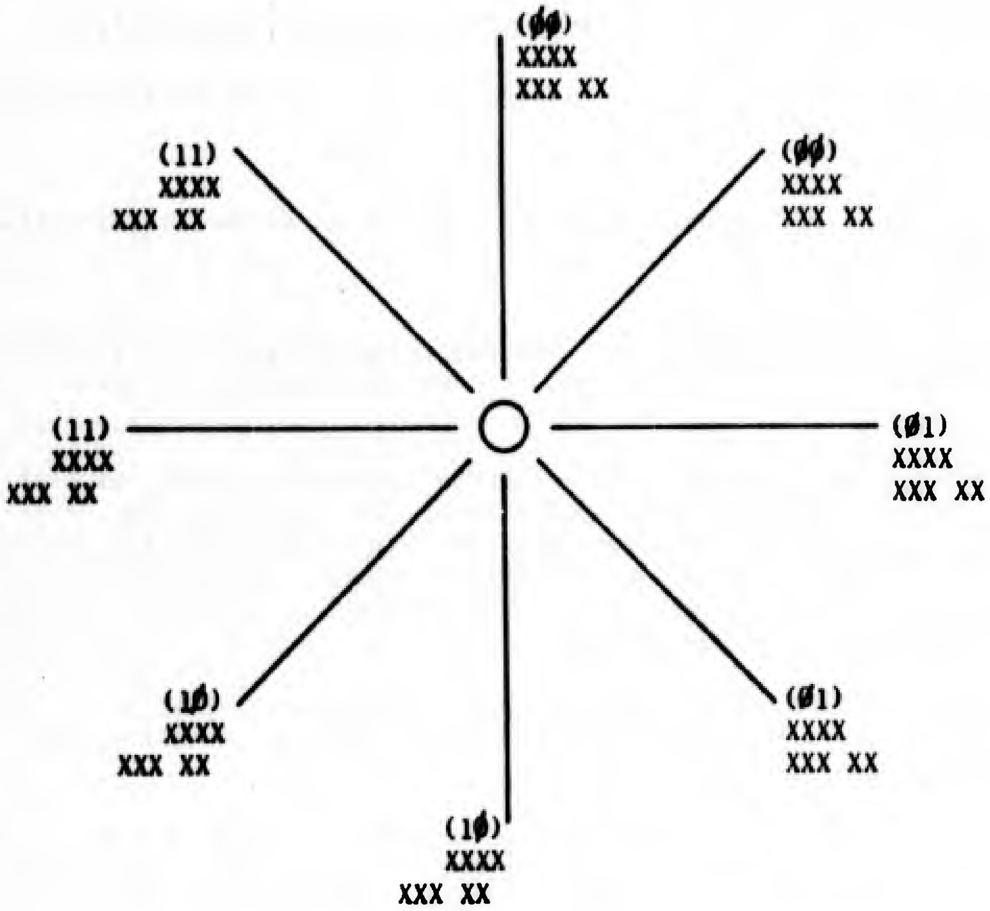


Figure 3-41. Leader Orientation

3.3.4.2.11.3 Automatic Offset Data Base.- The automatic offset subprogram shall require the following data tables:

1) A 12-word table, by display, containing the controller positions at that display (up to three/display)
2) A 12-word table, by display, defining selection of each display, alphanumeric size (including spacing between characters), and leader length
3) A 120-word map table
4) A 30-word table to facilitate map table (perimeter) preparation.

The auto offset function shall also require use of the CTS, the position data tables, and the CATB (see 3.3.4.2.14).

3.3.4.2.11.4 Automatic Offset Parameters.- These are no parameters associated with automatic offset.

3.3.4.2.12 Console Typewriter Output.- The following paragraphs describe the general requirements, design, and data base of console typewriter output.

3.3.4.2.12.1 General Requirements.- The console typewriter output function supports other major operational program functions. Tasks include the detection of printout requests, the preparation of the output data, and the transfer of that data to the console typewriter. Printout requests are made by the various subprograms. The types of printouts are divided into three categories: 1) alarm, 2) recording, and 3) requested.

Alarm printout requests result from program-detected malfunction in the hardware, as well as program-detected data errors in input data. A list of the alarm printouts is contained in table 3-22.

Recording printouts result from the receipt of selected keyboard messages. The purpose of these printouts is to provide a record, on hardcopy, of the event, the initiating position, and the time of occurrence. The various recording printouts are:

ALTM	K	14:04:01	29.92	Altimeter setting change
TIME	K	14:05:00	14:04:30	Time change
MEM	K	14:59:10	004240 0000000014	Memory contents change
STAT	K	15:30:00	X = PB	Keyboard status change
CFG	K	20:24:59	4	Configuration change
CONS	K	23:40:22	E = A	Consolidation - position E with A
DCON	K	06:20:01		Deconsolidation
MTU	K	07:19:59	(SELECT or INHIB)	MTU select or inhibit entry
IF	K	08:20:09	(SELECT or INHIB)	Interfacility select or inhibit entry

TABLE 3-22. ALARM PRINTOUTS

Printout[1]				Requesting Subprogram	Description
POWER FAIL	(TYPE)[3]	(TIME)	(SUBS)[2]	Executive	A power tolerance or auto restart interrupt was received.
BDAS FAILURE	(TYPE)[3]	(TIME)	(SUBS)	Beacon Input	No data is being received from the BDAS or unknown interrupt occurred.
BDAS IN PAR		(TIME)	(SUBS)	Beacon Input	Input (or interrupt) was received with a parity error.
BDAS FORMAT	(TYPE)	(TIME)	(SUBS)	Beacon Input	The first buffer word (azimuth) contained an error.
BDAS TEST TGT		(TIME)	(SUBS)	Beacon Input	The BDAS test target was not detected or was in error.
BDAS PRF		(TIME)	(SUBS)	Beacon Input	The beacon PRF was not within expected limits.
BDAS SENSOR		(TIME)	(SUBS)	Beacon Input	The BDAS received an error indication.
BDAS ALARM		(TIME)	(SUBS)	Beacon Input	The BDAS detected a range/azimuth error.
BDAS OVERLOAD	(TYPE)	(TIME)	(SUBS)	Beacon Input	Reply words were lost - DPS did not accept input.
RDAS FAIL	(TYPE)	(TIME)	(SUBS)	Radar Input/ Systems Timeout	See digitizer interface, I/O, video processing alarms, table 3-3.
RDAS PARITY	(TYPE)	(TIME)	(SUBS)	Radar Input	See parity alarms, table 3-3.
RDAS SYNC	(TYPE)	(TIME)	(SUBS)	Radar Input	Sync-code is not detected by the radar I/O routine, or Quantizer Control detects insufficient sweep data to perform zone update, table 3-3.
RDAS RTQC	(TYPE)	(TIME)	(SUBS)	System Timeout	The RVD-4 test target was missed; insufficient beacon radar correlations, table 3-3.
RDAS TIMING	(TYPE)	(TIME)	(SUBS)	Radar Input	The RVD-4 detected an azimuth or range alarm, table 3-3.
RDAS OVLD	(TYPE)	(TIME)	(SUBS)	Radar Input	Radar input processing lags or report table overflows, table 3-3.
DEDS FAILURE	(CHAN)	(TIME)	(SUBS)	System Timeout	An I/O failure detected on the indicated display channel.

(Table 3-22 continued on page 3-230)

TABLE 3-22. ALARM PRINTOUTS (continued from page 3-229)

Printout[1]				Requesting Subprogram	Description
DIS OUT PAR	(CHAN)	(TIME)	(SUBS)	Keyboard	A display output parity error was detected.
DIS OUT LOSS	(TYPE)	(TIME)	(SUBS)	Display Output	A DPS buffer overflow caused loss of output data.
KEY IN TIME	(CHAN)	(TIME)	(SUBS)	Display Output	A display input timing error was detected.
KEY IN PAR	(CHAN)	(TIME)	(SUBS)	Display Output	An input (or interrupt) parity error was detected.
KEY FORMAT	(CHAN)	(TIME)	(SUBS)	Display Output	An error in the input data format was detected.
KEY ILL INT	(CHAN)	(TIME)	(SUBS)	Display Output	An improper (illegal) interrupt was received.
CTS OVRFLO A	(N)[5]	(TIME)	(SUBS)	Tracking	Auto-initiation cannot take place because of system load.
BOT OVERFLOW	(N)	(TIME)	(SUBS)	Tracking	A beacon-only report was discarded because of system load.
ROT OVERFLOW	(N)	(TIME)	(SUBS)	Tracking	A radar-only report was discarded because of system load.
ALL CLEAR	(TYPE)	(TIME)	(SUBS)	System Timeout	Digitizer interface or timing clear, table 3-3.
CTS DUP ID	(N)	(ACID)[4]	(TIME)	System Timeout	An FP has been discarded from CTS because of duplicate ACID.
IF NO ACKNOL	(N)	(ACID)	(TIME)	Interfacility	An acknowledge message was not received.
DUP BCN	(N)	(ACID)	(TIME)	Interfacility/ System Timeout	Beacon code discarded due to two identical discrete codes (remainder of message discarded).
IF DUP ID	(N)	(ACID)	(TIME)	Interfacility	An IF FP message has been discarded because of duplicate ACID.
IF NO UPDATE		(ACID)	(TIME)	Interfacility	The handoff has been suspended because no update was received.
CTS OVERFLOW	(N)	(ACID)	(TIME)	Interfacility/ MT Flight Plan	An IF/MT FP message has been discarded because of system load.
IF FORMAT	(N)		(TIME)	Interfacility	A message received from the ARTCC contained a format error.
IF TEST FAIL	(N)		(TIME)	Interfacility	No response to test message.

(Table 3-22 continued on page 3-231)

TABLE 3-22. ALARM PRINTOUTS (continued from page 3-230)

Printout[1]	Requesting Subprogram	Description
IF OUT LOSS (N) (TIME)	Interfacility	System load resulted in data loss.
IF STATUS (TYPE) (TIME)	Interfacility	A hardware malfunction was detected.
MT DATA LOSS (N) (TIME)	MT Flight Plan	An FP has been discarded because of MT loss.
MT FORMAT (N) (TIME)	MT Flight Plan	Format error found in FP read from MT.
MT DUP ID (N) (ACID) (TIME)	MT Flight Plan	An FP message has been discarded from FP temporary table.
MT FAILURE (N) (TIME)	MT Flight Plan	Communication failure with the MTU.
TRK CAPACITY (+ or -) (TIME)	System Timeout	Change of CTS capacity relative to 85 percent (SP).
BOT CAPACITY (+ or -)(TIME)	System Timeout	Change of BOT capacity relative to 85 percent (SP).
ROT CAPACITY (+ or -)(TIME)	System Timeout	Change of ROT capacity relative to 85 percent (SP).

NOTES:

1) Program jump keys 3, 4, 5, and 6 shall inhibit BDAS, display (DIS and KEY), IF/MT, and RDAS printouts, respectively.
2) The subsystem shall be blank in a single beacon subsystem.
3) An alphanumeric character may indicate type of error. Refer to the related program for an explanation of the code.
4) If the error is associated with an aircraft, the ACID shall be provided. A two-word table is provided each ACID to be printed.
5) N is the actal number of times the message has been requested since the last printout.

3.3.4.2.12.1 (continued)

```
AH    K   09:31:39    (SELECT or INHIB)   Auto-Handoff select or
                                          inhibit entry
CHGP  K   10:15:20    (PARAMETER)         Parameter change
```

Requested printouts shall result from a keyboard entry (MULtifunction, CFG, X, ENTER). Two different printouts, both of which reflect the configuration of the system, may be requested: that is, the "X"may be a 1 or a 2.

Requested printout Number 1 consists of a header, CFG1, requesting position identifier and time, followed by one line for each position. Included with each position identifier shall be the associated display identifier, the keyboard channel, the keyboard status, the subsystem (for dual beacon systems), and up to five quick look position identifiers.

The keyboard status shall be designated by a C for controller,an M for maintenance, and a P for paired position. If paired, the P shall be followed by the associated position identifier(s). The printout format is shown below:

```
CFG1   K    06:28:12
A 01   C     1 FGHIJ
B 01   C     1 FA L
D 02   PE    1 BDRF
E 02   C     1
X 02   M     1
```

Requested printout Number 2 consists of a header, CFG2, requesting position identifier, current configuration number, and time, followed by one line for each entry/exit fix combination used to define the configuration. Included with each combination shall be the associated primary controller and the active controller, if different. The active controller is different from the primary controller only when a consolidation entry was made. The printout format is shown below:

```
CFG2    K   1   06:32:29
J21*BCD         A
V30*BCD         A
   *BCD         B     C
J21*XYZ         C
J21*            D
 .
 .
 .
```

<u>3.3.4.2.12.2 Console Typewriter Output Design</u>.- One executive referenced subprogram shall be used to provide the console typewriter output capability. This subprogram (CTYP) shall be referenced once per second.

3.3.4.2.12.2 (continued)

The recognition of alarm message, recording message, and requested message requests shall be performed by searching a print request table.

The print request table (described in 3.3.4.2.14) shall be modified by those executive subprograms and interrupt routines which determine the need for an error printout. The print request table shall be ordered by priority: higher priority printout requests shall be honored first. Print messages shall have the following priorities: 1) alarm messages, 2) recording messages, 3) requested messages.

Preparation of the output data for transfer to the console typewriter generally involves the unpacking of prestored data, placing the various fields of the data in an output buffer, and initiating the output transfer. The various fields of the message may include time and subsystem (for dual radar systems), as well as ACID or channel number.

The requested printouts shall involve several lines of data. Each line shall be prepared and transferred separately. Indexes shall be maintained to indicate the next line to be prepared and transferred. Alarm printouts and recording printouts shall have priority over the requested printouts and will will be honored when requested, even before the completion of a requested printout.

Alarm printouts may be inhibited through selection of Jump Keys 3, 4, 5, and 6 (for DAS, DEDS, interfacility/MTU, and RDAS error printouts, respectively). Also, each alarm printout may be prevented from occurring more than once per minute. The above two restrictions are both tasks performed by the CTYP subprogram.

3.3.4.2.12.3 Console Typewriter Output Data Base.- The print request tables are shown in 3.3.4.2.14. Additionally, CTYP shall use approximately 140 words of prestored output data, and a 40 word output buffer. The prestored data shall be packed six characters per word with all necessary letters/figures and space characters. The prestored data shall be unpacked and stored in the output buffer (one character per word) prior to transfer.

3.3.4.2.12.4 Console Typewriter Output Parameters.- There are no parameters associated with console typewriter output.

3.3.4.2.13 System Timeout Processing.- The following paragraphs describe the general requirements, design, and data base for system timeout processing.

3.3.4.2.13.1 General Requirements.- There are a few unrelated timed tasks which must be periodically executed from the executive routine. The following is a list of these tasks which shall be grouped together and called system timeout processing:

1) Timeout I/O activity on all of the DEDS channels
2) Timeout the receipt of beacon target inputs from the BDAS
3) Update the clock time displayed on each display console
4) Monitor controlled track files set up for a one-second delayed terminate.
5) Perform the 3 (system parameter) scan countdown on all accepted handoffs
6) Monitor flight plans
7) Timeout the data transfers to and from the digitizer
8) Perform the 3 (system parameter) scan countdown on all identified (MULtifunction, BCN) uncontrolled tracks
9) Monitor the EM/RF/HJ/SA presentation in the system data area.
10) Flush old tabular coast tracks
11) CTS capacity test
12) Automatic track drop/handoff.
13) Timeout radar input processing
14) Check RDAS alignment
15) Re-enable video processing following suspension due to malfunction.

3.3.4.2.13.2 System Timeout Processing Design.- The System TimeOut Processing (STOP) subprogram shall be a low priority executive subprogram and shall be executed at approximately one-half second intervals. It shall exist in both subsystems of a dual radar system. It shall perform various timing functions related to timing out of I/O activity on the DEDS, RDAS and BDAS channels, updating the system clock, terminating track files, timing out blinking handoff formats, checking digitizer status and alignment, and monitoring flight plans. The following sections describe the individual subtasks of the STOP subprogram.

3.3.4.2.13.2.1 DEDS Timeout.- This subtask shall insure that input and output data transfers are progressing on all DEDS channels. This shall be accomplished by having the KIP set a timeout flag (one flag for each DEDS channel) each time a DEDS input chain monitor interrupt is processed. The STOP subprogram shall clear all timeout flags of DEDS channels and, if a timeout flag is already zero, this shall be interpreted as an I/O failure on the corresponding DEDS channel. This method shall detect both input and output failures, since DEDS input is triggered (in the DEDS) by receipt of the display output buffer. If a failure occurs, an error printout (DEDS FAIL) shall be provided on the console typewriter and the input chain of the channel shall be re-initiated. The output chain shall also be re-initiated at the beginning of the fixed chain list of the console.

3.3.4.2.13.2.2 BDAS Timeout.- This subtest shall timeout the receipt of input data from the Beacon Data Acquisition System (BDAS). The BDAS input monitor shall set a flag each time a BDAS external interrupt is received. The STOP routine shall clear the flag and, if it was already zero, this shall be interpreted as a BDAS I/O failure. Accordingly, an error printout shall be produced (BDAS FAILURE). The BDAS input chain shall be re-established if a BDAS I/O failure occurs.

3.3.4.2.13.2.3 Update Clock.- The clock time displayed in the preview area of each display console shall be updated every one second, based on the realtime clock. In a dual radar system, only one of the STOP subprograms shall update the time.

3.3.4.2.13.2.4 Terminate Tracks Set Up for Delayed Terminate.- Whenever a controlled track is terminated from the system, a one-second delay must be observed before the CATB of the track may be used for a newly initiated track. This will allow display output processor enough time to remove the FDB chain command of the track from the output chain of any scope which may be referencing the CATB data of the track.

This subtask, therefore, shall time the one-second delay for tracks to be terminated. After the one-second delay has elapsed, this subtask shall determine the status of track being monitored. If the track's status is tabular, it shall be terminated, making the track file available for future use. However, if the track's status is active, it shall be changed to an uncontrolled track. History data shall be retained for the tracking function.

3.3.4.2.13.2.5 Blinking Handoffs Timeout.- For all accepted handoffs, a three scan (system parameter) countdown shall be performed, starting from the time the handoff was accepted. When the three-scan countdown has elapsed, the following actions shall be performed by STOP:

1) For an ARTCC track (a track just accepted by the ARTCC from ARTS), the file of the track shall be set up for termination (to be performed in one second) and the blinking format shall be erased from the former ARTS controller's scope. The track file cannot be terminated immediately since time must be given to the display output processor to remove the FDB chain command of the track.

2) For handoffs accepted with the ARTS system, the blinking format shall be removed from the sender's scope.

3.3.4.2.13.2.6 Monitor Flight Plans.- Every half-minute (approximately 60 executions of STOP) all flight plans (FPs) shall be checked. If an FP's ETA/PTD is within -15 minutes/+5 minutes of current time, it may be eligible to become a store track. If the FP has a duplicate ACID with another track file (except FP), then, of course, it may not become a store track. In this case, if the FP is a departure, its PTD shall be increased by two minutes. Otherwise, (if duplicate ACID) the FP shall be discarded and a console typewriter printout (CTS DUP ID) shall be provided. If no duplicate ACID exists, then the FP shall be changed to a store track. If the FP has an entry/exit fix, the track controller shall be re-determined according to the current entry/exit fix configuration table. A tabular line ID (if available) shall be assigned to the track and the track shall be displayed in the controller's tabular list. If the track has a duplicate discrete ABC (with another track), the ABC shall be discarded and a console typewriter printout (DUP BCN) shall be provided.

3.3.4.2.13.2.7 RDAS Interface.- This subtask shall time out the transfer of data to and from the RDAS. The radar input processing routine shall set buffer active flags whenever initiating input and output chains. One flag shall be reserved for each of these chains. The input and output flags shall be reset during input and output monitor interrupt processing, respectively. The STOP routine shall check these flags. A time-out alarm, as defined in table 3-3, shall be generated if a flag is not set. Otherwise, the flags are cleared and the assumption is made that input and output is proceeding normally.

3.3.4.2.13.2.8 Monitor Identified Beacons.- This subtask shall countdown each active identified uncontrolled track readout. Starting from the time the readout is requested (Multifunction, BCN entry), a three scan (system parameter) countdown is performed, and, when the countdown has elapsed, the readout request is terminated.

3.3.4.2.13.2.9 Monitor EM, RF, HJ, SA Display.- When an uncontrolled track correlates on a 7700, 7600, 3100, or 1236 code, an EM, RF, HJ, or SA, respectively, is displayed in the system data area. This subtask shall erase the display of the EM/RF/HJ/SA when the 7700, 7600, 3100, or 1236 is no longer found in the system.

3.3.4.2.13.2.10 Monitor Tabular Coast Tracks.- If a controlled track remains in the tabular coast/suspend list for a period of five (SP) minutes, it shall be automatically terminated from the system.

3.3.4.2.13.2.11 CTS Capacity Test.- When an increase in the number of used CTS files above 85% (SP) capacity is detected, an I/O console printout (TRK CAPACITY +) is requested. When a decrease to or below 85% capacity is detected, the printout (TRK CAPACITY -) is requested.

3.3.4.2.13.2.11 (continued)

The number of used tracks shall be tested for 90% (SP) of CTS capacity. This test permits additional magnetic flight plans to be transferred into CTS above the 85% capacity. This shall reduce the repeated (TRK CAPACITY +) and (TRK CAPACITY -) printouts when CTS is at capacity and magnetic tape flight plan input processing (3.3.4.2.15) is active.

3.3.4.2.13.2.12 Automatic Track Drop/Handoff.- For each controlled track, a check shall be made to determine if the position falls in the automatic track drop area and, if it does, the appropriate bits shall be set in CTS for a delayed terminate track. In addition, any associated tracks shall be erased and the current time shall be stored in the active track file to allow for a one-second time-out check for terminating the track from the system. Those tracks currently in handoff to the ARTCC shall not be placed in delayed terminate.

The automatic drop area shall be determined by the following criteria:

a) Those tracks designated as arrival at the airport at which the radar is located shall be terminated upon penetration of an area around the airport defined by three ranges and three azimuths.

b) Those tracks designated as arrivals at up to five other major airports shall be terminated upon penetration of area, or bin, around each of the airports consisting of two ranges and two azimuths each.

c) All departure aircraft in each radar system shall be automatically terminated when no longer within two major areas (two ranges and two azimuths).

d) All overflights or tracks with undefined arrival/departure information shall be terminated when no longer within one specific range.

If the track does not fall in an auto-drop area, an additional check shall be made to determine if its position falls in an automatic handoff area. Additional criteria used to determine if the track is eligible for handoff are the track's beacon code, heading, airport in use, runway in use, controller, and arrival/departure/overflight status. If it is determined that the track is eligible for handoff, the handoff shall be automatically initiated to the appropriate controller.

The automatic handoff areas shall be determined by the following criteria:

a) Those tracks designated as arrivals at the airport at which the radar is located shall be handed off upon penetration of an area around the airport defined by three ranges and three azimuths.

b) Those tracks designated as arrivals at up to five other major airports shall be handed off upon penetration of an area, or bin, around each of the airports consisting of two ranges and two azimuths each.

3.3.4.2.13.2.12 (continued)

c) All departure aircraft which were originally received as flight plans from the ARTCC shall be automatically handed off to the ARTCC when no longer within two major areas (two ranges and two azimuths). This only applies to ARTCC with automated tracking capability.

All ranges, azimuths, beacon codes, headings, runways in use, and controllers are system parameters and are a function of the site at which the system is installed.

See 3.3.4.2.7 for disabling the automatic track handoff task.

3.3.4.2.13.2.13 Timeout Radar Input Processing.- This subtest shall timeout the radar processing functions during normal operation. Flags shall be set by each radar subprogram upon entry from the executive. System timeout shall assess the rate and number of these settings over a given time interval. If a sufficient deviation from an expected value is noted, it shall be interpreted as an RDAS failure. Accordingly, an alarm shall (RDAS FAIL) be signaled as described in table 3-3.

3.3.4.2.13.2.14 Check RDAS Alignment.- This subtask checks to see if a misalignment exists between the RDAS and BDAS resulting in a failure to correlate radar and beacon reports. It shall accomplish this by examining the current number of correlations and beacon reports (maintained by the beacon-radar correlation subprogram). If the ratio falls below a threshold (SP), an alarm shall be declared and corrective response directed in the manner described in 3.3.4.2.4.2.4.

3.3.4.2.13.2.15 Re-enable Video Processing.- Some RDAS digitizer interface alarms (see 3.3.4.2.4.2.4) shall result in the temporary suspension of radar input processing, particularly to the extent that radar reports shall be withheld from the correlation and tracking functions. This task shall determine when a specified number of error-free scans have elapsed since the sensing of such an alarm condition. At that time it shall set flags permitting the resumption of normal video processing, while sending an "all-clear" message to the console typewriter.

3.3.4.2.13.3 System Timeout Processing Data Base.- System timeout requires, for the most part, only flags or counters stored by other subprogram. These establish a reference point for a timed response by STOP. Otherwise, the principal data items (e.g., CATB and CTS) are described in the system data base section (3.3.4.2.14).

3.3.4.2.13.4 System Timeout Parameters.- Table 3-23 contains a summary of the System Timeout Parameters (SP) together with their labels and ranges of values.

TABLE 3-23. SYSTEM TIMEOUT PARAMETERS

ITEM	DESCRIPTION	VALUE RANGE
MAPQ	Time, in minutes, allowed for exclusive use of mapping function	0-10
FPMONQ	Time, in seconds, between monitors of CTS flight plan data	0-2048
TCFCQ	Time, in seconds, allowed for a tabular coast track before termination	0-2048
CNTDNQ	Number of scans an FDB in handoff status is presented (forced and blinking) on the sender's console after acceptance of the handoff by the receiving console	1-5
ACNTQ	Number of consecutive scans of code match for auto acquisition	0-7
ASQ	Time, in minutes, prior to ETA when a flight plan is transferred to store status	0-500
DSQ	Time, in minutes, prior to PTD when a flight plan is transferred to store status	0-500
SATQ	Percent of track slots used as the criteria for the track capacity printout	0-100
BCNTSQ	Number of scans that an identified uncontrolled track readout request is displayed before being terminated	0-10
RLINQ	Percent of radar-reinforced beacon targets to total beacon targets as the criteria for misalignment between the RDAS and BDAS	0-100
SATHQ	Percent of CTS at which transfer of flight plans from TS to CTS is stopped	0-100

3.3.4.2.14 System Data Base.- The following paragraphs describe the data base for the entire Augmented RBTL system.

3.3.4.2.14.1 Radar/Beacon Target Store.- The radar/beacon target store contains information on declared radar and beacon targets for use by the tracking function. The store is divided into three tables:

1) Target report store
2) Sector access store
3) Sector time store.

3.3.4.2.14.1.1 Target Report Store.- This store area shall be a revolving table containing two words of information on each target declared within sixteen consecutive sectors. The number of targets per sector is a function of the particular site installation.

The target report store is illustrated in figure 3-42.

3.3.4.2.14.1.2 Sector Access Store.- This shall be a 32-word table containing the target store indexes at which each sector of data begins. The upper fifteen bits of each word shall contain the number of target reports in the sector.

The sector access store is illustrated in figure 3-43.

3.3.4.2.14.1.3 Sector Time Store.- This shall be a 32-word table containing the time at which the first azimuth word was received at each sector. If hardware failure should cause a sector miss, a time shall be generated by radar/beacon correlation using the previous sector time as a basis for the estimate. See figure 3-44.

3.3.4.2.14.2 Central Track Store.- The CTS shall be a horizontal table that is referenced by track file number. The bit configurations of each word of the table are shown in figure 3-45. It should be noted that since any unused track file may be used for either a controlled or uncontrolled track, a specific word or field within a word may be defined differently for the two types of tracks. Where these fields differ, they will be defined appropriately.

The first nine words of the CTS shall be used for all track file types including turning, deviation, and trial tracks. Where applicable, bit fields shall be shared; for example, bits 22 through 25 of Word 6 contain the count for a parent track and a deviation trial track.

Basically, the data in CTS shall contain the positional data for an active track, such as the predicted range and azimuth in Word 2 and the predicted X

<table>
<tr><td></td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Word 2K</td><td colspan="13">Azimuth LSB = 1 ACP</td><td>E</td><td>R</td><td>T</td><td colspan="3">Q</td><td></td><td colspan="10">Range LSB = 1/16 nm</td></tr>
<tr><td>Word 2K+1</td><td>S</td><td colspan="2">Va</td><td colspan="12">3/A Code</td><td>W</td><td colspan="2">Vc</td><td colspan="12">Altitude BCD</td></tr>
</table>

Azimuth is in BAMs (binary angular measurement, 1 BAM = 360°, scaled +29)
Range is in nm scaled +4, LSB = 1/16 nm
3/A code is in binary
Altitude (corrected) is in BCD (hundreds of feet)

W = 0 = Weak target
    1 = Strong target
Va = 3/A Code validity
    0 = All codes garbled
    1 = One code ungarbled
    2 = One ungarbled and one garbled agree
    3 = Two consecutive ungarbled codes agree
Vc = C Code Validity
    0 = No C replies received
    1 = All C replies garbled
    2 = At least one ungarbled reply
    3 = Two consecutive ungarbled codes agree

S = Special position indicator
E = Emergency - 3/A code should be 7700
R = Radio failure - 3/A code should be 7600
T = Type of report
    0 = Beacon or beacon and radar
    1 = Radar only (will contain only range and azimuth)
Q = Radar report quality
    0 = No radar report merged
    1 = Hit count ≤ 8 (SP)
    2 = Hit count = 9, 10 (SP)
    3 = Hit count = 11, 12 (SP)
    4 = Hit count = 13, 14 (SP)
    5 = Hit count = 15, 16 (SP)
    6 = Hit count = 17, 18 (SP)
    7 = Hit count > 18 (SP)

Figure 3-42. Target Report Store

	29 28 27 26 25 24 23 22 21 20 19 18 17 16 15	14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 1	No. of Targets	Sector 0 Starting Index
Word 2	No. of Targets	Sector 1 Starting Index
Word 3	No. of Targets	Sector 2 Starting Index
	. . . .	
Word 32	No. of Targets	Sector 31 Starting Index

Figure 3-43. Sector Access Store

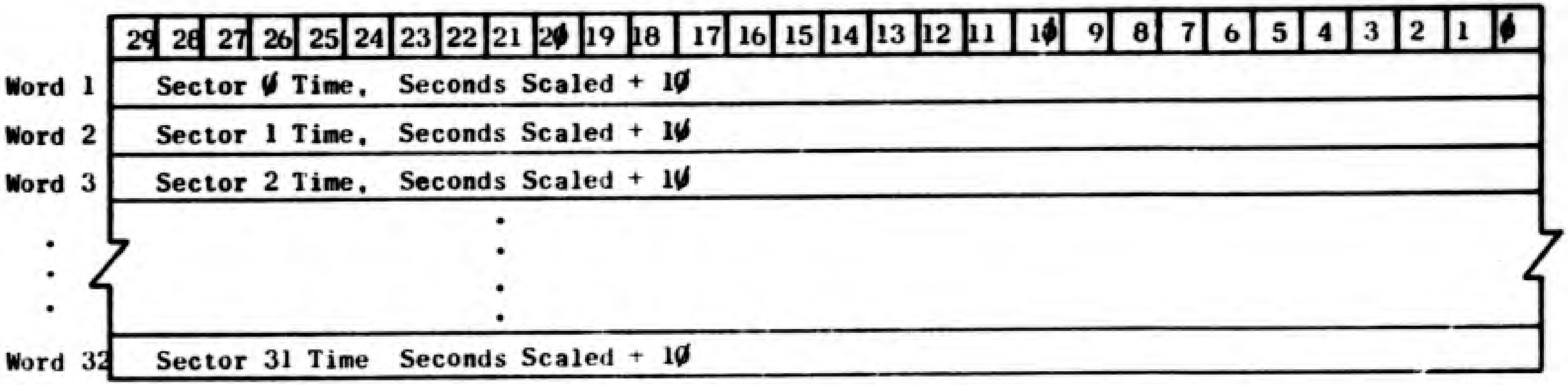


Figure 3-44. Sector Time Store

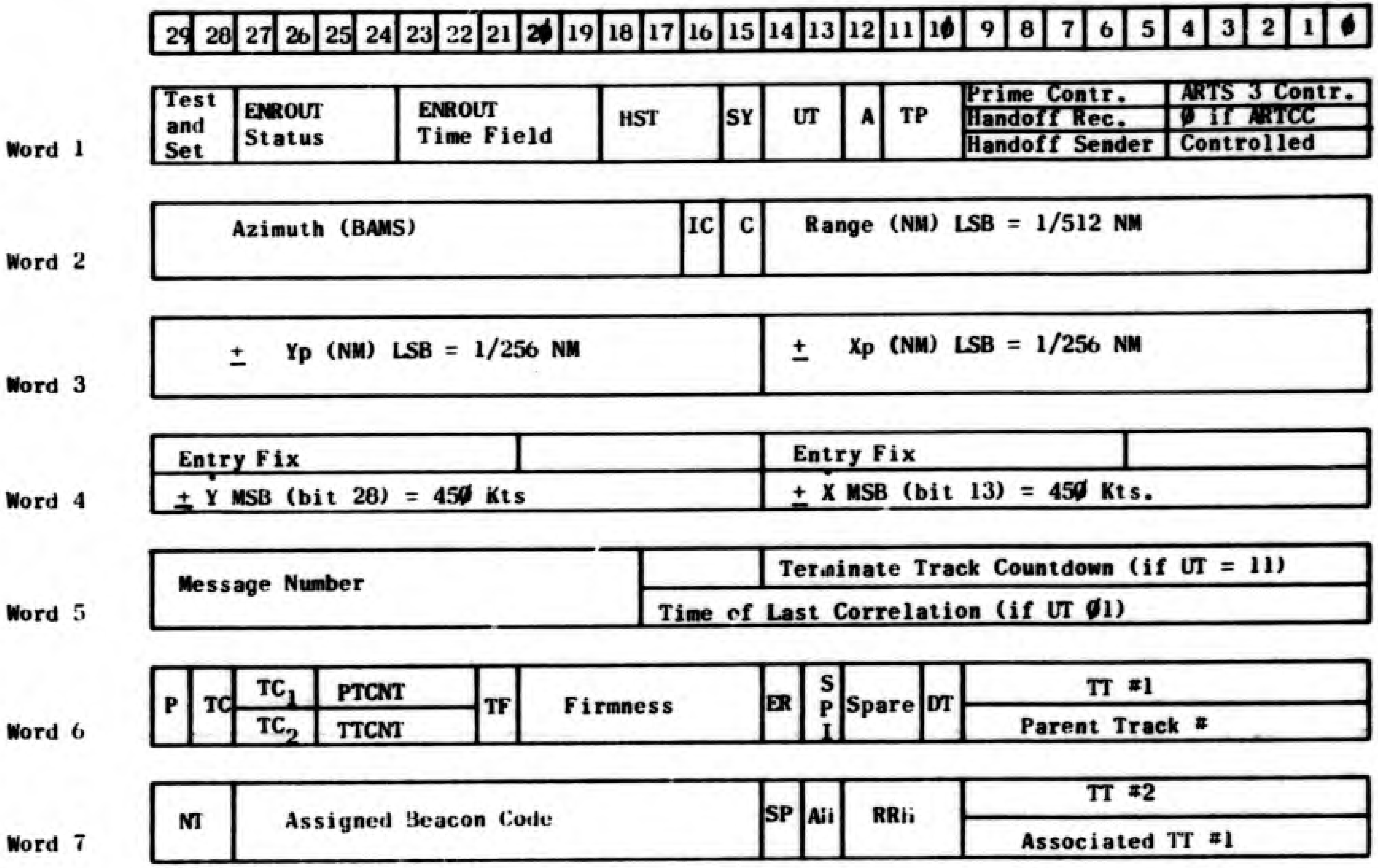
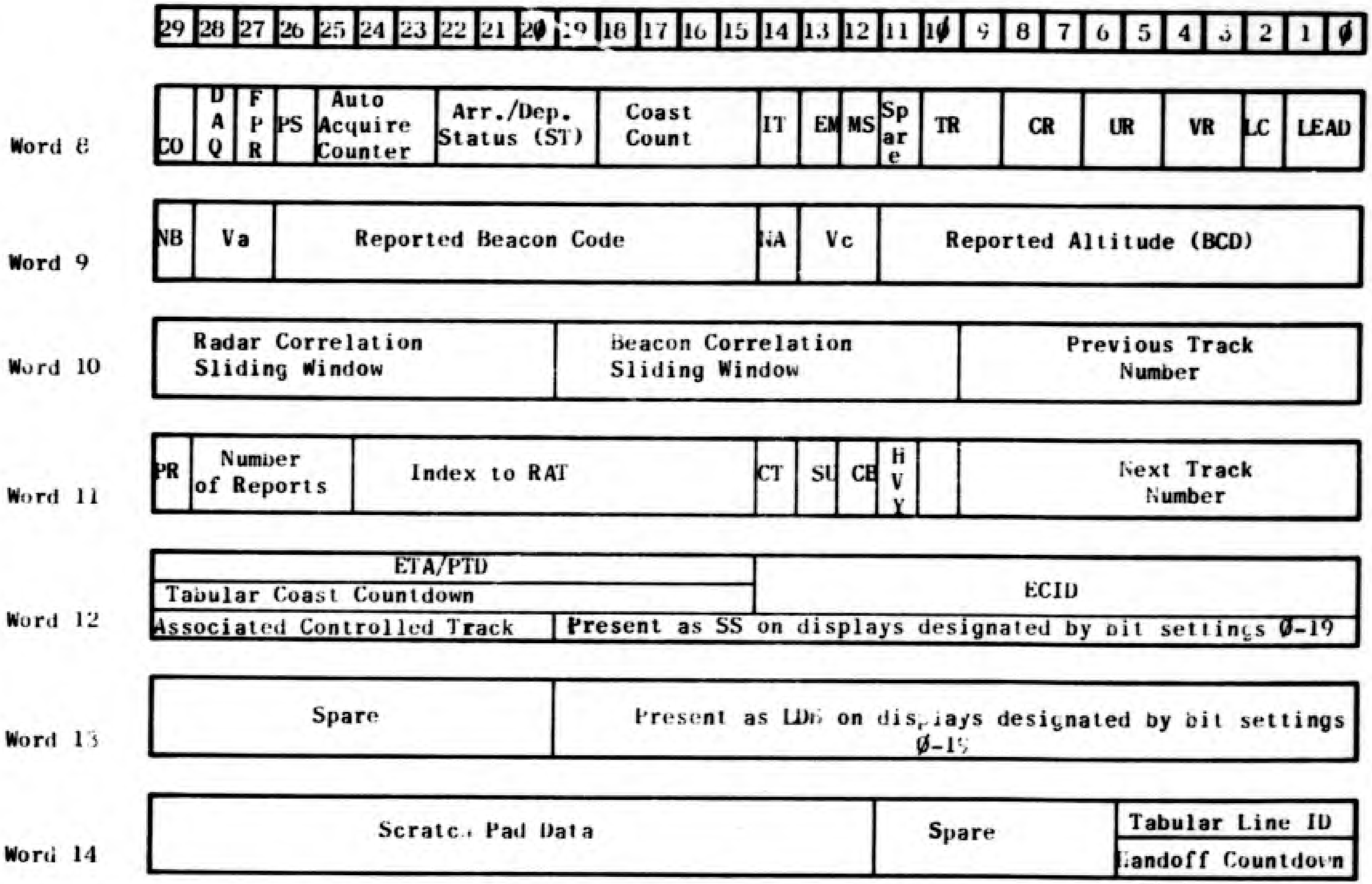


Figure 3-45. Central Track Store (continued on page 2-245)

(Figure 3-45 continued from page 2-244)



3.3.4.2.14.2 (continued)

and Y in Word 3, all in radar coordinates. In addition, the active track's X and Y components of velocity shall be found in Word 4, the time of last correlation in Word 5, and the Assigned Beacon Code (ABC) of the active track in Word 7, together with its associated turning or turning trial track numbers in Words 6 and 7 and its last reported code in Word 9. The remaining bits consist of flags and various sized fields related to a specific track file.

The size of CTS may be computed as follows:

$$15t + 9\ 1/8t = 15\ 1/8t$$

where

t = number of tracks in the system.

This allows for 12.5% of t as the number of trial tracks in the system.

Associated with CTS shall be three words used as pointers for the threading of controlled, uncontrolled, and unused track files, respectively. These pointers, together with the next and previous track numbers in the thread as maintained in CTS, provide immediate access to the three types of tracks without having to search all of CTS. These threads are maintained by the thread update task as described in 3.3.4.2.3.2.5.

3.3.4.2.14.2.1 Word 1.- Bits 0-4 contain the position number of the controlling position of the used controlled track. This field will be 0 if the track is controlled by the ARTCC and is undefined for uncontrolled track.

Bits 5-9 are defined as follows:

For store tracks, which were received as flight plans from the ARTCC, bits 5-9 contain the prime controller (i.e., that ARTS III controller which would normally have been assigned the track based on the flight-plan fix/airport data if no CFG keyboard entry had been made). This field is used for reassigning store tracks.

For tracks currently in handoff status, bits 5-9 contain the handoff receiver number.

For tracks recently accepted from handoff status, bits 5-9 contain the former (i.e., sender) track controller number.

Bits 10-14 define the type of track file and the status of the track file.

UT = 00, unused track file: a file available for new data
= 01, track file used, non-flight plan
= 10, track file used, flight plan
= 11, track file terminated (delayed terminate).

3.3.4.2.14.2.1 (continued)

For UT = 01:

A = 0, active track file, a general status referring to those files presented in an FDB format

TP =0, active normal, a file successfully maintaining positional association with a target (successfully tracking)

=01, active coast, a track which failed to correlate with a target

=10, active handoff coast, an active coast track in handoff to another controller (ARTS III or ARTCC)

=11, illegal

A = 1, tabular track file

TP=00, store track, a flight plan file which, because of its ETA/ETD, qualifies for presentation in a tabular list

=01, tabular coast, a file which was in active status but, because of extended unsuccessful tracking, was automatically transferred from Active Coast to Tabular Coast status

=10, suspend track, a file which was in active status, but because of a keybaord entry, had its tracking suspended

=11, illegal.

Bit 15 - subsystem bit

SY = 0, single radar system, or Subsystem 1 of a dual system

= 1, Subsystem 2 of a dual system.

Bits 16-18 are handoff status bits:

=000, track not in handoff or countdown

=001, intraradar or interradar countdown

=010, interfacility countdown, controller = ARTCC = 0

=011, intrradar or interradar handoff

=100, interfacility handoff to ARTCC, receiver = ARTCC = 01, 10.

Bits 19-23 and 24-27 are the ENROUT time field and ENROUT status for flight plans, respectively, and are interpreted as follows:

If ENROUT Status =	Then Do	Change ENROUT Status To	Change ENROUT Time To
0			
1	Send TO if ENROUT time non-zero		0
2	Send TI	3	Clock
3	*Send TI	4	Clock
4	*Setup printout IF NO ACKNOL (ACID)	0	
5	Send TA	5	Clock
6	*Send TA	6	Clock
7	*Setup printout IF NO ACKNOL (ACID)	0	
10	Send a DM	11	Clock
11	*Send a DM	12	Clock
12	*Setup printout IF NO ACKNOL (ACID)	0	
13	If 15 seconds (SP) has elapsed, place this track in OLD status		

*Perform this function only if ENROUT time indicates 500 miliseconds (SP) have elapsed.

3.3.4.2.14.2.1 (continued)

Bits 28 and 29 are used to implement the Test and Set instruction of the computer for the purpose of allowing one task to reference this track slot in specific instances.

3.3.4.2.14.2.2 Word 2.- Bits 0-14 contain the track's predicted range, scaled +9 in radar nautical miles, with the LSB = 1/512 NM.

Bit 15 contains the correlation flag, C.
C = 1, track correlated this scan
= 0, track did not correlate this scan.

Bit 16 contains the flag, IC, to inhibit PUR from attempting correlation on an active track that is coasting through an ambiguous situation.
IC = 1, inhibit correlation
= 0, do not inhibit correlation.

Bits 17-29 contain the predicted azimuth of the track, in BAMS, with bit 28 representing 180°, i.e., 1/2 BAM.

3.3.4.2.14.2.3 Word 3.- Bits 0-14 contain the track's predicted X coordinate, in one's complement and in radar nautical miles, scaled +8 with the LSB = 1/256 NM.

Bits 15-29 contain the track's predicted Y coordinate, in one's complement and in radar nautical miles, scaled +8 with the LSB = 1/256 NM.

3.3.4.2.14.2.4 Word 4.- Bits 0-14 and bits 15-29 contain shared fields. For an active track, bits 0-14 and 15-29 contain the track's X and Y components of velocity, respectively, in NM/second, with bits 13 (for X) and 28 (for Y) representing 450 knots. The LSBs (bits 0 and 15) represent approximately 1/20 of a knot.

Bits 6-14 and 21-29 contain a flight plan's Exit Fix and Entry Fix, respectively. The Exit Fix is the index to table APT of the destination airport for arrivals, coordination fix for departures, and exit fix for overflights. The Entry Fix is the index to the table APT of the coordination fix for arrivals and overflights and departure airport for departures.

3.3.4.2.14.2.5 Word 5.- Bits 0-17 contain a shared field. If it is actively tracked track, i.e.UT = 01, the field represents the time in seconds scaled T10 of the last successful correlation. If active tracking has been terminated, i.e., UT = 11, the field (bits 0-14 only) contains a counter for releasing a track file.

Bits 18-29 contain the 3-digit message number of the last T1 or TA message for this track sent to ARTCC.

3.3.4.2.14.2.6 Word 6.- Bits 0-9 contain a shared field. If this is a parent track, its first associated turning or trial track is stored in this field. If this is a turning or trial track, its associated parent track number is stored in this field.

Bit 10 defines the type of trial track.
DT = 1, deviation trial
= 0, turning trial.

Bits 11-12 are spare.

Bit 13 defines when a track has correlated with a target squawking ident.
SPI = 1, ident
= 0, no ident

Bit 14 defines where a track has correlated with a beacon report whose RBC = 7600, 7700, 3100, or 1236.
ER = 1, RBC = 7600/7700/3100/1236
= 0, RBC ≠ 7600/7700/3100/1236.

Bits 15-20 contain the track's firmness.

Bit 21 contains indication of whether a turning track was processed in first scan.
TF = 01, was processed in first scan
= 00, was not processed in first scan.

Bits 22-25 contain shared counters, TCNT for parent trial track, and TTCNT for a turning trial track.

TTCNT:	Counter for number of successful turning track correlations before transferring turning trial track data to associated parent track.
PTCNT:	Counter for number of successive successful correlations before a parent trial track becomes a normal track.

Bits 26-27 contain shared counters representing track class, one for straight-line tracks and the other for turning or turning trial tracks.
TC1 = 00, normal track
= 01, parent track
= 10, parent trial track
= 11, not used
TC2 = 00, right turn track
= 01, left turning track
= 10, right turning trial track
= 11, left turning trial track.

Bit 28 is a shared flag for initial and turning correlations.
TC = 1, a turning track created this scan with secondary reports; an initial track processed by initial correlation this scan
TC = 0, not the above turning track; an initial track not processed by initial correlation this scan.

3.3.4.2.14.2.6 (continued)

Bit 29 is the predict bit.
P = 1, track has been predicted this scan
= 0, track has not been predicted this scan.

3.3.4.2.14.2.7 Word 7.- Bits 0-9 contain a shared field. If this is a parent track with two turning tracks, the second associated turning track number is stored in this field. If this is a turning or turning trial track, its associated turning track number is stored in this field.

Bits 10-12 are the track's radar report history field.

Bit 13 is used to inhibit automatic handoff for this track.

Bit 14 is spare.

Bits 15-27 contain a track's ABC.

Bits 28-29 define the status of a track's beacon code.
NT = 00, track has ABC
= 10, track has tentative ABC
= 10, track has no ABC
= 11, not used.

3.3.4.2.14.2.8 Word 8.- Bits 0-1 define the new leader direction.
Lead = 00, N, NE
= 01, E, SE
= 10, S, SW
= 11, W, NW.

Bit 2 defines whether a keyboard entry changing the leader direction has been made.
LC = 1, new leader direction.

Bits 3-4 contain the flags to request a change to the unused CTS track file thread.
VR = 01, delete this track from the thread
= 10, add this track to the thread.

Bits 5-6 contain the flags to request a change to the uncontrolled CTS track file thread.
UR = 01, delete this track from the thread
= 10, add this track to the thread.

Bits 7-8 contain the flag to request a change to the controlled CTS track file thread.
CR = 01, delete this track from the thread
= 10, add this track to the thread.

3.3.4.2.14.2.8 (continued)

Bits 9-10 contain the TNP thread change request flags.
TR = 1X, delete track from TNP
= 01, add track to TNP.

Bit 11 is spare.

Bit 12 defines whether a track has established Mode C status through successive correlations.
MS = 1, track has Mode C status
= 0, track does not have Mode C status.

Bit 13 defines, via a keyboard entry, whether the indication for display of the detection of a 7700 and/or 7600 and/or 3100 and/or 1236 code should be inhibited.
EM = 1, inhibit display of EM and/or RF and/or HJ and/or SA
= 0, do not inhibit display of EM and/or RF and/or HJ and/or SA.

Bit 14 defines whether a track should be processed by initial correlation.
IF = 1, process in initial correlation
= 0, do not process in initial correlation.

Bits 15-18 contain the counter for the number of consecutive times a track has coasted. This counter is used to determine when the tracks should be automatically put in tabular coast or handoff coast.

Bits 19-22 contain the arrival/departure status of the track.
ST = 0000, overflight or unknown
0001, unknow arrival
0010, arrival at radar airport (UUU) for single or Subsystem 1 of a dual system
0011-0110, arrival at non-radar airports VVV,WWW,XXX,YYY
0111, arrival at radar airport (ZZZ) in Subsystem 2 of a dual system, or non-radar airport in single
1000, not used
1001, unknown departure
1010, departure from radar airport (UUU) for single or Subsystem 1 of dual system
1011-1110, departures from non-radar airports VVV,WWW,XXX,YYY
1111, departure from radar airport (ZZZ) for Subsystem 2 of a dual system, or a non-radar airport in single system.

Bits 23-25 contain the counter of the number of consecutive successful scans of code match for a track in store or coast with a discrete ABC. This counter will be used to determine when to start actively tracking a track, i.e., change it from inactive to active status.

Bit 26 is the 2nd pass flag used by primary/secondary correlation.
PS = 1, attempt 2nd pass correlation
= 0, do not attempt 2nd pass correlation.

3.3.4.2.14.2.8 (continued)

Bits 27 and 28 are defined as follows:

FPR (Flight Plan Received) gets set for a track slot if an interfacility flight plan was received for this track. It gets cleared whenever this flight plan (store track) becomes active. This bit, when set, permits ARTCC to modify this track slot.

DAQ (Disallow Auto Acquisition) this bit will be set for all interfacility arrival flight plans with a third ARTCC site. It may also be cleared via keyboard entry to allow auto acquisition for this track.

Bit 29 defines whether there is coordinate overflow in the dual beacon system.
C0 = 1, track coordinates are outside the limits of the other subsystem
= 0, track coordinates are within the limits of the other subsystem.

3.3.4.2.14.2.9 Word 9.- Bits 0-13 contain the altitude (in BCD) and the validity (Vc) of the latest report with which the track correlated.

Bit 14, if set, indicates no altitude on current scan.

Bits 15-28 contain the RBC and the validity (Va) of the latest report with which the track correlated.

Bit 29, if set, indicates no RBC on current scan.

3.3.4.2.14.2.10 Word 10.- Bits 0-9 contain the previous track number in the thread.

Bits 10-19 contain a sliding window which shows on which of the last ten scans the track correlated on a beacon target.

Bits 20-29 contain a sliding window which shows on which of the last ten scans the track correlated on a radar target (including a radar reinforced beacon).

3.3.4.2.14.2.11 Word 11.- Bits 0-9 contain the track number of the next controlled, uncontrolled or unused track file in the thread, dependent upon which one of the three (respectively) this track file is in.

Bit 10 is spare.

Bit 11 is the Heavy Jet indicator.
HVY = 1, Heavy
= 0, Non-heavy.

Bit 12 is indicator of last correlation on radar or beacon.
CB = 1, last correlated on radar only report
= 0, last correlated on beacon report.

3.3.4.2.14.2.11 (continued)

Bit 13 is used to designate that special suspend symbology is to be displayed for this uncontrolled track.

Bit 14 is used to define the type of track.
CT = 0, controlled track
= 1, uncontrolled track.

Bits 15-24 contain an index to RAT, where all reports found in the track's primary and secondary bins are stored.

Bits 25-28 contain the number of reports found in the track's bins.

These two fields, bits 15-24 and bits 25-28, are used in conjunction with the RAT table (see 3.3.4.2.9.3.5) to perform the cross referencing task in P/S correlation.

Bit 29 indicates whether the track has been processed by Primary/Secondary correlation this scan.
PB = 0, not processed
= 1, processed.

3.3.4.2.14.2.12 Word 12.- This word is shared for controlled and uncontrolled tracks.

Bits 0-14 contain the ARTCC internal computer identification and are used by the interfacility output processor in sending messages to ARTCC for controlled tracks.

Bits 15-29 contain shared fields for controlled tracks. For a store track or a flight plan, bits 16-27 contain the estimated time of arrival at the outer fix for arrivals and estimated time of departure from the departure airport for departures. For tabular coast tracks, bits 16-29 contain the counter to flush the track from the system.

For uncontrolled tracks the fields are as follows:

Bits 0-19 are used to designate the track as a Single Symbol (SS) on the displays represented by the bit settings.

Bits 20-29 contain the associated controlled track number.

3.3.4.2.14.2.13 Word 13.- Bits 0-19 are used to designate the uncontrolled track as a limited data block (LDB) on the displays represented by the bit settings.

Bits 20-29 are spare.

3.3.4.2.14.2.14 Word 14.- Bits 0-5 contain shared counters for controlled tracks, alphanumeric line identifier for a track in the tabular area, or a counter to timeout the blinking display of a handoff just accepted.

Bits 6-11 are spare.

Bits 12-29 contain controller entered scratch pad data in TI code.

3.3.4.2.14.3 Console Typewriter Print Request Tables.- The print request tables are shown in figure 3-46 and are described below.

Alarm Print Request Table (POWRFT) - contains one word for each type of failure print available. A requestor must set the appropriate information in the upper half-word. This information will be cleared after the request has been serviced.

Alarm Print Prestored Parameter Table (FALTMT) - contains one word for each type of failure print available. The information contained in this table is referenced during processing of the applicable print request.

Console Typewriter Canned Message Table (CTERMT) - contains two words for each type of failure print message available. This table is referenced by index in the FALTMT table. Each canned message consists of twelve 5-bit fields containing the least significant 5-bits of the applicable ASCII alpha codes.

Aircraft ID Table (ACIDXT) - consists of two words for each type of failure requesting an ACID printout. The two words may contain up to seven 6-bit TI codes. Each 6-bit field must contain a character or blank TI code. This table is reference by index in the FALTMT table.

Recording Print Request Table (CALTT) - contains one word for each type of recording print request available. A request is made by inserting the entering controller's index in bits 4-0. The remaining bits (29-5) contain modified ASCII codes for the fixed portion of the print message. Bits 4-0 will be cleared after the request has been serviced.

Recording Print Additional Data Table (ALTLT) - contains additional information to be stored at the time of the recording print request. This table is not cleared after the request has been serviced and a requestor must always store new information in all usable fields.

Requested Print Initiate Table (CFG12T) - is a one word table which requires the entering controller's SYMT table index in the applicable half-word. The applicable half-word request will be cleared at completion of all printouts related to the request.

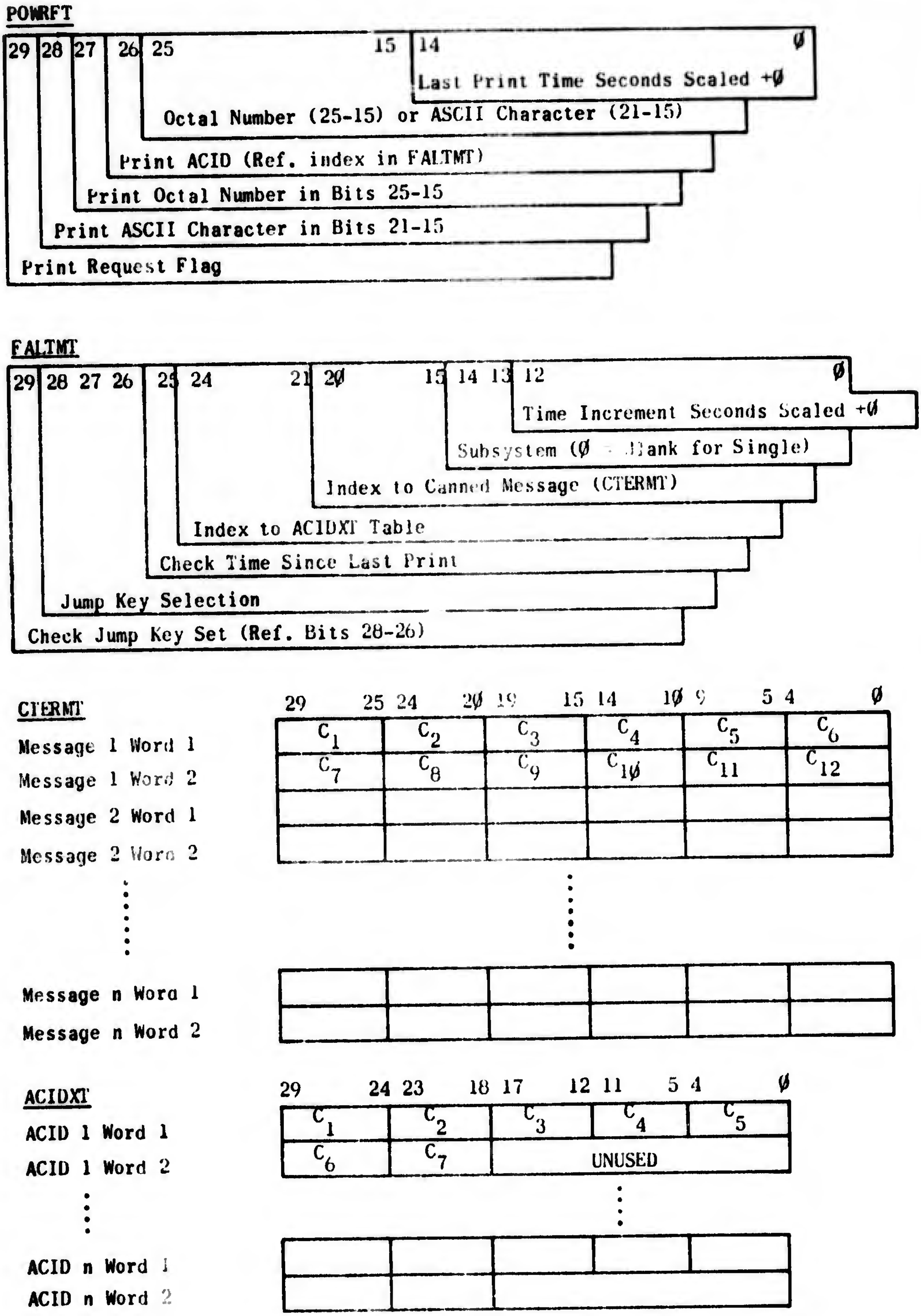


Figure 3-46. Console Typewriter Print Request Tables
(continued on page 2-256)

(Figure 3-46 continued from page 3-255)

CALTT

	29 25	20	19 15	14 10	9 5	4 0
CALTT	A	L	T	M		Index
CTIMT	T	I	M	E		Index
CMENT	M	E	M			Index
CSTAT	S	T	A	T		Index
CCFGT	C	F	G			Index
CCONT	C	O	N	S		Index
CDCOT	D	C	O	N		Index
CPARM	C	H	G	P		Index
CATIS	G	S	I			Index
CMTST	M	T	U			Index
CMTIT	M	T	U			Index
CIFST	I	F				Index
CIFIT	I	F				Index
CAHST	A	H				Index
CAHIT	A	H				Index

ALTLT

	29 0
ALTLT	Altimeter setting in 6-bit TI codes (five)
NTIMT	Old time in 5-bit BCD codes right justified
NMENT	Memory Address in Binary
NSTAT	Status Characters in 6-bit TI codes left justified (five)
NCFGT	Configuration numeric octal 1-11
NCONT	Consolidation characters in 6-bit TI left justified (two)
NDCNT	Contents of memory address changed
NPARM	Index for parameter change
NATIS	ATIS/GSI data plus number of characters entered
NMTST	SELECT in modified ASCII codes prestored
NMTIT	INHIB in modified ASCII codes prestored
NTIM2T	New time entered

CFG12T

29 15	14 0
CFG1 Requestor Index	CFG2 Requestor Index

Figure 3-46 (continued)

Sheet 2 of 2

3.3.4.2.14.4 Display Parameter Tables.- The display parameter tables shall contain data pertinent to each keyboard and each display console in the system. The display parameter tables are divided into eight sections:

1) Type 1, keyboard parameters and flags
2) Type 2, keyboard identified uncontrolled beacon tracks
3) Type 3, display console parameters and flags
4) Type 4, preview data
5) Type 5, fixed command chain list
6) Type 6, system data coordinates
7) Type 7, selected code buffer
8) Type 8, display information data.

3.3.4.2.14.4.1 Type 1 Tables.- The Type I tables contain controller data and are indexed by controller number. The QUIKT, SYMT, TABBT, CSBT, PREVT, and COUNT tables contain fixed and variable parameter data which must be preset. The TBAL1T, PULST, and TBAL2T tables contain transient controller data and shall be preset as all zeros. See figure 3-47 for bit configurations of each word in the table.

3.3.4.2.14.4.1.1 CSBT Word.- Bits 0-6 are zeros

Bits 7-17 contain the Coast/Suspend X base coordinates, in tabular coordinates, in display radii. The least significant bit is R/1024. Bit 17 contains the sign.

Bit 18 is zero.

Bits 19-29 contain the Coast/Suspend Y base coordinates, in tabular coordinates, in display radii. The LSB is R/1024. Bit 29 contains the sign.

3.3.4.2.14.4.1.2 COUNT Word.-

Bits 0-4 contain the number of lines in the preview area.

Bits 5-10 contain the character position of the first entered trackball period in the preview area.

Bit 11, when set, indicates supervisory position.

Bit 12 is used to inhibit automatic handoff of tracks controlled at this position.

<table>
<tr><th></th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>CSBT</td><td colspan="11">± Coast/Suspend Y</td><td>0</td><td colspan="11">± Coast/Suspend X</td><td colspan="7">0</td></tr>
<tr><td>COUNT</td><td colspan="15">Index to Preview</td><td>F7</td><td>S
I</td><td>I
A
H</td><td>S
V</td><td colspan="6">Character Position</td><td colspan="5">Number of Lines</td></tr>
<tr><td>QUIKT</td><td colspan="5">Paired Cont. #1</td><td colspan="5">Quick Look
Cont. #1</td><td colspan="5">Quick Look
Cont. #2</td><td colspan="5">Quick Look
Cont. #3</td><td colspan="5">Quick Look
Cont. #4</td><td colspan="5">Quick Look
Cont. #5</td></tr>
<tr><td>PREVT</td><td>T
D</td><td colspan="2">STA-
TUS</td><td>S
Y</td><td></td><td colspan="2">R
O</td><td colspan="2">Off
Set</td><td colspan="6">Not Used</td><td colspan="3">N R</td><td>M
F</td><td colspan="5">Function
Number</td><td colspan="6">Number of
Characters</td></tr>
<tr><td>PULST</td><td colspan="15">+ Trackball Change Y
- Pulses</td><td colspan="15">+ Trackball Change X
- Pulses</td></tr>
<tr><td>SYMT</td><td colspan="5">Paired
Cont. #2</td><td colspan="10">Track Number FDB Readout</td><td colspan="2">Key.
Sec.#</td><td colspan="6">FDB Symbol</td><td colspan="2">Key.
Input
Number</td><td colspan="5">Display
Number</td></tr>
<tr><td>TABBT</td><td colspan="11">± Store Y</td><td>0</td><td colspan="11">± Store X</td><td colspan="7">0</td></tr>
<tr><td>TBAL1T</td><td colspan="3">PP</td><td>T
1</td><td colspan="11">+ First Entered
- Trackball Y</td><td colspan="4">Not Used</td><td colspan="11">+ First Entered
- Trackball X</td></tr>
<tr><td>TBAL2T</td><td>M
D</td><td colspan="2"></td><td>T
2</td><td colspan="11">+ Second Entered
- Trackball Y</td><td colspan="4">Not Used</td><td colspan="11">+ Second Entered
- Trackball Y</td></tr>
</table>

Figure 3-47. Type 1: Keyboard Parameters and Flags

3.3.4.2.14.4.12 (continued)

Bit 13 is the select/inhibit flag for the tab list display of assigned beacon code.

Bit 14 is the malfunction entered flag:
1 = F7 entered, not data yet
0 = either no F7 entered or F7 and alpha entered.

Bits 15-29 contain indices to the various preview areas figured by the formula "controller number minus one times the number of words in TBPRET."

3.3.4.2.14.4.1.3 QUIKT Word.-

Bits 0-4 contain the controller number that corresponds to quick look switch #5.

Bits 5-9 contain the controller number that corresponds to quick look switch #4.

Bits 10-14 contain the controller number that corresponds to quick look switch #3.

Bits 15-19 contain the controller number that corresponds to quick look switch #2.

Bits 20-24 contain the controller number that corresponds to quick look switch #1.

Bits 25-29 contain the first controller with which this controller is paired.

3.3.4.2.14.4.1.4 PREVT Word.-

Bits 0-5 contain the number of characters in preview area.

Bits 6-10 contain the current selected function in preview area.

Bit 11, if equal to 1, indicates multiple function mode.

Bits 12-14 indicate number of words in readout area.

Bits 15-20 are not used.

Bits 21-22 contain the current offset of this controller.

Bits 23, 24 readout status:
0 = NO READOUT
1 = ERROR READOUT
2 = TRACK ALL DATA READOUT
3 = DATA READOUT

3.3.4.2.14.4.1.4 (continued)

Bit 25 is not used.

Bit 26 is radar subsystem (0-1) with which this keyboard is associated in dual radar. For single radar it is always zero.

Bits 27, 28 contain keyboard type status:
1 = CONTROLLER
2 = PAIRED POSITION
3 = MAINTENANCE POSITION

Bit 29 = TD = 1 inhibit tabular data.

3.3.4.2.14.4.1.5 PULST Word.-

Bits 0-14 contain the horizontal changes of the trackball in radar coordinates, scaled +8, LSB = 1/256 NM.

Bits 15-29 contain the vertical changes of the trackball in radar coordinates, scaled +8, LSB = 1/256 NM.

3.3.4.2.14.4.1.6 SYMT Word.-

Bits 0-4 contain the display number for this controller.

Bits 5-6 contain the keyboard number for this controller.

Bits 7-12 contain the FDB symbol of thsi controller.

Bits 13-14 contain the sequence number of the keyboard (1-3).

Bits 15-22 contain the track number of the FDB readout of this controller.

Bits 23-24 contain the current offset of this controller.

Bits 25-29 contain the second controller with which this controller is paired.

3.3.4.2.14.4.1.7 TABBT Word.-

Bits 0-6 are zeros.

Bits 7-17 contain the Store X base coordinates, in tabular coodinates, in display radii. The least significant bit is R/1024. Bit 17 contains the sign. sign.

3.3.4.2.14.4.1.7 (continued)

Bit 18 is zero.

Bits 19-29 contain the Store Y base coordinates, in tabular coordinates, in display radii. The LSB is R/1024. Bit 29 contains the sign.

3.3.4.2.14.4.1.8 TBAL1T Word.-

Bits 0-10 contain first entered trackball X coordinate, LSB = 1/16 NM.

Bit 10 contains the sign.

Bits 11-14 are not used.

Bits 15-25 contain first entered trackball Y coordinate, LSB = 1/16 NM.

Bit 25 contains the sign.

Bit 26 is the trackball entered bit:
T1 = 0, NO TRACKBALL ENTERED
T1 = 1, AT LEAST ONE TRACKBALL ENTERED.

Bits 27-29 contain flag to process preview:
PP=0: PREVIEW AVAILABLE
PP=1: PROCESS PREVIEW
PP=2: CLEAR PREVIEW
PP=3: DISCONNECT KEYBOARD
PP=4: ILLEGAL CHARACTER ENTERED
PP=5: INPUT LINE PARITY ERROR
PP=6: CAPACITY IN PREVIEW AREA
PP=7: ADD NEW LINE TO PREVIEW AREA.

3.3.4.2.14.4.1.9 TBAL2T Word.-

Bits 0-10 contain second entered trackball X coordinated, LSB = 1/16 NM.

Bit 10 contains the sign.

Bits 11-14 are not used.

Bits 15-25 contain second entered trackball Y coordinate, LSB = 1/16 NM.

Bit 25 contains the sign.

3.3.4.2.14.4.1.9 (continued)

Bit 26 is track ball entered bit.
T2 = 0, second trackball not entered
T2 = 1, two trackballs entered.

Bits 27-28 are not used.

Bit 29 is manually entered data:
MD = 0: NO MANUALLY ENTERED DATA
MD = 1: MANUALLY ENTERED DATA IN PREVIEW.

3.3.4.2.14.4.2 Type 2 Table.- The Type 2 table contains keyboard identified uncontrolled track LDB requests, one for each controller, requesting an uncontrolled track readout (via the BCN with trackball entry). The table consists of one word containing the uncontrolled track number together with other fields described in figure 3-48.

3.3.4.2.14.4.3 Type 3 Table.- The Type 3 table shown in figure 3-49 is a vertical table containing display console data. The first five words contain parameter data common to all keyboards on that console. The upper and lower altitude readout limits (bits 15-26 of words three and four) are in BCD and are used for altitude filtering of uncontrolled beacon tracks.

The upper and lower X, Y filter limits, bits 4-14 of Words 1, 2, 3, and 4 (LSB = 1/16 NM.), define the area of radar coverage on the display and are used to filter active track single symbols and uncontrolled track symbology.

The channel number, bits 15-18, is the IOP I/O channel number of the display console.

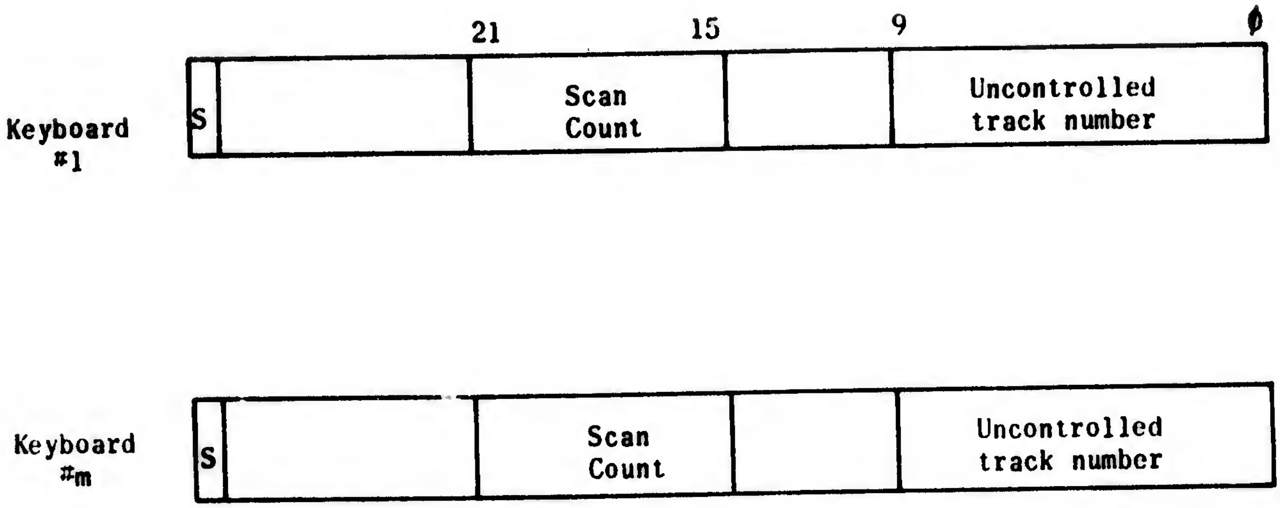
The index to the fixed chain, bits 19-29 of Word 1, is used to determine the start of the console's fixed chain list in the Type 5 Display Table.

The leader length, bits 23-27 of Word 2, is used to determine the position of a track FDB on the display.

The initial TCLT index, bits 0-17 of Word 5, is the 18 bit address of the start of the track chain list when it was last packed for this console. Bits 18-29 of Word 5 contains the remaining available write time, in micro-seconds scaled +3, after the system data has been packed for this console.

The other fields in Word 1-5 are described as follows:

SY = radar subsystem (0-1) with which this console is associated in a dual system. For single, it is always 0.
CL = 1, CL1 = 1: repack complete FCLT from system data on, for this console.



S: = 0, readout active
= 1, readout not active

Figure 3-48. Type 2: Keyboard Identified Targets

<table>
<tr><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td></td><td></td><td colspan="9">Index to FCL</td><td colspan="4">Channel Number</td><td colspan="9">± X-Upper Filter Limit</td><td colspan="2">1/16</td><td colspan="3"></td><td>SY</td></tr>
<tr><td>CL</td><td>IR</td><td colspan="5">Leader Length</td><td colspan="2">ANS</td><td>CL1</td><td colspan="5">CONT1</td><td colspan="9">± Y-Upper Filter Limit</td><td colspan="2">1/16</td><td>RS</td><td>DS</td><td colspan="2">KBS</td></tr>
<tr><td>TS</td><td>MS</td><td>NS</td><td colspan="12">Upper Altitude Readout Limit</td><td colspan="9">± X-Lower Filter Limit</td><td colspan="2">1/16</td><td></td><td>CO</td><td></td><td>TY</td></tr>
<tr><td>IO</td><td>OD</td><td>AO</td><td colspan="12">Lower Altitude Readout Limit</td><td colspan="9">± Y-Lower Filter Limit</td><td colspan="2">1/16</td><td colspan="3"></td><td>PS</td></tr>
<tr><td colspan="12">AWT after System Data</td><td colspan="18">Initial TCLT Index</td></tr>
<tr><td colspan="5"></td><td>R</td><td colspan="6">32 Range 1</td><td>OC</td><td colspan="7">Off-center Y</td><td colspan="7">Off-center X</td><td colspan="2"></td><td>0</td></tr>
<tr><td colspan="5">Quick Look</td><td>T</td><td colspan="7">TB Change Y</td><td colspan="7">TB Change X</td><td>C/F</td><td colspan="6">Data/Function</td><td colspan="2">0 1</td><td>0</td></tr>
<tr><td colspan="5">Quick Look</td><td>T</td><td colspan="7">TB Change Y</td><td colspan="7">TB Change X</td><td>C/F</td><td colspan="6">Data/Function</td><td colspan="2">1 0</td><td>1</td></tr>
<tr><td colspan="5">Quick Look</td><td>T</td><td colspan="7">TB Change Y</td><td colspan="7">TB Change X</td><td>C/F</td><td colspan="6">Data/Function</td><td colspan="2">1 1</td><td>1</td></tr>
<tr><td colspan="30">EFW</td></tr>
<tr><td colspan="30">BCW Input from Display</td></tr>
<tr><td colspan="30">IOSTOP W/Monitor</td></tr>
<tr><td colspan="30">Status Word 1</td></tr>
<tr><td colspan="30">Status Word 2</td></tr>
<tr><td colspan="30">Input Word 1</td></tr>
<tr><td colspan="30">Input Word 2</td></tr>
<tr><td colspan="30">Input Word 3</td></tr>
<tr><td colspan="30">Input Word 4</td></tr>
</table>

Figure 3-49. Type 3: Display Console Parameters and Flags

3.3.4.2.14.4.3 (continued)

CL = 1, CL1 = 0: repack FCLT from readout/preview area on (not including system data).
$$\left.\begin{array}{l}\text{CL} = 0,\ \text{CL1} = 1:\\ \text{CL} = 0,\ \text{CL1} = 0:\end{array}\right\}\ \text{do not repack FCLT.}$$
IR = 1: do not inhibit memory readout for this console.
= 0: inhibit memory readout for this console.
ANS = alphanumeric Size (0-3) - preset parameter for each display.
CONT1 = first controller number (index to Type 1 Display Table) associated with this console.
KBS = number of controllers associated with this console.
TS = 1: inhibit display of tracked single symbols.
= 0: do not inhibit display of single symbols.
MS = 1: inhibit display of Mode C single symbols.
= 0: do not inhibit display of Mode C single symbols.
NS = 1: inhibit display of non-Mode C single symbols.
= 0: do not inhibit display of non-Mode C single symbols.
TY = 1: staggered PRF radar subsystem.
= 0: non-staggered PRF radar subsystem.
TO = 1: do not reinitiate the input and output chain for this console.
= 0: reinitiate the input and output chain for this console.
OD = 1: FDB formats offset 45° (i.e., NE, NW, SE, SW).
= 0: FDB formats offset N, S, E, W.
AO = 1: inhibit auto-offset.
= 0: do not inhibit auto-offset.
PS = IOP device number with which this console is associated.
DS = 1: system data ended in smaller DT (staggered PRF).
= 0: system data ended in larger DT.
RS = 1: inhibit display of radar only single symbols.
= 0: do not inhibit display of radar only single symbols.
CO = 1: mapping control.
= 0: inhibit mapping control.

The next four words (Words 6-9) contain the last correctly received input data words from the display console. These words are used for comparison purposes, to determine whether the next console input buffer contains any changes. Word 6 also contains the console's current values of range (LSB=1 NM.) and off-centered Y and X.

The final nine words (words 10-18) are used in communication with the display console. Words 10-12 are the display's input chain, Words 13-14 are used for storage of status words received from the console, and Words 15-18 are used as the input buffer for data from the console.

Word 10 is an external function, sent with force, to terminate radar interrupts from the display.

3.3.4.2.14.4.3 (continued)

Word 11 is the Buffer Control Word (BCW) instruction which initiates input buffer in the IOP.

Word 12 is an IOSTOP instruction, with monitor, to terminate the input chain and create an internal interrupt to the IOP when the chain is completed.

3.3.4.2.14.4.4 Type 4 Tables.- The Type 4 table shown in figure 3-50 contains the controller's current trackball, readout, and preview data.

Words 1 and 2 contain a single symbol A-word and B-word for the controller's trackball. The B-word contains the current Y, X position of the trackball with bits 0-5 containing the controller's position symbol as the trackball symbol or a space when the trackball is in the homed position.

Words 3 and 4 contain a tabular A-word and B-word for the controller's readout and preview area. The B-word contains the current location, in display coordinates, of the controller's readout/preview area.

Words 5-11 are C-words used for displaying data in the controller's two-line readout area immediately preceding the preview area. The readout area, in addition to being a maximum of two lines, will contain a maximum of 32 data characters. If no data is being displayed in the readout area, Word 5 will contain two LF/CRs to position the following output data at the beginning of the preview area.

Words 12-18 are C-words used for displaying data in the controller's preview area. As a character/function is entered at the controller's keyboard, the character(s) will be placed in the next available character position (P1-P32) and output to the display. A maximum of 32 data/control characters will be allowed from the keyboard.

3.3.4.2.14.4.5 Type 5 Tables.- The Type 5 tables as shown in figure 3-51 contains the fixed command output chains which are executed as IOP background programs (each display channel has its own chain).

Word 1 is a jump to the TCL.

Word 2 is an I/O clear of a flag associated with this display which is used as a check to insure that output is progressing on this channel, i.e., for this display.

Word 3 chains out the system data display A and B-words from the Type 6 display table.

<table>
<tr><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="14"></td><td colspan="16">A-Word Trackball</td></tr>
<tr><td colspan="24">B-Word Trackball</td><td colspan="6">Symbol/Space</td></tr>
<tr><td colspan="14"></td><td colspan="16">A-Word Preview</td></tr>
<tr><td colspan="24">B-Word Preview</td><td colspan="6">Pad</td></tr>
<tr><td colspan="6">R1</td><td colspan="6">R2</td><td colspan="6">R3</td><td colspan="6">R4</td><td colspan="6">R5</td></tr>
<tr><td colspan="6">R6</td><td colspan="6">R7</td><td colspan="6">R8</td><td colspan="6">R9</td><td colspan="6">R10</td></tr>
<tr><td colspan="6">R11</td><td colspan="6">R12</td><td colspan="6">R13</td><td colspan="6">R14</td><td colspan="6">R15</td></tr>
<tr><td colspan="6">R16</td><td colspan="6">LC/CR</td><td colspan="6">R17</td><td colspan="6">R18</td><td colspan="6">R19</td></tr>
<tr><td colspan="6">R20</td><td colspan="6">R21</td><td colspan="6">R22</td><td colspan="6">R23</td><td colspan="6">R24</td></tr>
<tr><td colspan="6">R25</td><td colspan="6">R26</td><td colspan="6">R27</td><td colspan="6">R28</td><td colspan="6">R29</td></tr>
<tr><td colspan="6">R30</td><td colspan="6">R31</td><td colspan="6">R32</td><td colspan="6">LF/CR</td><td colspan="6">Pad</td></tr>
<tr><td colspan="6">P1</td><td colspan="6">P2</td><td colspan="6">P3</td><td colspan="6">P4</td><td colspan="6">P5</td></tr>
<tr><td colspan="6">P6</td><td colspan="6">P7</td><td colspan="6">P8</td><td colspan="6">P9</td><td colspan="6">P10</td></tr>
<tr><td colspan="6">P11</td><td colspan="6">P12</td><td colspan="6">P13</td><td colspan="6">P14</td><td colspan="6">P15</td></tr>
<tr><td colspan="6">P16</td><td colspan="6">P17</td><td colspan="6">P18</td><td colspan="6">P19</td><td colspan="6">P20</td></tr>
<tr><td colspan="6">P21</td><td colspan="6">P22</td><td colspan="6">P23</td><td colspan="6">P24</td><td colspan="6">P25</td></tr>
<tr><td colspan="6">P26</td><td colspan="6">P27</td><td colspan="6">P28</td><td colspan="6">P29</td><td colspan="6">P30</td></tr>
<tr><td colspan="6">P31</td><td colspan="6">P32</td><td colspan="6">Space</td><td colspan="6">Space</td><td colspan="6">Space</td></tr>
<tr><td colspan="30">⋮</td></tr>
<tr><td colspan="14"></td><td colspan="16">A-Word Trackball</td></tr>
<tr><td colspan="24">B-Word Trackball</td><td colspan="6">Symbol</td></tr>
<tr><td colspan="14"></td><td colspan="16">A-Word Preview</td></tr>
<tr><td colspan="24">B-Word Preview</td><td colspan="6">Pad</td></tr>
<tr><td colspan="6">R1</td><td colspan="6">R2</td><td colspan="6">R3</td><td colspan="6">R4</td><td colspan="6">R5</td></tr>
<tr><td colspan="6">R6</td><td colspan="6">R7</td><td colspan="6">R8</td><td colspan="6">R9</td><td colspan="6">R10</td></tr>
<tr><td colspan="30"></td></tr>
<tr><td colspan="6">P31</td><td colspan="6">P32</td><td colspan="6">Space</td><td colspan="6">Space</td><td colspan="6">Space</td></tr>
</table>

Figure 3-50. Type 4: Preview Data (One per Controller)

WORD		CHAIN COMMAND
1	IOJ	Track Data
2	IOCL	FLAGZT (for this display)
3	BCW	System Data A and B words
4	BCW	Time and Altimeter Setting
5	BCW	Selected Codes
6	BCW	EM/RF
7	BCW	HJ
8	BCW	SA
9	BCW/IONOOP	Memory Readout
10	BCW/IONOOP	SEP Code
11	BCW/IONOOP	Memory Readout
12	BCW/IONOOP	SEP Code
13	BCW/IONOOP	Memory Readout
14	BCW/IONOOP	SEP Code
15	BCW/IONOOP	Memory Readout
16	BCW/IONOOP	SEP Code
17	BCW/IONOOP	Memory Readout
18	BCW/IONOOP	SEP Code
19	BCW/IONOOP	Memory Readout
20	BCW/IONOOP	SEP Code
21	BCW/IONOOP	Memory Readout
22	BCW/IONOOP	SEP Code
23	BCW/IONOOP	Memory Readout
24	BCW/IONOOP	SEP Code
25	BCW/IONOOP	Memory Readout
26	BCW	Trackball and Readout #1
27	BCW/IONOOP	SEP Code
28	BCW/IONOOP	Readout #1
29	BCW/IONOOP	SEP Code
30	BCW/IONOOP	Readout #1
31	BCW	Preview #1
32	BCW/IONOOP	SEP Code

Figure 3-51. Type 5: Fixed Command Chain List (One per Display)
(continued on page 3-269)

(Figure 3-51 continued from page 3-268)

WORD		CHAIN COMMAND
33	BCW/IONOOP	Preview #1
34	BCW/IONOOP	SEP Code
35	BCW/IONOOP	Preview #1
36	BCW	Trackball and Readout #2
37	BCW/IONOOP	SEP Code
38	BCW/IONOOP	Readout #2
39	BCW/IONOOP	SEP Code
40	BCW/IONOOP	Readout #2
41	BCW	Preview #2
42	BCW/IONOOP	SEP Code
43	BCW/IONOOP	Preview #2
44	BCW/IONOOP	SEP Code
45	BCW/IONOOP	Preview #2
46	BCW	Trackball and Readout #3
47	BCW/IONOOP	SEP Code
48	BCW/IONOOP	Readout #3
49	BCW/IONOOP	SEP Code
50	BCW/IONOOP	Readout #3
51	BCW	Preview #3
52	BCW/IONOOP	SEP Code
53	BCW/IONOOP	Preview #3
54	BCW/IONOOP	SEP Code
55	BCW/IONOOP	Preview #3
56	BCW/IONOOP	Var. buffer (for staggered PRF)
57	IOJ	Word 1

3.3.4.2.14.4.5 (continued)

Word 4 chains out the time and altimeter setting display characters from an area common to all displays.

Word 5 chains out the selected codes from the Type 7 display table.

Words 6-8 chain out the EM-RF-HJ-SA characters from one of two common areas as a function of the display's radar subsystem.

Words 9-25 chain out the memory readouts (maximum of ten per system) from the memory readout buffer, together with the appropriate SEP codes used when all the data cannot be output in the same alphanumeric display time.

Words 26-55 chain out the trackball, readout, and preview areas from the Type 4 display table of all keyboards (maximum of three) associated with the display. There are ten BCWs required per keyboard which include provision for the appropriate SEP codes used when all of the readout and/or preview data cannot be output in the same alphanumeric display time.

Word 56 is used in a staggered PRF mode to buffer out a variable (by site) length buffer to insure that the TCL begins with a complete, large dead time. Word 56 does not appear in a non-staggered PRF mode.

Word 57 contains a jump back to the beginning of the display's fixed chain list to restart the chain.

3.3.4.2.14.4.6 Type 6 Table.- The Type 6 table, as shown in figure 3-52, contains the display's A and B-words for the system data display area. The format control word is a tabular, "do not process" (DNP) A-word containing the memory end, bit 16 = 1, for each refresh cycle.

The B-word contains the tabular Y, X coordinates for the location of the display's system data display area.

3.3.4.2.14.4.7 Type 7 Table.- The Type 7 table, as shown in figure 3-53, is the display's output buffer containing the selected code (a maximum of ten per display) display characters. For example, bits 24-29 and bits 18-23 of Word 1 contain numeric display characters, i.e., 01, which represent code block 0100-0177. One extra word is provided in the buffer for the storing of a separation (SEP) code to be used when all data in the table cannot be output in the same alphanumeric display time.

<table>
<tr><td>29</td><td>26</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="13">Unused</td><td>1</td><td colspan="16">A-Word (DNP)</td></tr>
<tr><td colspan="30">B-Word</td></tr>
<tr><td colspan="30"></td></tr>
<tr><td colspan="13">Unused</td><td>1</td><td colspan="16">A-Word (DNP)</td></tr>
<tr><td colspan="30">B-Word</td></tr>
</table>

Figure 3-52. Type 6: System Data A and B Words

<table>
<tr><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="6">C1</td><td colspan="6">C1</td><td colspan="6">Δ</td><td colspan="6">C2</td><td colspan="6"></td></tr>
<tr><td colspan="6">Δ</td><td colspan="6">C3</td><td colspan="6">C3</td><td colspan="6">Δ</td><td colspan="6">C[illegible]</td></tr>
<tr><td colspan="6">C4</td><td colspan="6">Δ</td><td colspan="6">C5</td><td colspan="6">C5</td><td colspan="6">LF/CR</td></tr>
<tr><td colspan="6">C6</td><td colspan="6">C6</td><td colspan="6">Δ</td><td colspan="6">C7</td><td colspan="6">C7</td></tr>
<tr><td colspan="6">Δ</td><td colspan="6">C8</td><td colspan="6">C8</td><td colspan="6">Δ</td><td colspan="6">C9</td></tr>
<tr><td colspan="6">C9</td><td colspan="6">Δ</td><td colspan="6">C10</td><td colspan="6">C10</td><td colspan="6">LF/CR</td></tr>
<tr><td colspan="6">Pad</td><td colspan="6">Pad</td><td colspan="6">Pad</td><td colspan="6">Pad</td><td colspan="6">SEP Code</td></tr>
</table>

Figure 3-53. Type 7: Selected Code Buffer (one per display)

3.3.4.2.14.4.8 Type 8 Tables.- The Type 8 tables contain display information and are indexed by display. The DINDT and ICINZT tables contain fixed data which must be preset. The CRTYXT and FLAGZT tables contain transient data and shall be preset as all zeros. See figure 3-54 for bit configurations of each word of the table.

3.3.4.2.14.4.8.1 CRTYXT Word.- Bits 0-14 contain the product of the current range and the current off-center of the X coordinate, complemented, scaled +4. Bits 15-29 contain the product of the current range and the current off-center of the Y coordinate, complemented, scaled +4.

3.3.4.2.14.4.8.2 DINDT Word.-

Bits 0-14 contain the product of the number of words in DCONT and the display number minus one.

Bits 15-20 contain the minimum range, in NM (LSB = 1 NM), at which radar only single symbols are displayed.

Bits 21-29 are not used.

3.3.4.2.14.4.8.3 FLAGZT Word.-

Bits 0-8 are not used.

Bits 9-11 represent the number of times a display's input is allowed to come in (one word at a time) before output progression is checked.

Bits 12-13 are not used.

Bit 14 is the radar interrupt flag:
0 = NO RADAR INTERRUPT
1 = RADAR INTERRUPT.

Bits 15-26 are not used.

Bit 27 is the synchronous flag:
0 = LAST INPUT BUFFER IN SYNCHRONOUS ORDER
1 = LAST INPUT BUFFER OUT OF SYNCHRONOUS ORDER.

Bit 28-29 represent output progression flag: if cleared, output has completed.

3.3.4.2.14.4.8.4 INCINZT Word.- This table is a set of instructions:

```
ICIN  DiQ*/-7, DCONT+10, B6, S2.
```

This table is referenced only by an XR (Executive Remote) instruction to initiate chain input.

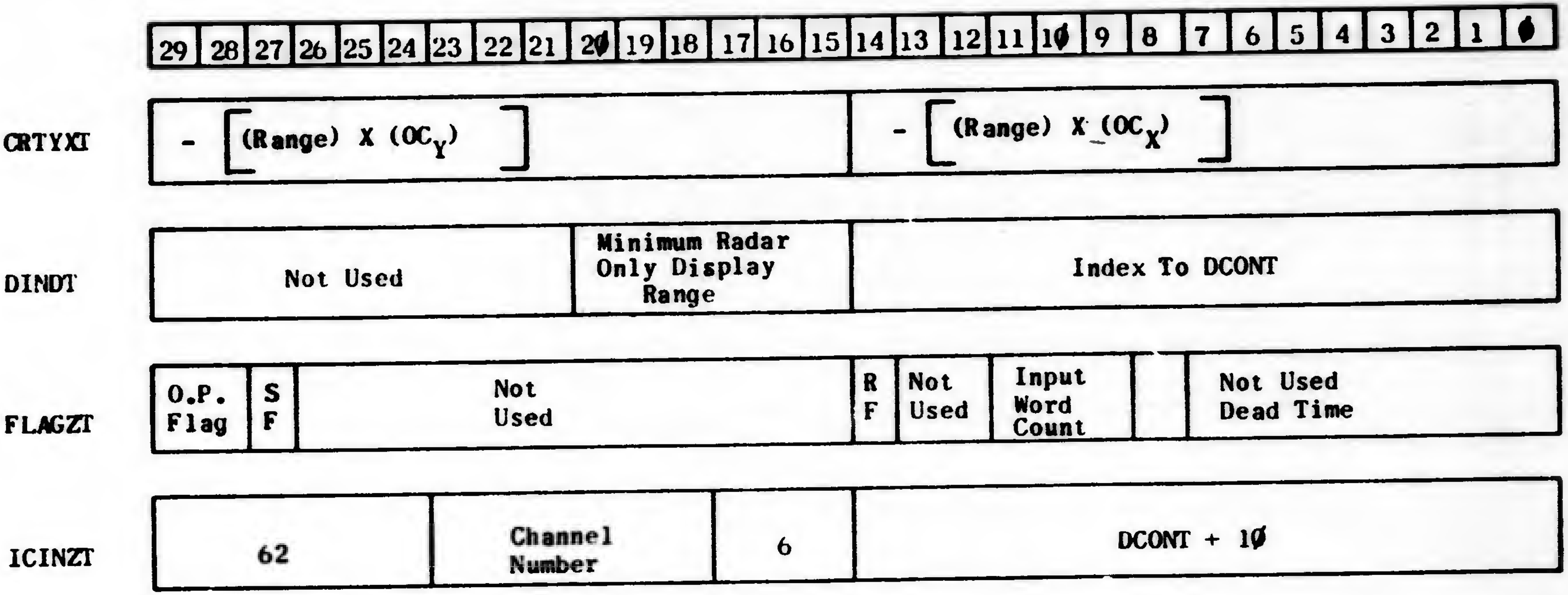


Figure 3-54. Type 8: Display Information Table

3.3.4.2.14.5 Configuration Tables (CONFIG).- Determination of a controller to handle a track shall be done via an airport/fix table (APT) as shown below:

	29	18	17 12	11 6	5 0
APT	0		X	X	X
	0		Y	Y	Y
	0		Z	Z	Z
	0		A1	A2	A3
	1				

The characters for the airports and fixes in the APT table are in display output code.

The airports will be the first entries in the table followed by the fixes. Each airport and fix will have associated with it a binary number which will equal the index of this table, e.g., airport YYY would equal two. This arrangement will insure that no fix and airport have the same index. Bit 29 set will indicate the end of the table.

	29 18	17 0
ADGFGT		+CFG1T (Address)
		+CFG2T (Address)
		+CFGiT (Address)

3.3.4.2.14.5 (continued)

The ADGFGT table contains the addresses of the one or more configuration tables where i = 1-5.

There may be up to 5 configuration tables in IOP memory. Only one table will be selected at any given time. The length of each table will depend on the number of entries required for all entry/exit fix combinations. Each entry will occupy one table word and have the following format:

	29	28	27 22	21 16	15 12	11	10	9 5	4 0
CFGiT	0	B	EF1	EF2	ST	C	S	PC	AC
	0	B	EF1	EF2	ST	C	S	PC	AC
	1								

where B = 0 for Subsystem 1 } subsystem of active controller
= 1 for Subsystem 2 }

EF1 = entry fix index
EF2 = exit fix index
ST = arrival/departure/overflight status
C = status compare flag
S = spare
PC = primary controller
AC = active controller

These tables will be constructed as follows:

All departures from a specific airport are grouped by primary controller. That group which contains the greatest number of entries will appear as one entry at the end of the table with a zero for the exit fix. All other entry/exit fix combinations for this airport will appear as individual entries at the front of the table. The same is done for each airport for departures.

The same method is used for arrivals, except that the airport would appear in the exit fix field.

3.3.4.2.14.5 (continued)

Overflights are now grouped by entry fix by controller. That group for each entry fix which contains the greatest number of entries is a candidate as one entry at the end of the table. The rest of the entries become candidates for individual entries at the front portion of the table. The same grouping is now done by exit fix. The method which yields the fewest number of entries in the table is selected. Thus the overflight entries at the end of the table may have a zero in either the entry fix or exit fix.

3.3.4.2.14.6 Common Active Track Buffer (CATB).- The CATB shall contain the active FDB formats for all track files. Five words shall be reserved for each track. The five-word block shall contain the display control word (A word), the coordinate and symbol word (B word), and three C words. The C words shall normally contain ACID, altitude, and speed.

The five-word block shall be initialized upon initiation of a new track file - keyboard messages Track Start or Flight Data Entry, or ARTCC flight plan message. Various subprograms shall update the CATB data. Tracking shall update the coordinate word (reported beacon/radar X, Y coordinates), the altitude, and the speed once per radar scan. Keyboard input processing shall adjust CATB data in response to various keyboard messages. Automatic offset shall modify format offset (contained in the A word) and may modify the left/right justification of the ACID for the offset change.

The display output Chain Preparation Subprogram (CPS) shall use the CTS and the display parameter tables to determine the display or displays (if any) to which the FDB format is to be transferred. The display output chain shall contain BCDW words which transfer FDBs directly from the CATB. For those tracks which are to be presented as single symbols or for tabular status tracks, the CATB data shall be transferred to another area for buffering to the displays.

The CATB is shown in figure 3-55.

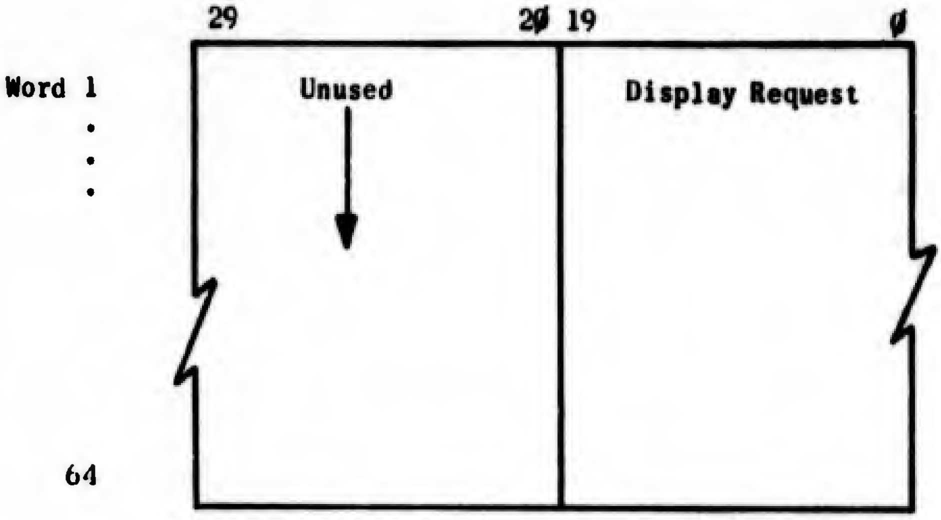
3.3.4.2.14.7 Selected Code Table (SCT).- The SCT (figure 3-56) shall be a 64-word table which contains all the selected beacon code readout requests of the display console. The primary purpose of the table shall be to minimize the time required in checking uncontrolled beacon tracks for selected code readouts. The SCT table shall be updated by the BCN operational multifunction whenever a selected code readout is requested/inhibited. It shall also be used to reformat the system data display buffer of selected codes whenever a selected code readout is requested/inhibited.

3.3.4.2.14.8 Tabular Track Index (TTI).- The TTI table (figure 3-57) shall be a 36-word table used as a reference to obtain an unused tabular line ID (an alphanumeric). Whenever a tabular line ID is assigned to a track, a bit is set in the table indicating that that tabular line ID is being used. Whenever a tabular line ID is de-assigned from a track, the corresponding bit in the TTI

<table>
<tr><th></th><th>Bit Position</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td rowspan="5">Track #00 (Normal Track - Active or Tabular)</td><td>1</td><td colspan="13">Spare</td><td>M</td><td>D</td><td colspan="2">Br</td><td>B</td><td>F</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>2</td><td>S</td><td colspan="10">Y Coordinate 1/16 NM</td><td>0</td><td>S</td><td colspan="10">X Coordinate</td><td>BL</td><td colspan="6">Symbol</td></tr>
<tr><td>3</td><td colspan="6">ACID1</td><td colspan="6">ACID2</td><td colspan="6">ACID3</td><td colspan="6">ACID4</td><td colspan="6">ACID5</td></tr>
<tr><td>4</td><td colspan="6">ACID6</td><td colspan="6">ACID7</td><td colspan="6">LF/CR</td><td colspan="6">Altitude 1</td><td colspan="6">Altitude 2</td></tr>
<tr><td>5</td><td colspan="6">Altitude 3</td><td colspan="6">Space</td><td colspan="6">Ignore</td><td colspan="6">Speed 1</td><td colspan="6">Speed 2</td></tr>
<tr><td rowspan="5">Track #01 (Active Track Reporting 7700, 7600, 3100, 1236, or SPI)</td><td>6</td><td colspan="12">Spares</td><td colspan="2">F</td><td>Br</td><td colspan="2">B</td><td></td><td colspan="3">L</td><td colspan="2">T</td><td>P</td><td colspan="6">Ones</td></tr>
<tr><td>7</td><td>S</td><td colspan="10">Y Coordinate</td><td>0</td><td>S</td><td colspan="10">X Coordinate</td><td>BL</td><td colspan="6">Symbol</td></tr>
<tr><td>8</td><td colspan="6">ACID1</td><td colspan="6">ACID2</td><td colspan="6">ACID3</td><td colspan="6">ACID4</td><td colspan="6">ACID5</td></tr>
<tr><td>9</td><td colspan="6">ACID6</td><td colspan="6">ACID7</td><td colspan="6">LF/CR</td><td colspan="6">Altitude 1</td><td colspan="6">Altitude 2</td></tr>
<tr><td>10</td><td colspan="6">Altitude 3</td><td colspan="6">Space</td><td colspan="6">Start Blink</td><td colspan="6">E/R/H/S/I</td><td colspan="6">M/F/J/A/D</td></tr>
<tr><td>Tracks 02-n</td><td></td><td colspan="30"></td></tr>
</table>

Word 1 (A word)	M:	Memory End (end of refresh)
	D:	Coordinate Type: 1 = display, 0 = radar
	F:	Force (1), No Force
	Br:	Brightness; 11 = full, 10 = 3/4, 01 = 1/2 and 00 = 1/4 brightness
	B:	Blink (1), No blink (entire format)
	L:	Offset; 00 through 11 = north, east, south and west respectively
	T:	Format Type: 00 = single symbole, 01 = data block, 10 = tabular data, and 11 is undefined
	P:	Process (0), No process (this dead time)
Word 2 (B word)	S:	Sign bit
	BL:	Blink (1), No Blink (symbol only)
Words 3-5 (C words):		Data characters as shown above

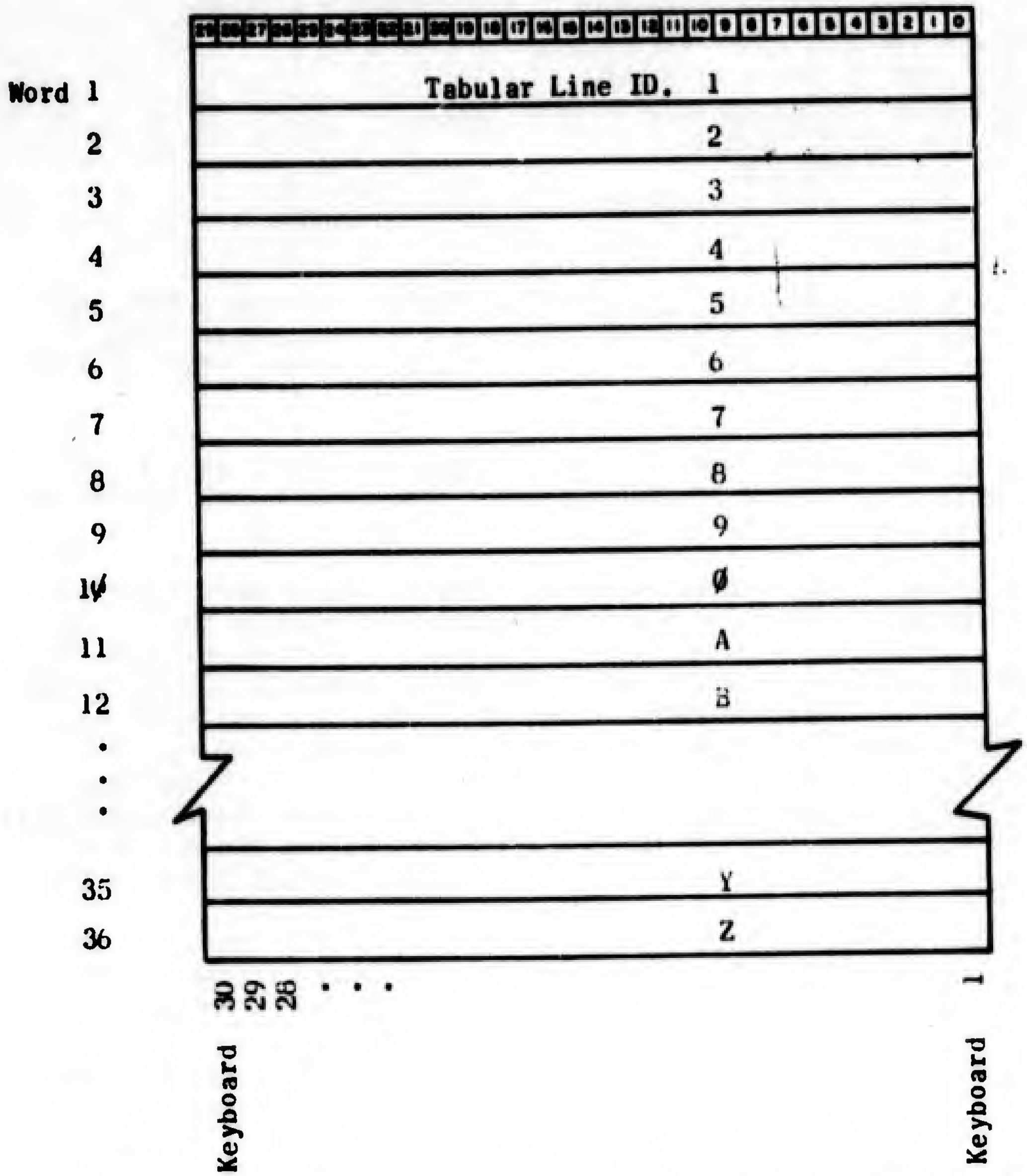
Figure 3-55. Common Active Track Buffer (CATB)



Word number N corresponds to beacon code N-1, i.e. Word 5 corresponds to beacon codes 0400 to 0477 inclusive, that is all discrete and non-discrete code 04s.

In each word, bit 1 corresponds to display number i+1 (i.e., bit 2 corresponds to display number 3).

Figure 3-56. Selected Code Table



Each word of TTI corresponds to a particular tabular line ID, and each of the 3Ø bits in the word corresponds to a particular keyboard. (For example, if keyboard #2 is assigned tabular line ID "B" for a track, then Word 12 bit 1 would be set.

Figure 3-57. Tabular Track Index Table

3.3.4.2.14.8 (continued)

table shall be cleared. The following tasks use the TTI table:

1) Assign a track file to store status.
2) Assign a store track to FP status.
3) Initiate active tracking on a tabular track.
4) Terminate a tabular track.
5) Suspend an active track.
6) Assign a coast track to tabular coast status.

3.3.4.2.14.9 Track Number Pointer Table (TNP).- The TNP shall be a threaded table which, together with its associated TSSS, shall be used to determine what and how many track file numbers are in a particular sector. TNP and TSSS are shown in figure 3-58.

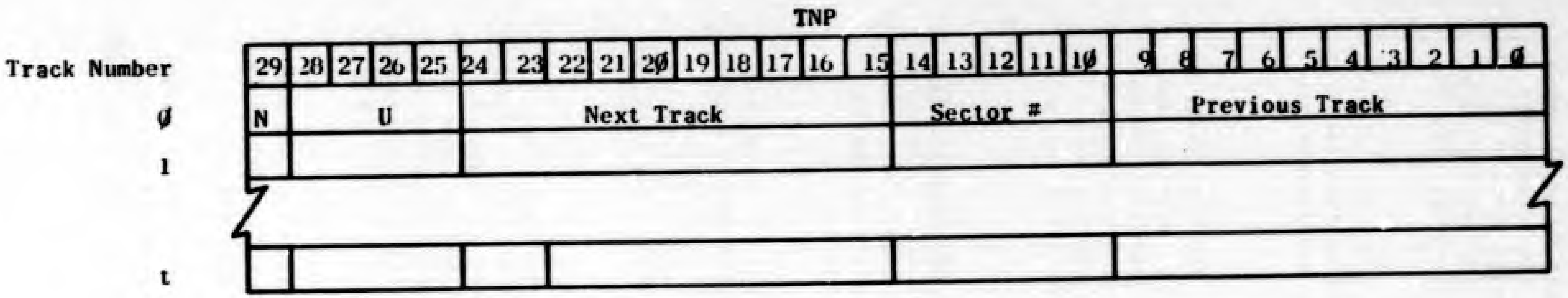
TNP is ordered by track number, and, for each entry, there shall be a field containing the next track number in that sector, a field containing the sector number, and a field containing the previous track in the sector.

TSSS shall be a 32-word table ordered by sector number. Each entry contains the start track for that sector and the total number of tracks in the sector.

When a new track is added to a sector and there is not currently a start track for that sector, the new track shall be stored as a start track in TSSS, the track count in TSSS shall be incremented, and the sector number of the new track shall be stored in TNP. If there is currently a start track for that sector, the above still applies, but, in addition, the current start track shall be stored in the next track field of the new track in TNP, and the new track shall be stored in the previous track field of the current start track in TNP.

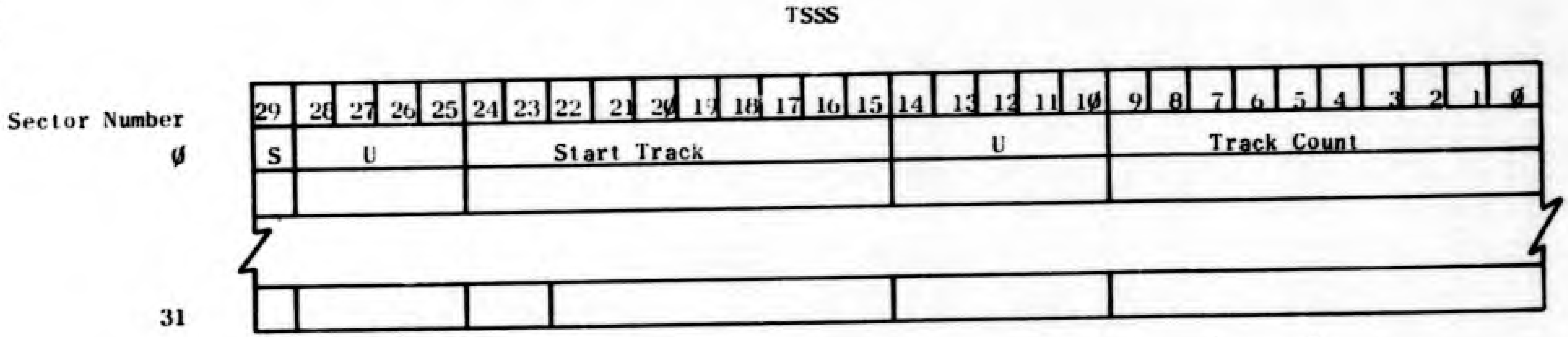
When a track is deleted from a sector and there is no previous track or next track, a bit shall be set in TSSS to show there are no tracks in the sector. If the deleted track has no previous track but has a next track, the next track shall be stored as the start track of the sector in TSSS, and the previous track field of the former start track shall be cancelled. If the track being deleted has a previous track but no next track, the next track field of the previous track and the previous track field shall be cancelled, and next track field of the deleted track shall also be cancelled. If the track being deleted has both a previous track and a next track, the next track shall be stored in the next track field of the previous track, the previous track shall be stored in the previous track field of the next track, and the previous track field and next track field of the deleted track shall be cancelled. In all of the above cases, when deleting a track from a sector, the track count in TSSS for that sector shall be decremented.

The size of TNP is t, where t is the number of tracks in the system.



N: = 0, next track exists
= 1, no next track

Bits 0-9 are set to all ones if no previous track exists.



S: = 0, tracks in sector
= 1, no tracks in sector
U: Unused

Figure 3-58. Track Number Pointer Table and Sector Summary Store

3.3.4.2.14.10 Temporary Flight Plan Store (TS).- The TS shall be an horizontal table which shall be used to contain flight plan data prior to transfer to the CTS. Each flight plan shall require 3 words. The TS shall provide for the storage of T flight plans, where T is a site parameter representing the number of flight plan files required. Thus, the TS shall require 3T words. The TS format is shown in figure 3-59.

3.3.4.2.14.11 VFR/IFR Code Table (VICODT).- The VICODT shall contain the VFR and IFR beacon codes available for program assignment and an used/unused bit for each code. The VICODT format is shown in figure 3-60.

3.3.4.2.14.12 Time, Altimeter Setting and ATIS/GSI (TAST).- The TAST shall be a six word vertical table containing the system time (in hours, minutes, and seconds), the altimeter setting (in inches of mercury), the Automatic Terminal Information Service (ATIS), (one alpha character), and General Systems Information (GSI) (e. g., runway is use, up to 13 alphanumeric characters with a space as the only allowable special character. The TAST is buffered out to each display and is shown in figure 3-61.

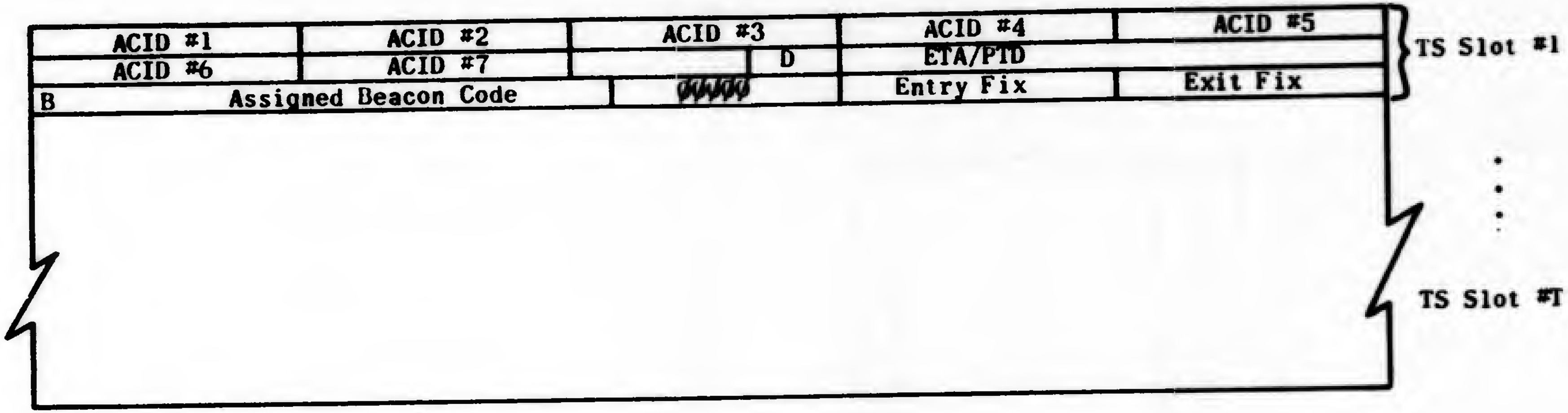
3.3.4.2.14.13 Emergency/Radio Failure (EMRFT), Hijack (HJT) and Suspect Aircraft (SAT).- The EMRFT, HJT and SAT are each one word tables (per radar subsystem) containing any or all of the EM (7700 code), RF(7600 code), HJ (3100 code), and SA (1236 code) if the applicable codes have been detected, which are buffered out to each display. The tables are shown in figure 3-62.

3.3.4.2.14.14 Memory Readout (ERMAT).- The ERMAT shall consist of ten blocks of four words per block. Each block shall be a complete line of memory readout and shall be composed of an LF/CR, six address characters, two space characters, five contents characters (most significant), one space character, and five contents characters (least significant), all in TI code. The ERMAT is shown in figure 3-63.

3.3.4.2.14.15 Beacon Report Store (REPRiT).- The beacon report store (one for each radar subsystem) shall consist of an NREPiQ - word vertical table. Each tabular item shall represent a two-word beacon report formatted as shown in figure 3-64. Reports are stored in a circular fashion by the beacon input processor, which maintains an index to the next available storage location for that purpose. Periodically, reports are retrieved by the correlation subprogram, after which their storage location shall be available for new reports as they are generated.

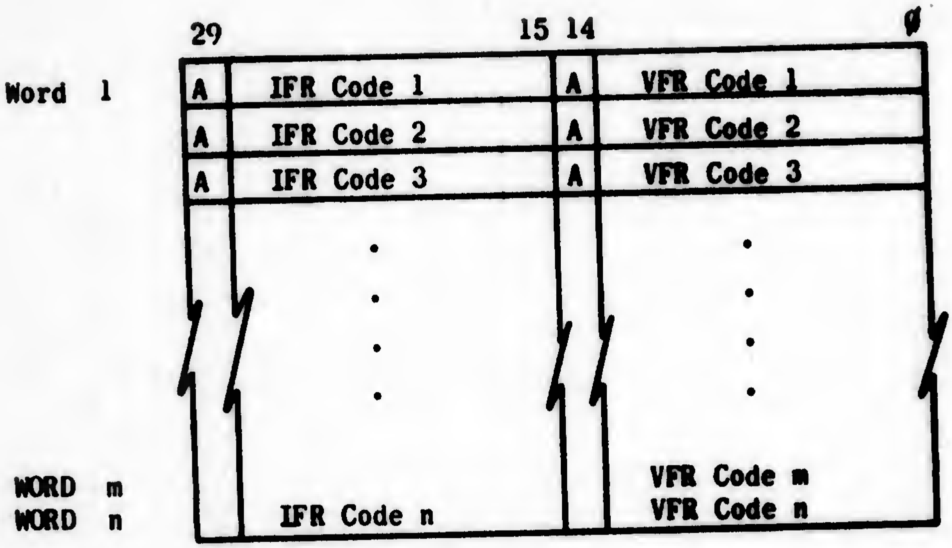
The length of the beacon report store shall be sufficient to hold the maximum of NREPiQ/2 (SP) reports produced during a single correlation cycle (nominally, 62.5 ms, which corresponds approximately to 5.6° of antenna rotation).

Data contained within one beacon report consists of azimuth and range of target center, altitude of target (if known), emergency and radio failure indicators, special position and weak target indicators, e/A code, and e/A or C code validity.



D = 00, if flight plan is an arrival
= 01, if flight plan is a departure
= 10, if flight plan is on overflight
B = 1, if beacon code entered
Entry/Exit Fix Stored as Index

Figure 3-59. Temporary Flight Plan Store (TS)



A = 0, if the code is available
  = 1, if the code is not available

n and m are site parameters for the number of IFR and VFR codes, respectively.

Figure 3-60. VFR/IFR Code Table

H1	H2	Virgule	M1	M2
Virgule	S1	S2	Space	A1
A2	Period	A3	A4	LF/CR
ATIS	GSI1	GSI2	GSI3	GSI4
GSI5	GSI6	GSI7	GSI8	GSI9
GSI10	GSI11	GSI12	GSI13	LF/CR

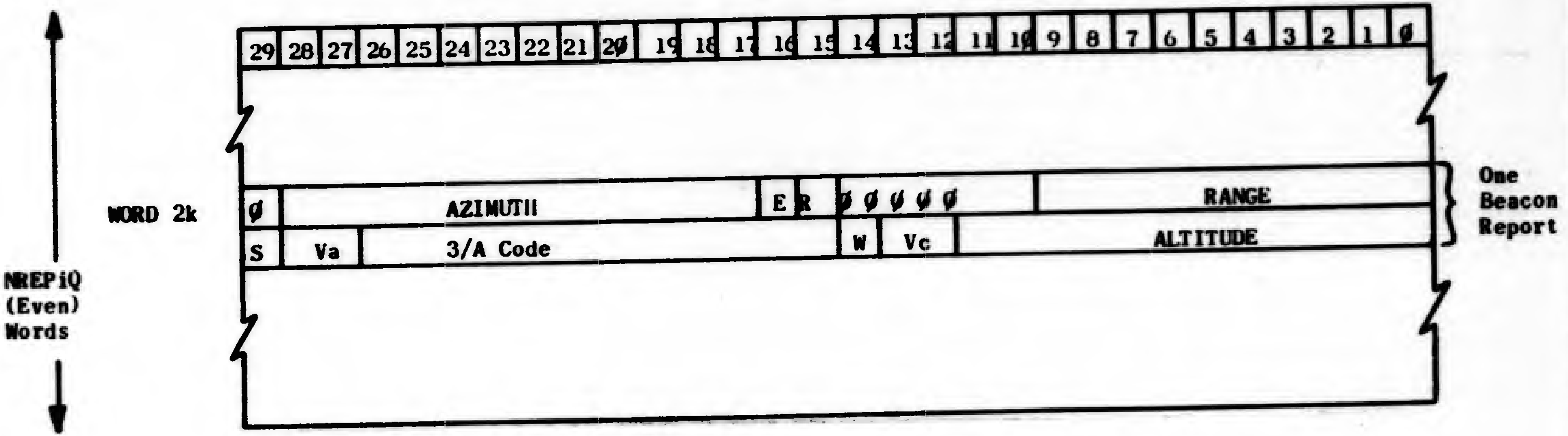
Figure 3-61. Time, Altimeter Setting, and ATIS/GSI (TAST)

Space/E	Space/M	Space	Space/R	Space/F
Ignore	Ignore	Space	Space/H	Space/J
Ignore	Ignore	Space	Space/S	Space/A

Figure 3-62. EM/RF (EMRFT), HJ(HJT), SA(SAT)

LF/CR	A1	A2	A3	A4
A5	A6	Space	Space	C1
C2	C3	C4	C5	Space
C6	C7	C8	C9	C10

Figure 3-63. Memory Readout (ERMAT)



k	Ranges from 0 to NREPiQ/2
Azimuth	ACPs scl + 0 (LSB = 1 ACP where 4096 ACPs = 360 degrees)
E	Emergency - 3/A code should be 7700
R	Radio failure - 3/A code should be 7600
Range	Nautical miles, scaled +4 (LSB = 1/16 nm)
S	Special position indicator
Va	3/A code validity (see beacon record format, figure 3-27)
3/A Code	Same as in reply word format (see figure 3-27)
W	Weak target indicator
Vc	C code validity (see beacon record format figure 3-27)
Altitude	Feet, binary coded decimal (least significant BCD digit = 100 feet)

Figure 3-64. Beacon Report Store (REPRiT)

3.3.4.2.14.16 Track Present Map (TPMT).- The track present map is a 128-word vertical table which is maintained by tracking for the purpose of beacon target detection enhancement. Bits will be set to one to indicate a region containing the predicted position of an active track. The aggregate of ones amidst the zeroes in the map depict an image of all the tracks in the system.

Each bit shall correspond to a 2 NM X 32 ACP zone (annular sector): bit k of word j represents the zone bounded in azimuth by 2j and 2(j+1) ACPs, and in range by 2k to 2(k+1) nautical miles, (J = 1, ..., 29; k = 0, ..., 127). Each word therefore, represents an entire 32 ACP sector extending in range from 0 to 60 nautical miles.

The TPMT is shown in figure 3-65.

3.3.4.2.14.17 Radar Report Store (RRSIT).- The radar report store shall consist of an RRPTQ - word vertical table. Each tabular item shall represent a one-word radar report, formatted as shown in figure 3-66. Reports are stored in circular fashion by the radar input processor, which employs push/pull parameters to identify the active table segment and, consequently, the address to the next available storage location. When storing reports, the radar input processor (specifically, report finalization) shall assure that the reports currently contained within the active segment are ordered according to range. I.e., BAP (the Bottom Address Pointer) is the address of the report with least range.

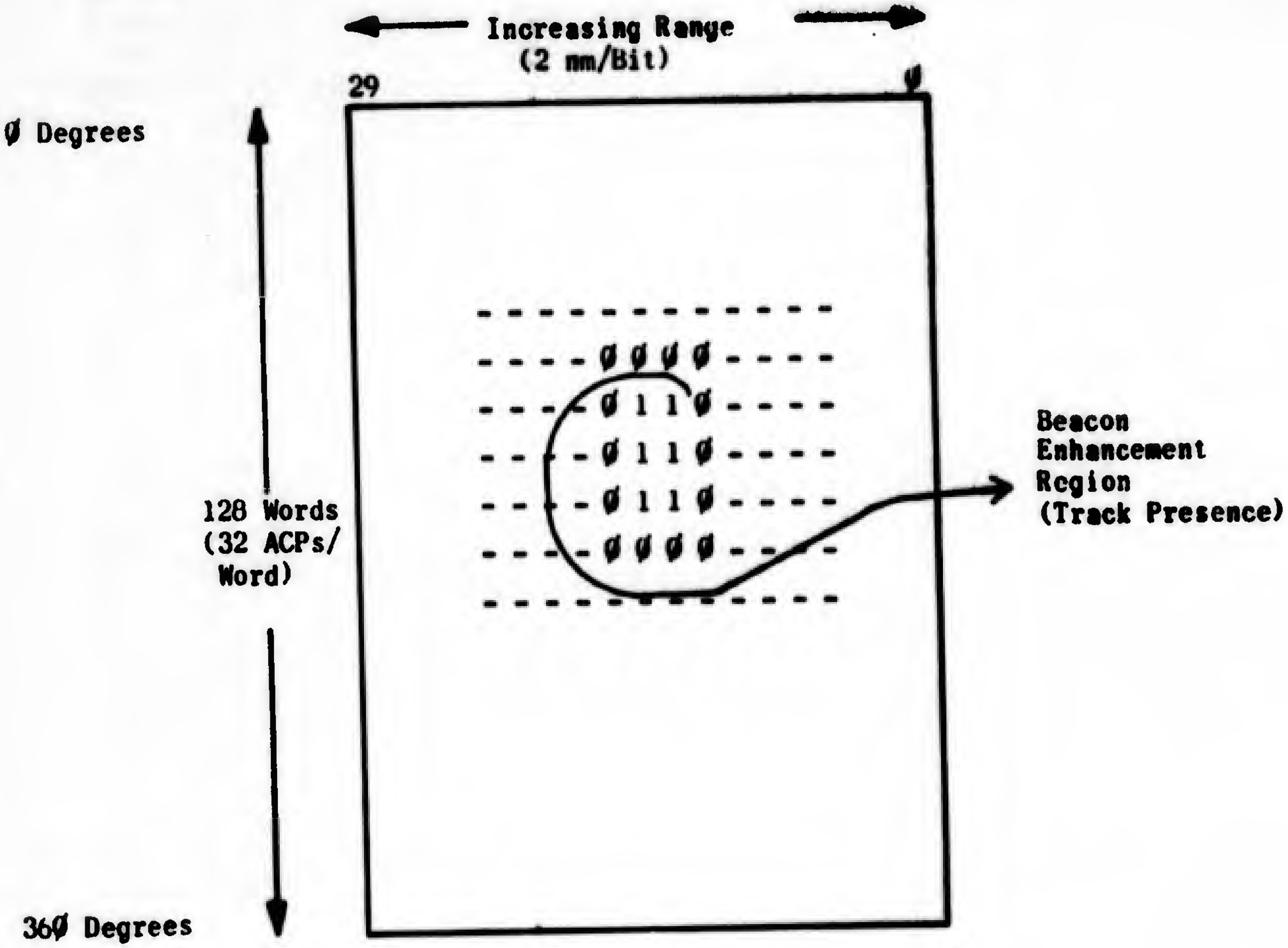
The length of the radar report store shall be sufficient to hold the maximum of RRPTQ reports produced during a single beacon/radar correlation cycle (nominally, 62.5 ms, which corresponds approximately to 5.6° of antenna rotation).

Data contained within one radar report consists of the azimuth and range of the target center, an assignment of report quality, and a report hold count. The latter is used by correlation to hold until the next cycle the radar report which is near a cycle boundary. This will prevent a failure to correlate a beacon and radar report (if they are indeed correlatives) in the case where each is declared in a different cycle.

3.3.4.2.14.18 Radar Detection Map (RDMT).- The radar detection map is a 128-word vertical table which is maintained by tracking for the purpose of enhancing radar target detection. The structure and bit significance of the RDMT is identical to the track present map (3.3.4.2.4.16). The RDMT is shown in figure 3-67.

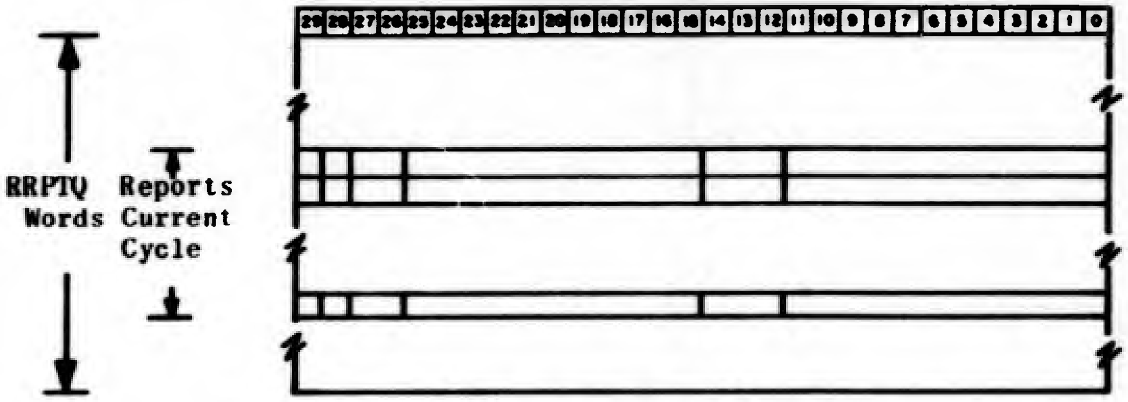
3.3.4.2.15 Magnetic Tape Flight Plan Input.-

3.3.4.2.15.1 General Requirements.- The input of flight plan information from magnetic tape shall provide automatic initiation and controller assignment of prestored (schedule) aircraft. The FP input capability shall be an independent



(Each bit represents one 2 NM X 32 ACP zone; each word represents one 60 NM X 32 ACP sector.)

Figure 3-65. Track Present Map (TPMT)



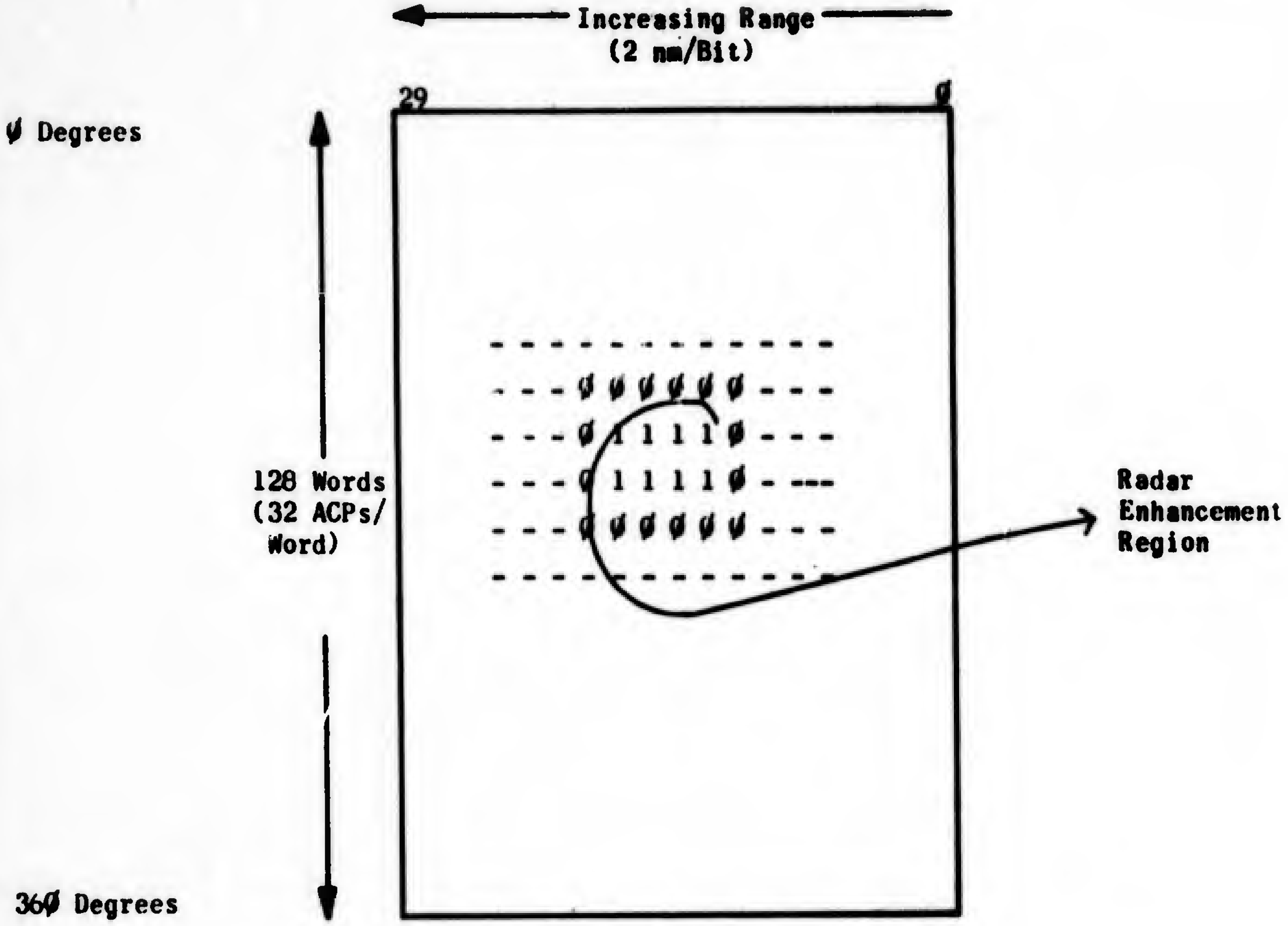
Radar Report Store, RRSIT

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RHC		* * *			Range LSB - 1/16 nm										Q			Azimuth LSB - 1ACP											

Radar Report Format

RHC	Radar Hold Count
*	Unused
Range	Range of Radar Report, NM, SC + 4 (LSB = 1/16 NM)
Q	Quality Assignment
Azimuth	Azimuth of Radar Report, ACPs, SC + 0 (LSB = 1 ACP = 1/4096 degree)

Figure 3-66. Radar Report Store (RRSIT)



(Each bit represents one 2 NM X 32 ACP zone; each word represents one 60 NM X 32 ACP sector).

Figure 3-67. Radar Detection Map (RDMT)

3.3.4.2.15.1 (continued)

operational function with on-line operator control, i.e., a keyboard message shall be provided to select or inhibit the input function, and the magnetic tape input may be used with interfacility (ARTCC) communication. When used with ARTCC communication, the magnetic tape FP information shall consist of scheduled aircraft whose flight plans are not received from the ARTCC.

The FP data shall be prestored on magnetic take in time-ordered sequence. The data shall be taken from the tape and, after a proper validation of the data is made, shall be formatted and placed in the Temporary Flight Plan Store (TS) area (see 3.3.4.2.14.10). The validation checks consist of the following:

- The FP time must be within 4 (SP) hours of the current time and the day code must be the same as the current day. If the FP is not valid for the present day, it is discarded.

- The FP sequence number must be in order. If it is not, an MT DATA LOSS printout is requested, and the sequence number is resynched.

- The FP's seven character ACID must pass the following checks:

  1) The number of non-blank characters must be greater than one.
  2) Character 1 must be an alpha.
  3) Character 2 must be a numeric if the remaining five characters are blanks.
  4) Once a blank is found, the remaining characters must be blanks.
  5) If there are exactly three non-blanks characters, the characters cannot be "ALL".

  Any error in the ACID shall result in an MT FORMAT print request, and the FP shall be discarded.

- The three character entry and exit fixes must be valid; one of the fixes may be all blanks. An illegal fix shall result in an MT FORMAT print request, and the FP shall be discarded.

An FP shall be transferred from TS to the Central Track Store (CTS) when the following criteria are satisfied:

- For departure flight plans, the time is within 6 (SP) minutes of the current time.

- For arrival flight plans, the time is within 16 (SP) minutes of the current time.

- The CTS is not at 90% (SP) capacity.

- The FP's discrete beacon code is not duplicate with the assigned beacon code of any non-FP track in CTS.

3.3.4.2.15.1 (continued)

- The FP's ACID is not duplicate with the ACID of any non-FP track in CTS.

- The FP's entry and exit fixes constitute a legal fix pair.

A duplicate beacon code, ACID or illegal fix pair shall result in one of the following print requests:

DUP BCN
MT DUP ID
MT FORMAT,

and the FP shall be discarded.

The magnetic tape performance shall be monitored, and the program shall provide error recovery and MT FAILURE print requests when the following failure conditions are detected.

- A backspace command is given at the beginning of tape.

- A forward command is given at the end of tape.

- Any tape command is given when the tape unit is not in the auto condition.

- The read function resulted in an improper condition or IOP parity error.

3.3.4.2.15.2 Magnetic Tape Flight Plan Input Design.- The on-line operational FP input function shall be performed by one executive controlled subprogram and one MT channel interrupt routine.

3.3.4.2.15.2.1 Magnetic Tape Input Interrupt Routine.- The interrupt routine will be referenced upon completion of each operation. If a read was successfully completed, the busy flag will be cleared and the input data will be left for subsequent processing by the executive subprogram. If unsuccessful, recovery procedures (up to 3-system parameter-attempts) will be initiated. If recovery is unsuccessful, an alarm printout (MT DATA LOSS) will be requested, and the next FP shall be read.

3.3.4.2.15.2.2 Magnetic Tape Input Executive Subprogram.- This subprogram shall be referenced once every twelve seconds. Because the MT function is controlled on-line, an on-line preset shall be provided; i.e., until the SELECTED flag is set, all FPs shall be discarded until the ETA/PTD is greater than or equal to the time specified in the MT selection (see 3.3.4.2.7). After preset, this subprogram will store new FP data in the TS and search the TS for any FP meeting the criteria for transfer to the CTS. If any FP meets the

3.3.4.2.15.2.2 (continued)

criteria, a common subroutine shall be referenced to initiate the track file. If an initiate is performed, the TS search shall be aborted to avoid excessive processing time. Checks shall be made for unsuccessful initiates because of the FP data, and an appropriate alarm printout shall be requested. When a TS slot is available and the MTU is not busy, input of the next FP file will be initiated.

3.3.4.2.15.3 Magnetic Tape Flight Plan Input Data Base.- The operational FP input function shall require one 12-word magnetic tape input buffer operating in half word mode to handle each 13 character FP. Figure 3-68 shows the character format.

3.3.4.2.15.4 Magnetic Tape Flight Plan Input Parameters.- Table 3-24 contains a summary of the magnetic tape flight plan input parameters (SP) together with their labels and ranges of values.

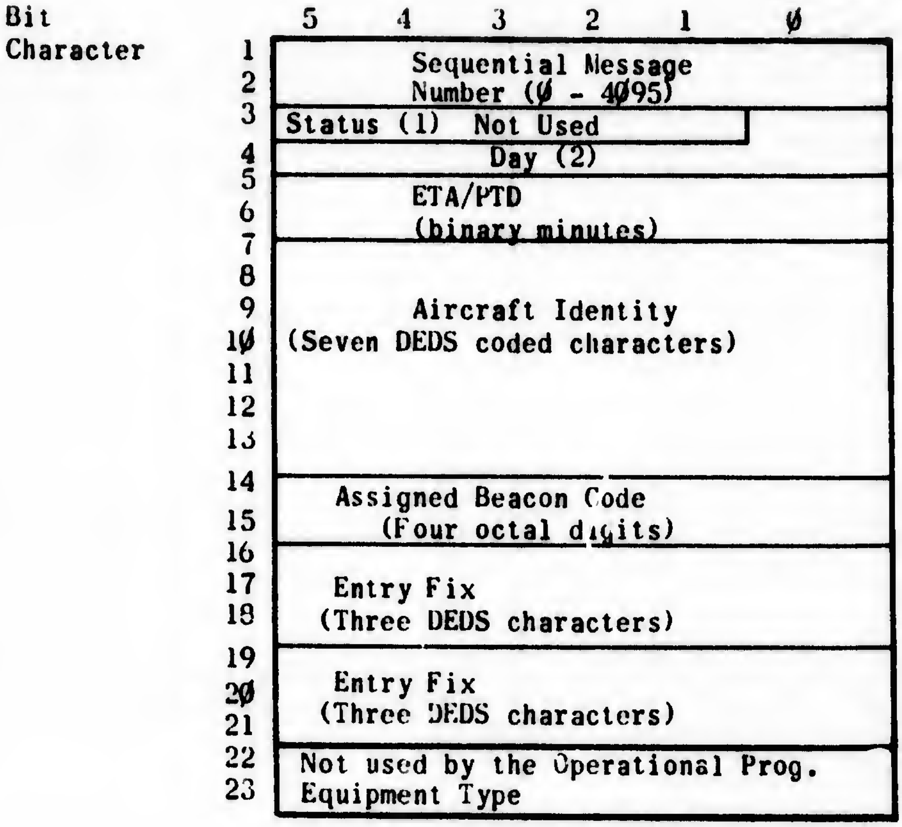
3.3.4.2.16 Data Base Utilization Summary.- Table 3-25 summarizes the relationship between the operational subprograms and the major tables and buffers.

3.3.4.2.17 Program Storage and Timing Estimates.- The following paragraphs describe the storage and timing estimates for the Augmented Tracking Level system.

3.3.4.2.17.1 Memory Requirements.- Table 3-26 shows the storage estimates for the Augmented Tracking Level subprograms and subroutines. Table 3-27 shows the memory estimates for the data base, including all tables and buffers. In many cases, the size of these areas shall be determined according to the expected data load (number of beacons, track, displays, etc.) and/or the equipment configuration.

3.3.4.2.17.2 Program Timing Estimates.- The Augmented Tracking timing analysis is summarized in table 3-28. The timing estimates assumed the following parameters:

1) 250 beacon reports per scan
2) 350 radar reports per scan
3) 250 tracked targets
4) 6 displays
5) 15 keyboards.



(1) Status: 00 = Arrival
01 = Departure
10 = Overflight

(2) Day: bit 0 of Word 3, if set, indicates the record is to be used on Sunday. Bits 5 through 0 in Word 4, if set, represent scheduled days Monday through Saturday respectively.

Figure 3-68. Flight Plan Format on Magnetic Tape

TABLE 3-24. MAGNETIC TAPE FLIGHT PLAN INPUT PARAMETER TABLE

ITEM	DESCRIPTION	VALUE RANGE
FPRQ	Time, in minutes, in advance of current time that flight plans are read from magnetic tape	0-1440
MTRECQ	Number of attempts made to recover from magnetic tape timing or read parity error	0-7
PSFLQ	Number of files to pass to position magnetic tape for read	0-100
ATSQ	Time, in minutes, prior to ETA when a flight plan in TS is transferred to store status in CTS	0-500
DTSQ	Time, in minutes, prior to PTD when a flight plan in TS is transferred to store status in CTS	0-500
SATHQ	Percent of CTS at which transfer of flight plans from TS to CTS is stopped	0-100

TABLE 3-25. DATA BASE UTILIZATION SUMMARY

NOTE:

S = Store
R = Retrieve

SUBPROGRAM	Target Report Store	Sector Access Store	Sector Time Store	Central Track Store	Print Request Table	Display Parameter Tables	Configuration Tables	Common Active Track Buffer	Selected Code Table	Tabular Track Index	Track Number Pointer Table	Temp. Flight Plan Store	VFR/IFR Code List	Time-Altimeter Setting	EM/RF/HJ/SA	Memory Readout	Beacon Report Store	Track Present Map	Radar Report Store	Radar Detection Map		
Radar Input Processing					S														S	R		
Beacon Input Processing					S												S	R				
Beacon/Radar Correlation	S	S	S														R		S R			
Keyboard Input Processing				S R	S	S R	S R	S R	S R	S R	S R	S R	S R	S R		S						
Interfacility I/O Processing				S R	S		R	S R					S R									
Tracking	R	R	R	S R	S	S R		S R	R		S R		S R		S			S		S		
Display Output Processing				R	S	R		S R		S R												
Automatic Offset				R		R		S R														
Console Typewriter Output					S R																	
System Timeout Processing				S R	S	R			S R				S R	S	S	S						
Mag Tape Flight Plan Input				S	S R	R	R	S				S R	S R									
Thread Update			S R								S R											

TABLE 3-26. PROGRAM STORAGE

Program	Storage Estimate
Executive	400
Thread Update	100
Beacon Input Processing	900
Radar Input Processing	1000
Radar/Beacon Correlation	300
Quantizer Control	350
Tracking	3000
Unused Report Processing	600
Keyboard Input Preprocessing	700
Keyboard Functional Processing	4000
Display Output Processing	900
Interfacility I/O Processing	1450
Auto Offset	250
Console Typewriter Output	650
System Timeout Processing	750
Magnetic Tape Flight Plan Input	500
Common Subroutines	1800
Miscellaneous	7200
TOTAL PROGRAM STORAGE	17,850

TABLE 3-27. DATA BASE

DATA BASE	STORAGE ESTIMATE (Words)
Beacon Input Buffers and Record	800
Beacon Data Stores and Parameters	200
Beacon Target Report Store (3B/2)	375
Central Track Store (15.125T)	3780
Tracking Tables and Parameters	1400
Parameters 400	
RAT (3T) 750	
TNP (1T) 250	
Beacon Only Table	100
Radar Only Table	150
Display/Keyboard Tables (32D+28K +100)	712
Display Output Chain List (3T(D+1)+100)	5350
Common Active Track Buffer (5T)	1250
Fixed Chain List (25D+10K)	300
Console Typewriter Tables and Buffers	275
Configuration Tables	325
Interfacility Tables and Buffers	375
Minor Tables (VFR/IFR, Selected Codes, etc.)	650
Literals, Flags, Chains, Pointers, etc.	650
Radar Input Store	2736
Zone Control Map	1920
Input Process Masks and Zone Maps	450
Radar Record Stores	120
Radar Report Stores	90
Clutter Map Stores	768
Target Report Store (B+R)	600
Mag Tape Flight Plan Data Base (3T+50)	800
Executive Data Base	250
Miscellaneous Data and Working Storage	200
TOTAL	24,626

NOTE: B = number of beacon reports/scan = 250
R = number of radar reports/scan = 350
T = present number of tracks in system = 250
D = number of displays = 6
K = number of keyboards = 15

TABLE 3-28. PROGRAM TIME ESTIMATES

Subprogram	TIME(%)	
	IOP1	IOP2
Executive Control	3.0	3.0
Beacon Input Processing (1 1.8N + .06B + .0031P_b + 2.2)	19.7	
Keyboard Input Preprocessing (.4D)		2.4
Keyboard Functional Processing		0.1
Interfacility I/O Processing		1.6
Tracking (1.0 + 0.12T + .004T_uD)		33.4
Tracking Feedback		1.5
Process Unused Reports (.04U)		4.0
Display Output Chain Preparation (.1 + .01F_c + .002 S_c + .07 TB + .013S_u + .026L_u)D		15.0
Console Typewriter Output Processing		0.1
Magnetic Tape Input Processing		0.3
System Timeout Processing	1.8	1.8
Automatic Offset (.4 + .1D)		1.0
Input/Output Requirements (.5 + 1.2D)	1.5	7.7
Beacon/Radar Correlation (37.5P_c + 20B + 72.5R + 400)·10^{-4}	3.3	
Radar I/0 Control	4.0	
Radar Target Detection (.00375P + .038R + .005P_r + 1.25)	18.8	
Quantizer Control (f + 4000)/320	16.2	
TOTAL	68.3	71.9

NOTE:
R = radar targets (350)
B = beacon targets (250)
T = tracks (250) = Tu + Tc
D = displays (6)
K = keyboards (15)
U = unused reports (100)
T_u = uncontrolled tracks (100)
T_c = controlled tracks (150)
N = fruit/SWP (.25)
F_c = controlled track FDBs/display (25)
S_c = controlled track SS/display (125)
TB = tabular tracks/display (0)
S_u = uncontrolled track SS/display (75)
L_u = uncontrolled track LDB/display (25)
P_b = entries/scan for beacon input proc (64)
P_c = entries/scan for beacon/radar correlation (64)
f = prf (1200 pps)
P = radar predetections (850)
P_r = entries/scan for radar target detection

3.4 Reliability.- This section specifies the reliability requirements for the Augmented RBTL system and equipments.

3.4.1 Reliability Definitions.-

3.4.1.1 Mean Time Between Failure (MTBF).- The reciprocal of unit failure rate expressed in hours (MTBF = $1/\lambda$ where λ equals unit failure rate).

3.4.1.2 Unit Failure Rate (λ).- The sum of the individual component density failure rates within a unit. The individual component density failure rate is the number of components times the expected failure rate for that component type.

3.4.1.3 Mean Time To Repair (MTTR).- The mean time to effect repair of the unit to put the unit in an "up" condition.

3.4.1.4 Mean Up Time (MUT).- The mean time to a failure of the system given that the system was performing its intended function at time zero.

3.4.1.5 Mean Down Time (MDT).- Mean time to effect repair of the system sufficient to put the system in condition to perform its intended function.

3.4.1.6 Availability (A).- The intrinsic availability expressed as follows:

a) For the system, MUT/(MUT + MDT)
b) For the subsystem, MTBF/(MTBF + MTTR).

3.4.1.7 Classes of Failures.-

a) Transient failure - Self-clearing transient disturbances, such as transient parity errors, which do not require deactivation of an active unit.
b) Non-transient failure - Non-clearing failures of an active unit requiring deactivation of this unit.

3.4.2 Subsystem Reliability.-

3.4.2.1 Beacon Data Acquisition Subsystem (BDAS).- The BDAS shall exhibit an MTBF equal to or greater than and an MTTR equal to or less than the existing field implemented ARTS III BDAS.

3.4.2.2 Radar Video Digitizer (RVD-4).- The RVD-4 shall exhibit an MTBF equal to or greater than S x 10^3 hours and an MTTR equal to or less than 0.5 hours (assuming spare part availability).

3.4.2.3 Data Processing Subsystem (DPS).- The DPS shall consist of one eight channel IOP, one 12 channel IOP, two 16K memory modules with 2 access port front ends, and one 8K memory module with two access port front end. The subsystem based on the reliability model composed of these basic unmodified modules shall exhibit an MTBF equal to or greater than 1360 hours and an MTTR equal to or less than 0.5 hours.

3.4.2.4 Data Entry and Display Subsystem.- The Data Entry and Display Subsystem reliability shall be specified in FAA-TD/S-120-801A.

3.4.3 Component Reliability - The reliability of control switches, indicator lights, and lamps shall be as specified in FAA-TD/S-120-801A.

3.4.4 System Reliability.- The reliability of the Augmented RBTL system shall be outlined in the following table:

Equipment	FPMH $\lambda(10^{-6})$ hours	MTBF Hours
RDAS *	200	5000
BDAS	268	3740
$IOP_{12\ ch}$	160	6250
$IOP_{8\ ch}$	150	6667
16K Mem	168	5943
8K Mem	89	11223
System **	1203	833

* RDAS design goal

** System based on the following reliability model

Reliability Model (Single Thread)

3.4.5 Reliability Design Features.- The Augmented RBTL system shall contain the same reliability design features as ARTS III. These features are delineated in section 3.8.5 of FAA-TD/S-120-801A.

3.5 Maintainability.- The software and hardware maintenance features shall provide the means to meet the MDT and MTTR requirements set forth in section 3.4. The Contractor will be guided by section 3.9 of FAA-TD/S-120-801A in maintenance approach and maintenance features.

3.6 System Acceptance Testing.- The Contractor shall verify the performance standards of this system by comprehensive testing at all levels. Satisfactory completion of system testing shall be the demonstration of a system with operational capabilities in accordance with the requirements stated in the specification.

3.6.1 Factory Tests.- The Contractor shall demonstrate at the factory the capability of the radar video digitizer to meet the requirements of this subsystem contained in section 4 of this document.

3.6.2 Off-Site Tests.- The Contractor shall deliver, install, and integrate the Augmented RBTL hardware and software into an ARTS III system located at a Government Test Facility. The Contractor shall demonstrate system operation in compliance with the design requirements stated in this specification.

3.6.3 On-Site Tests.- The Contractor shall deliver, install, and integrate Augmented RBTL hardware and software into an ARTS III System located at a terminal air traffic control facility. The Contractor shall demonstrate system operation in compliance with the design requirements stated in this specification.

3.6.4 Test Plan.- The Contractor shall prepare and submit in draft form ten copies of a recommended test plan within six months from the date of contract for review and approval by the Government. The Government will review, approve, and/or direct necessary changes to the test plan within 60 days after receipt. The Contractor shall incorporate such direct changes and resubmit one reproducible and ten copies of the final test plan at least 15 days prior to any equipment tests.

3.6.5 Test Reports.- Upon completion of the applicable tests in accordance with the approved test plan, the test results shall be recorded for submission to the FAA. The test report shall contain a complete description of the test results and shall be certified and submitted within 15 days after completion of each major system test. One reproducible and ten copies shall be submitted for FAA acceptance.

3.6.6 Test and Inspection.- Section 3.10.7 of FAA-TD/S-120-801A shall apply.

3.6.7 Field Test.- Section 3.10.7 of FAA-TD/S-120-801A shall apply.

3.6.8 Failure During Testing.- Section 3.10.8 of FAA-TD/S-120-801A shall apply.

3.6.9 Test Record Forms.- Section 3.10.9 of FAA-TD/S-120-801A shall apply.

3.6.10 Additional Tests.- Section 3.10.10 of FAA-TD/S-120-801A shall apply.

3.6.11 Problem Areas.- Section 3.10.11 of FAA-TD/S-120-801A shall apply.

3.6.12 Equipment Modification.- Section 3.10.12 of FAA-TD/S-120-801A shall apply.

3.6.13 Documentation.- Section 3.10.13 of FAA-TD/S-120-801A shall apply.

3.7 General Requirements.- Section 3.11 of FAA-TD/S-120-801A shall apply.

3.8 Test Equipment.- Section 3.13 of FAA-TD/S-120-801A shall apply.

3.9 Pre-Installation Planning.- The Contractor may conduct a number of on-site inspections to become familiar with the environment which will be encountered at a typical ARTS III site during installation and checkout of the Augmented RBTL system. This particularly applies to the radar video environment which may vary from site to site depending on such things as radar receiver type, distance of radar site from IFR room, and type line drivers utilized to carry radar signals from site to IFR room.

3.9.1 Procedure.- Section 3.14.1 of FAA-TD/S-120-801 Applies.

3.9.2 Installation Planning Report.- Within 60 days of the contract date, the Contractor shall provide sufficient technical information on the installation of the Augmented RBTL system in report form to permit its distribution to the field by the Government. Two reproducible and ten copies of the installation planning report shall be provided.

3.9.3 Government Prepared Preliminary Installation Plan.- Based on the Contractor prepared installation planning report (3.9.2), the Government will prepare a site-by-site preliminary installation plan and submit this to the Contractor for review.

3.9.4 System Simulation.-

3.9.4.1 General.- A simulation model entitled ARTS Multiprocessor Executive Simulator (MES) has been developed under the ARTS Enhancement contract. This model will be utilized to support the design and implementation of the software for the Augmented RBTL operational system.

The model accepts inputs to define the characteristics of the system such as:

a) Number of processors and memories
b) Software structure

    1) Task schedules of lattices
    2) Memory maps

c) System loading data

    1) Number of radars and their characteristics
    2) Tracks
    3) Displays
    4) Beacon targets (airborne count)
    5) Radar targets (airborne count).

The model will be utilized to support the system implementation as follows:

a) Determine processing requirements for each site
b) Optimize software or task schedules to minimize inefficiencies
c) Balance processing loads
d) Size buffers to eliminate data losses
e) Minimize memory queuing
f) Minimize task delays to insure meeting system response times
g) Monitor overall software development.

3.9.4.2 Basic Model Description.- The ARTS Multiprocessor Executive Simulation (MES) model was developed to provide a means of observing the performance of an ARTS multiprocessing system based on the system configuration and load. Because the execution of all tasks in the ARTS system is controlled by the executive, data on the performance of the system can be obtained by observing the activities of the Exec. The MES model provides a means of observing Exec activities without the necessity of an entire system.

For a particular configuration, the model can be run using a variety of loads (tracks, beacon/radar reports, etc.) to determine system response time, system capacity, size and location of queues, and amount of idle time. The model can also be run using different configurations for a given load to show the effects of adding or deleting system devices.

In addition to configuration and load parameters, the model also accepts task lattice structures and popup requirements as input. By varying the lattice structures and popup times for a given configuration and load, the optimum software structure for a system can be determined.

The dynamic portion of the MES model is written in Univac System Simulation Language (USSL) and executed on a UNIVAC 1100 Series computers under EXEC-8 control. USSL is a high-level, discrete-time, simulation language written in FORTRAN V.

3.10 System Design Data.- Section 3.15 of FAA-TD/S-120-801A shall apply.

4. QUALITY ASSURANCE PROVISIONS

4. QUALITY ASSURANCE PROVISIONS.- The Contractor shall verify the performance of the system by comprehensive testing at all levels. Quality assurance provisions specified in FAA-TD/S-120-801 form a part of this specification and shall be complied with. Where FAA-TD/S-120-801 is not applicable, the Contractor shall be guided by the contract for ARTS III equipment (DOT FA69WA-2071). All items will be designed and constructed in a manner similar to that used for ARTS III equipment and will resemble ARTS III equipment in workmanship, quality, design and general appearance.

4.1 Design Qualification Tests.- The Contractor shall conduct design qualification tests to demonstrate to the Government that the equipment meets all contractual and specification requirements defined in FAA-TD/S-120-801A. These tests will be conducted in the factory, at a Government approved test facility, or some combination thereof, on all new equipment needed to bring existing ARTS III systems up to an Augmented RBTL system. Design Qualification testing shall consist of:

a) Unit tests
b) Subsystem tests
c) System tests
d) Reliability tests
e) Maintainability tests
f) Environmental tests
    1) Type tests

4.1.1 Unit Tests.- The Contractor shall conduct unit tests to verify that each individual piece of hardware meets the performance requirements as specified herein as well as the performance requirements delineated in this design specification.

4.1.2 Subsystem Tests.- Subsystem tests are tests of equipment combinations and/or equipment and operational software combinations. The Contractor shall conduct subsystem tests as necessary to verify proper operation of the subsystems and to provide confidence that the system tests will have a high probability of success.

4.1.3 System Tests.- The Contractor shall conduct system tests to verify that all requirements of this specification have been met. These tests shall be designed to exercise the total system comprising of basic ARTS III equipments, new ARTS III equipments, and the operational software.

4.1.3.1 Confidence/Stability Test.- As part of each system test, a continuous confidence/stability test shall be performed using video inputs with the operational program running. Manual inputs from the display data entry devices shall also be used. Measurements shall be made at the beginning of the test and at specified intervals which shall be indicative of the stability of the system. All system adjustments shall be made prior to the start of the test and no further adjustments will be allowed for the duration of the test. During the last half-hour of the test, a simulated power failure test shall be made. This test shall be made by interrupting all AC power to the system for a period of at least 15 seconds. When power is restored, all malfunctions or errors shall be recorded. The test shall be resumed without any equipment adjustments. If manual adjustments or intervention is required to re-initiate operation, these shall be fully documented in the test report.

4.1.4 Reliability Tests.- The Contractor shall conduct reliability tests to verify that the equipment meets the reliability requirements of this specification and to obtain the necessary data to assist in verifying that the system availability requirements are met. The reliability tests shall be conducted in accordance with MIL-STD-781.

4.1.5 Maintainability Tests.- The Contractor shall conduct maintainability tests to verify that the equipment meets the maintainability requirements of this specification. The maintainability tests used will be based on Method 4 of MIL-STD-471.

4.1.6 Environmental Tests.- The Contractor shall conduct environmental tests on all new equipment to verify that these equipments meet the requirements of FAA-TD/S-120-801A.

4.1.6.1 Type Tests.- The Contractor shall conduct type tests on all new equipment to verify that these equipments meet the requirements as specified in FAA-G-2100/1b.

4.2 Production Tests.- The Contractor shall conduct production tests to demonstrate to the Government that the equipment and systems manufactured during a production run are equivalent to the equipment and systems that have passed the design qualification tests. Production tests will consist of unit, subsystem, and system tests, and are a combination of factory and site tests.

4.2.1 Factory Tests.- Factory tests are those unit and subsystem tests conducted within the Contractor's plant to ensure that each unit and subsystem meets the requirements of this specification prior to delivery.

4.2.1.1 Factory Inspection.- The quality assurance provisions specified in FAA-G-2100 and MIL-I-45208A form a part of this specification and shall be complied with. All inspections and tests at the Contractor's plant shall be performed by the Contractor, and may be witnessed by and subject to approval by FAA inspectors. The Government reserves the right to waive the requirements of any portion of the inspections and tests.

4.2.1.2 Incoming Inspection.- The Government may elect to make an incoming inspection of all or any portion of the components and materials used in construction of the equipment to determine compliance with the specifications covering component procurement.

4.1.3.1 (continued)

4.2.1.3 Unit Inspection.- Each completed unit supplied as an integral part (or spare unit) of each system under the contract shall be given a mechanical electrical examination. The mechanical examination shall be used to determine compliance with the applicable specifications covering fabrication requirements such as strength and rigidity, accessibility, type of components and materials, choice of insulation, layout of chassis, panel, and wiring, finish, and so on. The Contractor shall perform an electrical inspection to determine compliance with the applicable specifications covering electrical requirements and performance, such as electrical continuity, leakage resistance, power supply voltages, and regulation, signal to noise ratio, pulse and wave shapes, resolution, storage characteristics, and so on. Units built, tested, and approved in accordance with the applicable specifications may be retained temporarily by the Contractor in order to facilitate testing of associated units; however, such units used for test purposes shall be given a mechanical and electrical re-inspection prior to Government acceptance if required by the Contracting Officer.

4.2.2 Site Tests.- The Contractor shall conduct site tests for every system installation. Site tests shall be conducted at the unit, the subsystem, and the system level. Site tests shall be organized so that the implementation requirement of section 3.1.4 is met. Each site test shall be designed to meet the following objectives:

a) To verify that the installed unit, subsystem, or system meets the requirement of this specification

b) To verify that the basic ARTS III functions can be performed with the unit, subsystem, or system installed

c) To provide the required certification procedures to enable the FAA to operate with the installed unit, subsystem, or system.

Site tests will consist of both off-site and on-site tests. Off-site tests will be conducted at a Government test facility on Augmented RBTL hardware and software. On-site tests will be conducted at an existing ARTS III air traffic control facility on Augmented RBTL hardware and software.

4.3 Test Conduct.-

4.3.1 General.- The Contractor shall be responsible for conducting all tests. Whenever testing is scheduled, the Contractor shall ascertain that all necessary personnel are available and that Contractor provided procedures, test scripts, and test data sheets have been distributed. All test personnel shall normally be provided by the Contractor. However, the FAA reserves the right to use FAA personnel in lieu of Contractor personnel to man any operating position in the equipment configuration under test. The Contractor shall conduct a test briefing and debriefing for each test and shall assure that

4.3.1 General.- (continued)

all personnel have been properly instructed in their duties. The Contractor shall make any and all additional tests necessary to demonstrate compliance to the required system performance. If, during the course of any tests, errors or malfunctions occur, the Contractor shall make entries in the appropriate logs. In addition, the Contractor shall document each error or malfunction indicating the type, the procedures taken, the time required to circumvent, and the assignment to the appropriate equipment or software element.

4.3.2 Test Procedures.- The Contractor shall provide all test procedures and/or scripts to be used during the conduct of a test. These procedures shall include all test record forms to be used as test data sheets, test operator logs, and reports. These documents shall be provided by the Contractor and submitted for review and approval 45 days prior to the scheduled performance of a test so as to allow 30 days for FAA review and approval.

4.3.3 Test Reports.- Upon conducting the applicable tests in accordance with the approved test plan, the results shall be recorded for submission to the FAA. The test report shall contain a complete description of the test results and shall be certified and submitted within 15 days after completion of each test. One reproducible and ten copies shall be submitted for FAA acceptance.

The test report shall, as a minimum, contain the information specified below:

a) Indicate the performance of each equipment under test and whether it meets the system limits

b) Functions that were tested

c) Information as to whether the results of the test are in agreement with the required reliability of the unit or system

d) The quantity and type of spare parts needed to correct the errors or malfunctions

e) A record of any engineering changes found necessary to correct design deficiencies.

4.3.4 Failure Accountability.- There are two major classes of failure: relevant (countable) failures and non-relevant (non-countable) failures. Relevant failures are defined as:

a) Manufacturing defects
b) Parts defects
c) Design defects
d) Unknown.

4.3.4 Failure Accountability.- (continued)

Failures due to other causes shall be classified non-relevant. This class includes failures due to:

a) Accident or mishandling
b) Operator (where not due to improper design)
c) Failure of part not supplied by the Contractor
d) Test equipment or facility failure
e) Maintenance induced failure
f) Installation error
g) Drawing specification or procedure error.

The burden shall be on the Contractor to show that a failure should be classified non-relevant.

4.3.4.1 Failure Recording and Reporting.- Failures shall be recorded in accordance with the Facility Outage and Equipment Failure Report (FAA Handbook SMP 6040.1B). Maintenance logs shall utilize FAA Form 406C.

4.3.4.2 Additional Tests.- The FAA may require the Contractor to repeat tests, or portions thereof, if the original tests fail to demonstrate compliance with the specification.

4.3.4.3 Problem Areas.- The Contractor shall be responsible for solving problems encountered in providing a system to the requirements of this document. He shall notify the FAA promptly of any problems beyond his jurisdiction.

4.3.4.4 Equipment Module or Subsystem Modification.- The Contractor shall be responsible for incorporating and testing any modifications to this design that are necessary to meet, approve, and/or direct necessary changes to the test plan within 60 days after receipt. The Contractor shall incorporate such directed changes and resubmit one reproducible and ten copies of the final test plan at least 15 days prior to any equipment tests.

4.4.1 Test Plan(s) Content.- The test plan(s) shall be comprehensive, including all details necessary to assure that test procedures and testing will satisfactorily demonstrate equipment software, subsystem, and system compliance with all requirements specified herein.

4.4.1 Test Plan(s) Content.- (continued)

The test plan(s) shall include, as a minimum, the following:

a) Test description and its purpose. The description shall include a block diagram showing the system configuration and interfacing and procedures for conducting each test of the series, together with the personnel necessary to perform the test.

b) Designation of all inputs that are required to test each function

c) Test output records including a description of required outputs, the types of equipment used to observe or provide the outputs, etc.

d) A complete time sequenced schedule of events

e) A list and description of each software program to be used, including the total running time for each program. The description shall include the format and contents of each type of message output and of any printouts or records to be maintained.

f) A detailed description of analysis or combination of analysis and test results which may be offered in lieu of testing, where complete test results may be difficult or impractical to obtain.

5. PREPARATION FOR DELIVERY

Preparation for delivery shall be in accordance with FAA-R-1030d unless air ride padded van shipment is used. Equipment delivered under this specification shall be F.O.B. destination, within consignee's premises, including delivery to specific rooms within a building. Transportation charges shall be billed as separate invoice item.

6.0 LIST OF ABBREVIATIONS AND ACRONYMS

ABC	Assigned Beacon Code
ACE	Automatic Clutter Eliminator
ACID	AirCraft IDentification
ACP	Azimuth Change Pulse
APE	Arrival, Departure, or Overflight Code
APG	Azimuth Pulse Generator
APRT	Active Popup Request Time
ARBTL	Augmented Radar Beacon Tracking Level
ARP	Azimuth Reference Pulse
ARTCC	Air Route Traffic Control Center
ARTG	Azimuth, Range, and Timing Group
ARTS III	Automated Radar Terminal System III
ASCII	American Standard Code for Information Interchange
ASR	Airport Surveillance Radar
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon Subsystem
AWT	Alphanumeric Write Time (DEDS)
BAM	Binary Angular Measurement (1 BAM = 2^{12} ACPs = 360°)
BAP	Bottom Address Pointer
BC/B.C.	Beacon Code
BCD	Binary Coded Decimal
BCW	Buffer Control Word
BDAS	Beacon Data Acquisition Subsystem
BDM	Beacon Detection Map
BIP	Beacon In Process
BRG	Beacon Reply Group
BTL	Beacon Tracking Level
BTRS	Beacon Target Report Stores
CATB	Common Active Track Buffer
CID	Refers either to TCID or ECID (computer identification)
CIFRR	Common Instrument Flight Rules Room
Clock	Realtime Incrementing Clock
CPE	Center Pulse Enable
CPS	Chain Preparation Subprogram
CPU	Central Processor Unit
CR	Carriage Return
CRT	Cathode Ray Tube (DEDS Scope)
CS	Clutter Select
C/S	Coast/Suspend
CT	Cycle Table
CTS	Central Track Store
DAS	Data Acquisition Subsystem
dB	Decibels
Decr.	Decrement
DEDS	Data Entry and Display Subsystem
DNP	Do Not Process (Refers to DEDS AWT)

6.0 (continued)

DP	Display Processor
DPS	Data Processing Subsystem
DS	Density Select
DT	DEDS Dead Time
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECID	Enroute Computer IDentification
EF	External Function
EFR	External Function Request
ENCHIN	Enroute Interrupt Routine
ENRIN	Enroute Input Processor
ENROUT	Enroute Output Processor
EOM	End of Message
ETA/PTD	Estimated Time of Arrival/Planned Time of Departure
EXEC	Executive Control Program
FCF/FCLT/FCL	Fixed Chain List
FDB	Full Data Block
FP	Flight Plan
FTC	Fast Time Constant
GFE	Government-Furnished Equipment
GMT	Greenwich Mean Time
HCD	Hit Count Discriminator
IAM	Intermediate Area Map
ICA	Interfacility Adaptor
ID	Identification
IF	Interfacility
IFR	Instrument Flight Rules
Incr.	Increment
I/O	Input/Output
IOP	Input/Output Processor
KHz	Kilo hertz
KIP	Keyboard Input Processing
KOF	Keyboard Operational Function
LBJ	Load B Register and Jump Instruction
LDB	Limited Data Block
LDT	Lattice Description Table
LF	Line Feed
LGC	Last Good Code
LL	List Length
LR	Leading Range
LRC	Longitudinal Redundancy Check
LS	Threshold (Lead Edge) Select
LSB	Least Significant Bit
MC	Master Clear
MHz	Mega hertz
MSB	Most Significant Bit
MT/MTU	Magnetic Tape Unit
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
MTI	Moving Target Indicator
nm	nautical mile

6.0 (continued)

NOOP	NO OPeration (Do nothing instruction)
n sec	nano seconds
ODR	Output Data Request
OUTB	Output Untracked Target Buffer
PAM	Peripheral Adapter Module
PFA	Probability of False Alarm
PPI	Planned Position Indicator
PRF	Pulse Repetition Frequency (cycles/second)
P/S	Primary Secondary
PTD	Proposed Time of Departure
PTP	Post Task Pointer
PUR	Process Unused Reports
RAT	Report Address Table
RBC	Reported Beacon Code
RBTL	Radar Beacon Tracking Level
R&D	Research and Development
RDS	Range Density Snapshot
RDAS	Radar Data Acquisition Subsystem
RIL	Release Interrupt Lockout
RIP	Radar in Process
RLD	Run Length Discriminator
RNIS	Radar (Digitizer) Not In Synchronization
RPM	Regional Performance Map
RSM	Report Screening Map
RTC	RealTime Incrementing Clock
RTL	Radar Tracking Level
RTQC	Real Time Quality Control
RVD	Radar Video Digitizer
Scaling	Scaled +n means Bit 2^n has the value of unity
SCF	Scan Correlated Feedback
SEP	DEDS Code to Terminate AWT
SIL	Set Interrupt Lockout
SL	System Load (Capacity of System Capability)
SP	System Parameter
SPI	Special Position Indicator
SS	Single Symbol
Synch	Synchronization
TABC	Tentative Assigned Beacon Code
TABIT	Tabular Index Table
TAP	Top Address Pointer
TCID	Terminal Computer Identification
TCL/TCLT	Track Chain List
TI	DEDS Character Code
TL	Target Leading Edge (for BDAS Target Declaration)
TLGC	Tentative Last Good Code
TN	Track Number
TNP	Track Number Pointer
TNT	Track Number Table

6.0 (continued)

TP	Target Declaration Processor
TR	Trailing Range
TS	Temporary Store or Test and Set
TSSS	Track Sector Summary Store
TT	Target Trailing Edge (BDAS Target Declaration)
TTY	ASR-37 teletypwriter
Va	Mode 3/A Validity
Vc	Mode C Validity
VFR	Visual Flight Rules
VS	Video Select
VSM	Video Select Map
ZCM	Zone Control Map
ACT	Zone Control Table
ZULU	Current System Time of Day
μF	micro farad
μsec	micro second

APPENDIX A

RADAR DATA ACQUISITION SUBSYTEM

DESIGN SPECIFICATIONS

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A.1 SCOPE

This specification covers equipment suitable for detecting target hit returns in either normal or MTI video received from short range airport surveillance radars. The equipment is designated as a "Radar Data Acquisition Subsystem" (RDAS). The video hits, from which targets may be detected, as well as clutter hit data for video selection, weather hit data for feedback control of the quantizers, and target predetection data are provided on a sweep by sweep basis to a digital computer. The computer performs target detection, tracking, and associated functions. Various operating parameters within the RDAS are controlled dynamically by the computer on either a non-periodic basis or synchronously every 32 azimuth change pulses. The RDAS also provides quantized and azimuth integrated video to a CRT display console.

A.2 APPLICABLE DOCUMENTS

The following specifications, in effect on the issue date of the specification, form a part of this specification to the extent specified herein:

MIL-STD-243A	Types and Definition of Models For Communications Electronics Equipment
FAA-G-2100/1A	Electronic Equipment, General Requirements
UNIVAC SB-10205(A)	Input/Output Channel Characteristics (IOP)
FED-STD-595	Colors

A.3 REQUIREMENTS

A.3.1 Equipment to be Furnished by the Contractor.- The equipment to be supplied under this specification shall consist primarily of a single unit designed to perform to the requirements detailed under paragraphs A.3.3 and A.3.5 of this appendix. The specific items to be delivered are:

a) One self-contained, free standing equipment cabinet
b) One set of mating connectors for installation on the site cables not included under this specification
c) One set of maintenance manuals including logic diagrams
d) One set of spare cards and parts.

A.3.2 Definitions.-

Radar Data Acquisition Subsystem (RDAS).- The hardware portion of the Radar Beacon Tracking Level system (RBTL) which receives broadband radar video digitizes it, and transfers hit and related data to the DPS

Input/Output Processor (IOP).- The ARTS III computer portion of the Data Processing System (DPS) which interfaces with the RDAS

Quantizer.- A device for sensing the presence of a video pulse which meets certain standards of amplitude and width relative to the video conditions in the immediate vicinity.

A.3.3 Functional Requirements.-

A.3.3.1 General.- The RDAS accepts basic timing information and video from the search radar. From this information and parameter settings derived in the IOP, the RDAS extracts video hit data by use of regulated amplitude quantizers. In order to specify in detail the functional requirements of the RDAS, a functional organization is described in the following paragraphs. The functional requirements of the RDAS are partitioned into the following groups:

a) Timing
b) Amplitude quantization
c) Hit processing
d) Hit integration
e) Input/output
f) Maintenance provisions
g) Display outputs.

A.3.3.2 Timing.-

A.3.3.2.1 General.- The timing group is comprised of a range oscillator and range counter and azimuth counter logic. It shall provide the basic timing signals for all RDAS functions. Additionally, logic for IOP sweep synchronization shall be provided.

A.3.3.2.2 Range Oscillator Logic.- The range oscillator shall be crystal-controlled. The crystal shall provide a nominal master clock frequency of 82.807 mHz (1/1024 nautical mile). An accuracy of ± 0.01 percent of nominal frequency shall be maintained. Timing signals representing 1/64 and 1/16 nautical miles shall be derived from the master clock. Logic shall be provided to synchronize these timing signals to the leading edge occurrence of each radar pretrigger such that synchronization jitter of all timing signals relative to the pretrigger shall not exceed one master clock pulse interval (12.1 nanoseconds).

A.3.3.2.3 Range Counter.- A range counter shall be provided that counts in 1/16 nautical mile increments from 0 to 127 nautical miles. Up to six sequential independent radar Maximum Range (MR) decodes shall be available for accommodating staggered PRF operation. These decodes shall be manually adjustable by wire strap cards.

A.3.3.2.4 Radar Synchronization.- For each radar pretrigger, the range counter is preset to a negative range corresponding to the time interval between radar pretrigger and radar range zero. This preset value shall be manually adjustable by wire strap card. The MR decode sequence shall be aligned to the radar by allowing the sequence to advance each pretrigger only if the next pretrigger occurs within 8 μsec after the MR decode. When the sequence advances in six consecutive radar sweeps, a control flip-flop shall be set declaring synchronization.

After synchronization to the radar, the synchronization logic shall continually check for a loss, premature, or late occurrence of the radar pretrigger (see A.3.3.7.5.3 for a detailed explanation). A range alarm signal shall be made available to the input/output group if one of these events occurs. A range alarm indicator shall be activated and cleared by an alarm control bit in Command Word 0 from the IOP. The activating and clearing of the indicator shall be solely dependent upon computer control when the RDAS is on-line. The range alarm logic shall be capable of monitoring PRF rates from 713 to 1200 Hz (see A.3.5.2.1).

A.3.3.2.5 Range Decoder.- Range decodes, adjustable by wire strap when required by radar variations, shall be provided to support other logic of the RDAS. Development of the processing range envelope (nominally 0 to 60 nautical miles) and RTQC range gate signal are examples of the range decoder function.

A.3.3.2.6 Azimuth Counter.- The azimuth counter shall accept 4096 equally spaced Azimuth Change Pulses (ACP) and one Azimuth Reference Pulse (ARP) per each full rotation of the radar antenna.

A 12-bit counter shall be provided for counting ACPs. Provision shall be made to preset the counter to a zero value upon receipt of the ARP. No azimuth bias correction shall be provided by the RDAS. The value of the azimuth counter shall be made available to all groups of the RDAS.

Logic shall be provided to detect loss, premature, or late occurrence of ARPs and ACPs (see paragraph A.3.3.7.5.2 for a detailed explanation). In that event, an azimuth alarm signal shall be made available to the input/output group. An azimuth alarm indicator shall be activated and cleared by an alarm control bit in Command Word 0 from the IOP when the RDAS is on-line.

A.3.3.2.7 IOP Sweep Synchronization Logic.- A master clear signal shall be derived by the input/output group from the IOP Command Word 0 MC field. Logic shall be provided to sense the occurrence of the MC field. When the MC field is a logic ONE, a control flip-flop shall be set. When the MC field is a logic ZERO, the next radar pretrigger shall cause the control flip-flop to be reset.

The reset state of the control flip-flop shall be used by the input/output group to enable exchange of radar sweep data with the IOP.

The set state of the control flip-flop shall inhibit the transfer of all except command words as defined in the input/output section (A.3.3.6) of this appendix.

A.3.3.2.8 Zone Size.- Each zone shall consist of 2 nautical miles in range and 32 consecutive ACPs in azimuth. Zones shall begin at range zero and the sweep following the receipt of the ARP.

A.3.3.3 Amplitude Quantization.-

A.3.3.3.1 General.- Each RDAS shall contain three binary amplitude quantizers (Q1, Q2 and Q3) for simultaneously thresholding two types of radar video. The amplitude quantizer outputs shall be sent to their hit processing groups. The various components of each quantizer are shown in figure A-1. A simplified block diagram of the RDAS quantizer, hit processing, clutter sensing, and hit integration and selection is shown in figure A-2.

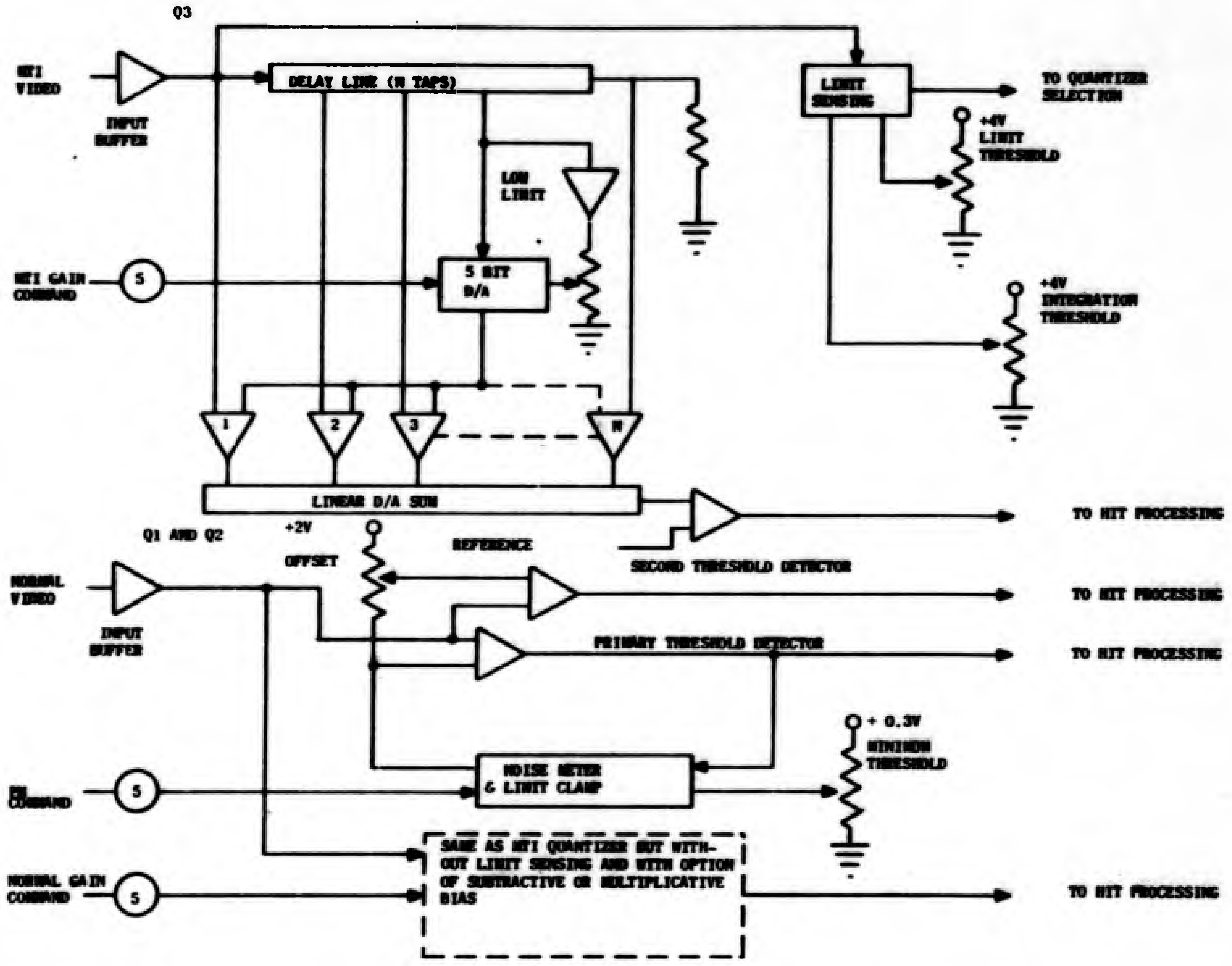


Figure A-1. Digitizer Normal and MTI Quantizers

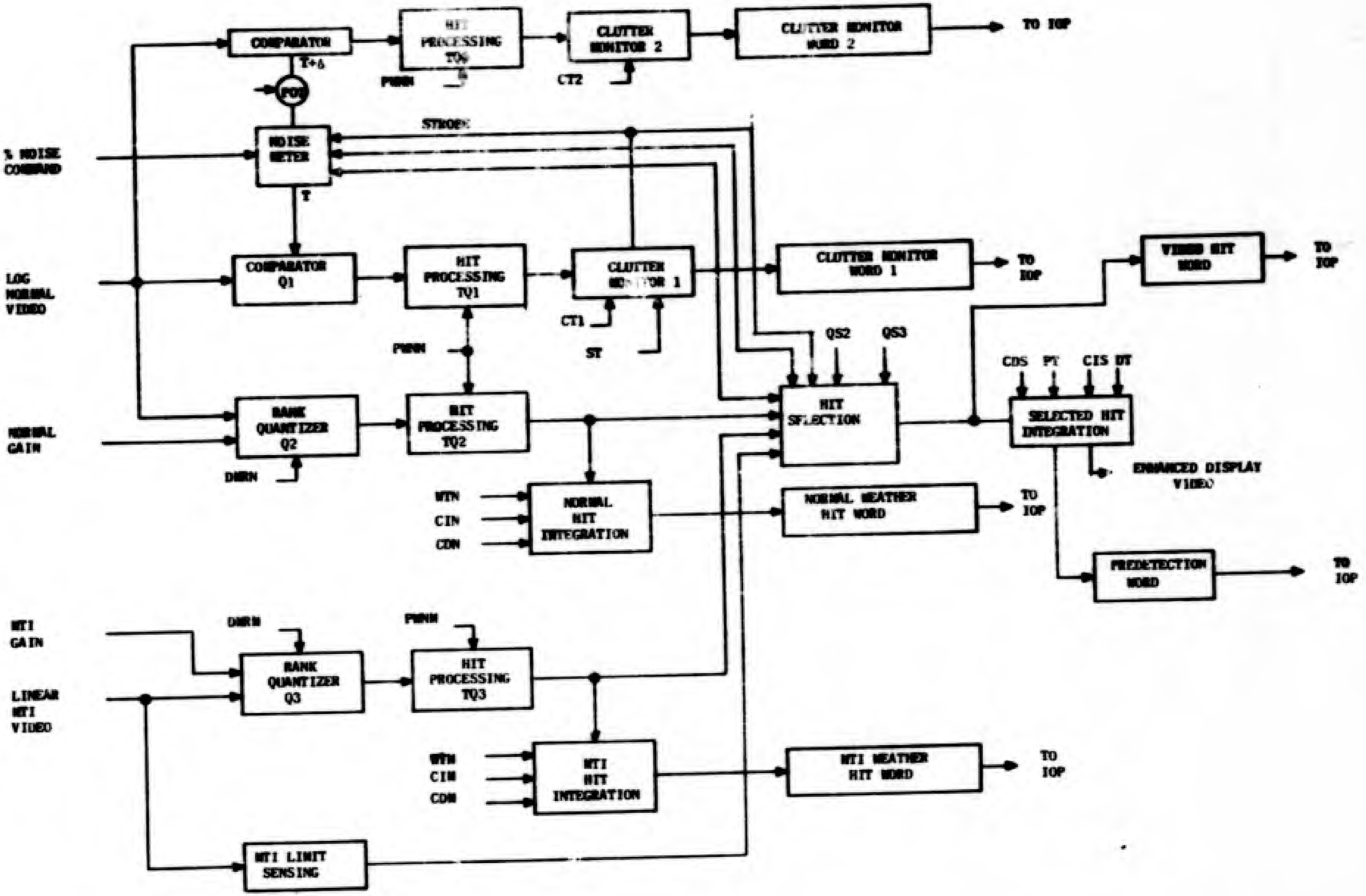


Figure A-2. RDAS Quantizers, Clutter Sensing, Hit Processing, Hit Integration, and Selection

A.3.3.3.1 (continued)

The normal quantizer, Q1, shall have a closed loop regulator for the establishment of an amplitude threshold. The loop shall regulate on thermal noise. It shall establish its threshold by employing a closed loop noise metering circuit. A second normal quantizer, Q2, shall employ a rank order technique in which a video pulse must exceed in amplitude the signal at a number of adjacent taps on a video delay line. A multiplicative gain adjustment on the center tap controlled by the IOP shall permit gain adjustment between 0 and unity. The MTI quantizer, Q3, shall employ the same rank order technique and gain adjustment method as does Q2.

A.3.3.3.2 Video Types.- The normal quantizers shall be capable of processing the following radar videos:

a) Linear normal
b) Log normal.

The MTI quantizer shall be capable of processing the following radar videos:

a) Linear MTI
b) Log MTI.

A.3.3.3.3 Input Buffer.- An input buffer shall be provided for the radar input to each quantizer. Each input buffer shall consist of a 4-pole high pass filter. The filter shall provide 24 db of attenuation at 60 Hz. The filter 3 db attenuation cutoff shall be at 120 Hz. The output of the buffer shall be clamped to insure that the baseline of the signal is held at zero. Provision shall be made for mixing test pulses and video at the buffer input.

A.3.3.3.4 Normal Quantizer Q1.- The normal quantizer Q1 shall derive a quantizer amplitude threshold based on the integration of hits over approximately a one second time period. This shall be accomplished by a noise metering circuit containing a differential integrator which compares the average number of hits being declared with a calibrated voltage representing a desired hit average (Pn). The noise meter hit input shall be based upon a 1/16 nm range cell rate. The calibrated reference voltage used to select the percentage noise regulation value shall be derived from a 6-bit digital command in the Percent Noise Normal (PNN) field of Command Word 0. The least significant bit in the 6-bit PNN field shall represent 1/4%.

A.3.3.3.4.1 Input Inhibit.- Gating shall be provided to inhibit the hit input to the noise meter during the following conditions:

a) When the count in the Hit Density Counter 1 exceeds the 5-bit Strobe Threshold (ST) found in Command Word 1

A.3.3.3.4.1 (continued)

b) When the hit processing output of Normal Quantizer Q1 is not selected
c) During dead time.

During the time that the hit input to the noise meter is inhibited, the amplitude threshold shall be permitted to drift upward (in the direction of reducing hit count) with a time constant of 100 or more seconds for a full excursion of 0 to 4 volts.

A.3.3.3.4.2 Minimum Threshold.- A 0 to 0.3 volt potentiometer-adjustable minimum threshold shall be provided so that the Q1 quantizer threshold can be adjusted to remain above zero.

A.3.3.3.4.3 Second Threshold Detector.- A second video amplitude threshold shall be derived by the addition of an adjustable offset to the threshold established by the noise metering circuit. This threshold shall be compared with the incoming video to provide input to Clutter Monitor 2. The offset shall be adjustable from 0 to 2 volts.

A.3.3.3.5 Normal Quantizer Q2.- The Normal Quantizer Q2 shall employ the rank comparison technique in which the amplitude at the center tap of a video delay line is either multiplied by a fractional constant or decreased by a subtractive bias and compared with the signal amplitude at each of a series of adjacent taps. If the Normal Bias (NB) field in Command Word 2 equals zero, the center tap will be multiplied by a fractional constant which is linearly proportional to the digital gain value prior to comparison. If NB equals one, a bias will be subtracted from the center tap, the magnitude of which bias is linearly proportional to the digital gain value. In either case, the rank of the center tap output relative to the other taps is determined and then is compared to a rank threshold. If it is higher than the threshold, an output representing a video hit is produced. The rank threshold shall have a maximum value equal to the number of taps adjacent to the center tap. It shall be reduced by an amount up to seven counts below the maximum by the value specified in the Difference From Maximum Rank-Normal (DMRN) field, bits 24 through 26 in Command Word 1.

The quantizer delay line will be 12.35 microseconds in length and will contain 25 taps. The 12 taps on either side of the center tap will be spaced .475 microseconds from one another and the two taps immediately adjacent to the center tap will be spaced .95 microseconds from the center tap to provide a guard band. The delay line shall have a distortion factor no greater than 2% and a delay-to-rise time ratio of 60 to 1 or greater.

A.3.3.3.5.1 Center Tap Bias Control.- When NB equals zero in Command Word 2, the fractional multiplier applied to the signal amplitude on the delay line center tap shall be determined for each two nautical mile increment of range by the decoding of a 5-bit normal gain word. The gain values shall be transmitted from the IOP to the RDAS in six normal gain zone control words, each containing five gain fields (for ten nautical miles) of five bits each. The range of the multiplier which represents the digital gain value shall be adjustable by a potentiometer between 0 and unity. A value of 0 in the gain word shall represent the minimum fractional multiplier. A value of 32 shall represent a unity fractional multiplier. Each gain value, in addition to applying to two nautical miles in range, shall be subject to update by the IOP each 32 ACPs.

When NB equals one in Command Word 2, the bias subtracted from the signal amplitude on the delay line center tap shall be determined for each two nautical mile increment of range by decoding of a 5-bit normal gain word. The range of the amplitude of the subtractive bias which represents the digital gain value shall be adjustable by a potentiometer between 0 and 1 volt. The granularity on this adjustment shall be such that one revolution of the potentiometer shall represent .1 volts or less. A value of 0 in the gain word shall represent the maximum subtractive bias and a value of 32 shall represent zero bias.

A.3.3.3.6 MTI Quantizer Q3.- The MTI Quantizer Q3 shall be identical to the Normal Rank Detector Quantizer Q2 (with no Q1 noise meter loop), but shall interpret the digital gain only as a multiplicative bias and shall contain limit sensing. The gain input for center tap bias control shall be transmitted from the IOP to the RDAS in six MTI gain zone control words, each containing five gain fields of five bits each. The Difference From Maximum Rank-MTI (DMRM) value for the rank threshold shall be specified in bits 24 thru 26 of Command Word 2.

A.3.3.3.6.1 Limit Sensing.- The MTI signal shall be amplitude quantized via a 0 to 4 volt pot adjustable threshold. The amplitude quantized signal shall then be integrated with a time constant of 1 nautical mile. The integrated value of the video shall be compared with a 0 to 4 volt adjustable threshold for the purpose of determining limit video conditions. The limit signal shall be used for quantizer selection.

A.3.3.4 Hit Processing and Selection.-

A.3.3.4.1 General.- The hit processing and selection group shall contain four time quantizers (TQ0, TQ1, TQ2, and TQ3), two clutter monitors, and a hit selector. The time quantizers shall provide time decision logic for the amplitude quantized video data.

A.3.3.4.1 (continued)

The strobe and clutter monitors shall provide the means for development of hit and zone density data for transmission to the IOP and for hit selection control. The hit selector logic determines which quantizer output shall be processed.

A.3.3.4.2 Time Quantization.- Each time quantizer shall provide the following time decision functions for its respective amplitude-quantized video pulse.

A.3.3.4.2.1 Narrow Pulse.- The time quantizers shall reject a pulse that is shorter than a minimum limit specified by the three bit PWNN field for TQ0, TQ1, and TQ2 and the PWNM field for TQ3 of Command Word 0. The limit shall be adjustable in 1/64 nautical mile increments and range from 1/64 to 7/64 nautical miles.

A.3.3.4.2.2 Normal Pulse.- For a pulse longer than the minimum limit but shorter than or equal to a maximum limit as specified by a wire strap selection, the time quantizers TQ0, TQ1, TQ2 and TQ3 shall produce a single 1/64 nautical mile pulse. The wire strap values for maximum limit shall be different for the normal time quantizers (TQ0, TQ1 and TQ2) than for the MTI time quantizer (TQ3). The maximum limit shall be adjustable in 1/64 nautical mile increments and range from 2/64 to 31/64 nautical miles. The maximum limit shall always be greater than either minimum limit, PWNN for TQ0, TQ1, and TQ2 or PWNM for TQ3.

A.3.3.4.2.3 Wide Pulse.- For a pulse longer than the maximum limit, the time quantizers shall produce a single 1/64 nautical mile output pulse for each corresponding consecutive whole maximum limit increment, and for any final residual fractional limit increment, they shall produce an additional single 1/64 nautical mile output pulse.

A.3.3.4.2.4 Pulse Position.- The time quantizers shall position the output pulse(s) to a resolution of a 1/64 nautical mile to correspond to the center of the amplitude-quantized pulse. This function shall perform as follows:

a) For the output described in A.3.3.4.2.2 (a normal pulse), position the output pulse to correspond to the center of the amplitude quantized pulse.
b) For the output described in A.3.3.4.2.3 (a wide pulse), position each consecutive output pulse to correspond to the center of the final maximum limit interval, whether it be whole or fractional.

A.3.3.4.2.5 Range Binning Logic.- The range binning logic shall interpret the two bit Double Hit (DH) field in Command Word 2 to determine whether an additional 1/64 nm pulse should be generated for each 1/64 nm time quantized pulse output from TQ1, TQ2, or TQ3. If DH = 00, no additional pulses will be generated. If DH = 01, one additional 1/64 nm pulse shall be generated immediately adjacent to and farther in range than each 1/64 nm pulse output from TQ1, TQ2, and TQ3. If DH = 10, two 1/64 nm pulses shall be generated immediately following in range each 1/64 nm pulse output from TQ1, TQ2, or TQ3. If DH = 11, three additional 1/64 nm pulses shall be generated following each 1/64 nm pulse output from TQ1, TQ2 or TQ3.

In any case, the range binning logic shall then convert the 1/64 nautical mile resolution time-quantized video to 1/16 nautical mile resolution by combining in an inclusive OR function four 1/64 mile increments for each 1/16 mile bin. For TQ0 and TQ1, the resultant time-quantized output shall be made available to the strobe and clutter monitors.

A.3.3.4.3 Strobe and Clutter Monitoring.-

A.3.3.4.3.1 Clutter Density Logic.- Two clutter density counters, one using the output of TQ0 and the other the output of TQ1, shall be provided to indicate the number of hits in a 1 13/16 nautical mile interval. Each 1/16 nautical mile, the value in the counters shall be updated. Logic shall be provided to detect a "0110" hit sequence. The counters shall be incremented by one for each hit from the respective time quantized outputs except when the "0110" hit sequence is detected. When this sequence is detected, the first hit shall increment the counter by one but the second hit shall not increment the counter. Concurrently, each 1/16 nautical mile a hit from the respective time quantized outputs, delayed 1 13/16 nautical miles, shall decrement the corresponding counter by one except when the "0110" hit sequence is detected. When this sequence is detected, the second hit will cause a decrement of the counter. The counters shall be capable of counting from zero to twenty nine. At the beginning of each sweep, the counters shall be reset to zero. Figure A-3 illustrates the functional design of the clutter density logic.

A.3.3.4.3.2 Clutter Monitor Word Development.- During each two nautical miles, the value in the clutter density counters shall be compared with their respective 5-bit clutter monitor thresholds. Clutter Threshold 1 (CT1) for the clutter monitor associated with TQ1 shall be specified in Command Word 1. Clutter Threshold 2 (CT2) for the clutter monitor associated with TQ0 shall be specified in Command Word 2. Sampling of the hit density counters shall be performed continuously each two-mile zone. When the value in a counter is sampled and exceeds the threshold, a logic ONE shall be stored for that 2 nautical mile increment in the clutter monitor word for that counter. Thus, at the conclusion of each radar sweep, two 30-bit clutter monitor words representing the Clutter Monitor threshold crossings for 60 nautical miles for each of the clutter density counters shall have been developed and made available to the input/output group for transmission to the IOP.

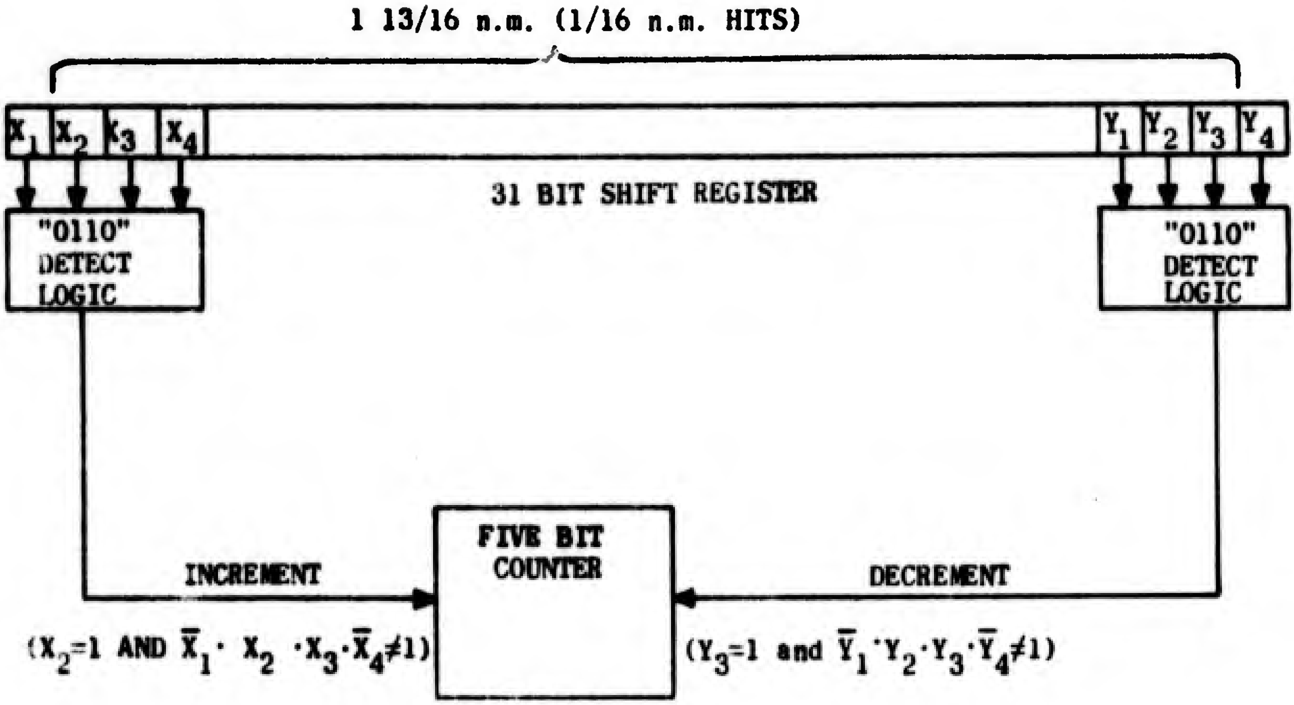


Figure A-3. RDAS Clutter Density Logic

A.3.3.4.3.3 Strobe Inhibit.- The time quantized output delayed one nautical mile (the center bit of the 31-bit shift register) shall be sampled at 1/16 nautical mile intervals. Each 1/16 nautical mile, the value in the clutter density counter associated with TQ1 shall be compared with a Strobe Threshold (ST) found in Command Word 1. When the value in the counter exceeds the strobe threshold, a strobe signal shall be generated and sent to the hit selection logic, and hits shall be inhibited from the normal noise meter input. The threshold shall be expressed by five bits and shall vary from zero to thirty-one.

A.3.3.4.4 Hit Selection.-

A.3.3.4.4.1 General.- The hit selector shall select either the output of the TQ1 or TQ2 hit processing (normal video) or TQ3 hit processing (MTI video) for further processing. The selection shall be controlled as described in A.3.3.4.4.2 by the appropriate zone fields of the Quantizer Select 2 and Quantizer Select 3 zone control words, by the declaration of a strobe condition by the hit count in Clutter Density Counter 1 equaling or exceeding the strobe threshold, or by sensing of an MTI limit video condition. The selected hits shall be used to develop 32 video hit words per sweep and, after hit integration, to develop the predetection word and the enhanced display video.

The quantized hit inputs shall be time aligned prior to hit selection.

A.3.3.4.4.2 Hit Selection Equations.- The hit selection logic shall be designed to select the hit processing outputs of the three quantizers in accordance with the following logical equations. Input signals are the Quantizer Select 2 and 3 zone control data (QS2 and QS3), the Strobe signal (ST), and the MTI Limit signal (LIM).

$$
\begin{aligned}
Q1 &= \overline{QS2} \cdot \overline{QS3} \cdot \overline{ST} \cdot \overline{LIM} \\
Q2 &= \overline{QS2} \cdot LIM + \overline{QS3} \cdot LIM + QS2 \cdot \overline{QS3} \cdot \overline{ST} \\
Q3 &= QS2 \cdot QS3 + QS3 \cdot \overline{LIM} + ST \cdot \overline{LIM}
\end{aligned}
$$

The truth table from which these equations are derived is shown below for reference purposes:

QS2	QS3	ST	LIM	QUANTIZER
0	0	0	0	Q1
0	0	0	1	Q2
0	0	1	0	Q3
0	0	1	1	Q2
0	1	0	0	Q3
0	1	0	1	Q2
0	1	1	0	Q3
0	1	1	1	Q2
1	0	0	0	Q2
1	0	0	1	Q2

A.3.3.4.4.2 (continued)

QS2	QS3	ST	LIM	QUANTIZER
1	0	1	0	Q3
1	0	1	1	Q2
1	1	0	0	Q3
1	1	0	1	Q3
1	1	1	0	Q3
1	1	1	1	Q3

The hit selection logic will be designed in such a way that by a wire strap or wiring change the strobe signal may inhibit hits entirely rather than choose the output of one of the rank quantizers.

A.3.3.4.4.3 Video Hit Word Development.- For each 30 consecutive samples of 1/16 nautical mile range (1 7/8 nautical miles), a 30-bit video hit word shall be made available to the input-output group, indicating the selected time-quantized output for the previous 1 7/8 nautical miles. The input-output group, in turn, will transmit the video hit word to the IOP each 1 7/8 nautical miles.

A total of 32 video hit words shall be required to cover the 60 nautical mile range.

A.3.3.5 Hit Integration.-

A.3.3.5.1 General.- Short term azimuth integration of hits shall be performed by three similar sets of logic as follows:

a) Integration of the hits from Quantizer 2 for weather hit sensing to enable the IOP to sense azimuth correlation in weather and control rank quantizer bias for the processing of normal video
b) Integration of the hits from Quantizer 3 for weather hit sensing to enable the IOP to sense azimuth correlation in weather and control rank quantizer bias for the processing of MTI video
c) Integration of hits from the hit selection logic for two purposes:
    1) Target predetection hit generation to indicate to the IOP those range cells with probable targets
    2) Display video generation to provide an enhanced video presentation on the system display console.

A.3.3.5.2 Normal and MTI (Quantizer 2 and 3) Weather Hit Integration Logic.- The normal weather hit integration logic shall consist of a four-bit sequential counter capable of being up or down counted and a means of storing the counter value at each of the 960 range cells (16 x 60). As each cell is reached in realtime, the old count for that cell shall be used to preset the counter. A hit from the Quantizer 2 hit processor, TQ2, at that cell shall increment the count by either 2 or 3 as selected by the Counter Increment Normal (CIN) bit 17 in Command Word 1. Bit 17 = 0 selects a 2 and bit 17 = 1 selects a 3. A miss at that cell shall decrement the count by a value of either 1 or 2 as selected by the Counter Decrement Normal (CDN) bit 23 in Command Word 1. Bit 23 = 0 selects a 1 and bit 23 = 1 selects a 2. An attempt to increment the counter beyond the maximum value of 15 shall cause it to assume the value of 15. An attempt to decrement the counter below 0 shall result in the counter remaining at 0.

The MTI weather hit integration logic shall be identical to the normal logic except that it shall receive hits from the Quantizer 3 hit processor, TQ3, and that the counter increment and decrement bits shall be in Command Word 2. The Counter Increment MTI (CIM) bit is 17 and the Counter Decrement MTI (CDM) bit is 23 in Command Word 2. Significance of the bits is the same as in the normal weather hit integration.

A.3.3.5.2.1 Normal and MTI Weather Hit Declaration.- The normal weather hit declaration logic shall compare the normal hit integration counter value at each range cell with the four-bit Weather Threshold Normal (WTN) located in bits 4 through 7 of Command Word 1 to obtain a weather hit/no hit indication. In order that only leading edge hits shall be produced, the comparison shall require that only positive-going threshold crossings be recognized. The hit shall be produced on the sweeps in which the threshold crossing occurs. The MTI weather hit declaration logic shall be identical to the normal logic except that the four-bit Weather Threshold MTI (WTM) located in bits 4 through 7 of Command Word 2 shall be used to compare with the MTI hit integration counter value.

A.3.3.5.2.2 Normal and MTI Weather Hit Word Development.- Normal weather hits shall be assembled in a 30-bit shift register. Each bit of the normal weather hit word shall represent 2 nautical miles of range, therefore corresponding to the zone control data range breakdown. Any bit set in the normal weather hit word indicates that, at one or more of the 32 correponding 1/16 nm increments, the normal hit integration counter value increased to equal or exceed the value of the weather threshold normal. The complete 30-bit normal weather hit word representing 60 nm of range shall be transferred to the IOP at the end of the sweep immediately following transfer of the predetection word discussed in A3.3.5.3.1. This data shall be used by the weather hit regulation in the IOP for control of the bias in the normal rank quantizer, Q2.

The MTI weather hit word shall be developed in a similar fashion.to that of the normal weather hit word. The complete 30-bit MTI weather hit word representing 60 nm of range shall be transferred to the IOP at the end of the sweep immediately following transfer of the normal.weather hit word. This data shall be used by the IOP for control of the bias in the MTI rank quantizer, Q3.

A.3.3.5.3 Selected Hit Integration Logic.- The selected hit integration logic shall be similar to the normal and MTI weather hit integration logic. It shall consist of a four-bit sequential counter capable of being up or down counted and a means of storing the counter value at each of the 960 range cells (16 x 60). As each cell is reached in realtime, the old count for that cell shall be used to preset the counter. A hit from the hit selection logic at that cell shall increment the count by either 2 or 3 as selected by the Counter Increment Selected (CIS) bit 15 in Command Word 2. Bit 15 = 0 selects a 2 and bit 15 = 1 selects a 3. A miss at that cell shall decrement the count by a value of either 1 or 2 as selected by the Counter Decrement Selected (CDS) bit 16 in Command Word 2. Bit 17 = 0 selects a 1 and bit 17 = 1 selects a 2. An attempt to increment the counter beyond the maximum value of 15 shall cause it to assume the value of 15. An attempt to decrement the counter below 0 shall result in the counter remaining at 0.

A.3.3.5.3.1 Target Predetection.- The target predetection logic shall compare the selected hit integration counter value at each range cell with the four-bit Predetection Threshold (PT) located in bits 0 through 3 of Command Word 1 to obtain a hit/no hit indication. In order that only leading edge hits shall be produced, the comparison shall require that only positive going threshold crossings be recognized. The hit shall be produced on the sweep in which the threshold crossing occurs. Target predetection hits shall be assembled in a 30-bit shift register. Each bit of the predetection word shall represent 1 7/8 nautical miles of range (30 x 1/16 nm) and shall therefore correspond to one video hit word. Any bit set to ONE in the predetection word indicates that, at one or more of the corresponding 1/16 nm increments, the selected hit integration counter value increased to equal or exceed the value of the predetection threshold. The complete 30-bit predetection word shall be transferred to the IOP at the end of the sweep immediately following transfer of the last video hit word. It thus allows the IOP to analyze only those video hit words which contain potential targets. It should be noted that the predetection word only covers the first 30 of the 32 video hit words generated per sweep.

A.3.3.5.3.2 Enhanced Display Video Generation.- The display video generation logic shall compare the selected hit integration counter value at each range cell with the four-bit Display Threshold (DT) located in bits 8 through 11 of Command Word 1 to provide a control for gating of target hit data to the PPI display. Whenever the selected hit integration counter value equals or exceeds the display threshold on any sweep, display of a target hit, if present, is generated. This target hit data, designated enhanced display video, shall be delayed by 59 nm (944 cells by 1/16 nm) to compensate for the prior 1 nm (16 range cell) delay in target hits. This will provide range realignment to the analog display with a one sweep delay.

The enhanced display output shall represent a mix of normal and MTI hits as determined by the two computer quantizer select words, the digitizer strobe signal in Clutter Density monitor 1, and the MTI limit signal. Adjustment of the display threshold in Command Word 1 will establish the display sensitivity

A.3.3.5.3.2 (continued)

and residual noise level. The enhanced display video shall be provided as an option to be used in place of the analog MTI input. The normal analog video shall be retained on the display.

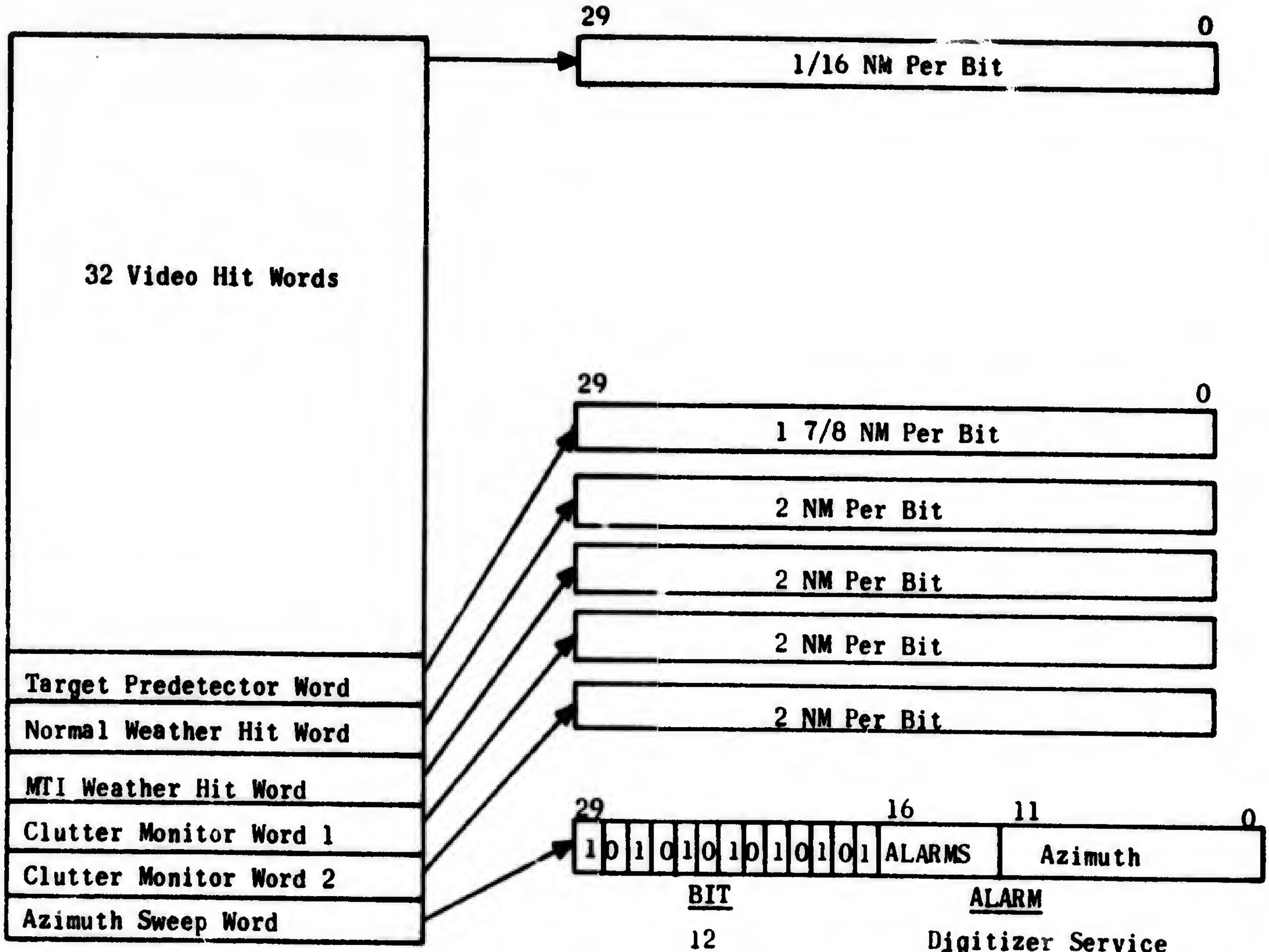
A.3.3.6 Input/Output.- The input/output group shall provide the interface for all data transferred to or from the IOP. It shall provide the specified buffering to match data rates between the various RDAS I/O groups and the IOP.

The digitizer shall interface with the IOP on a single input/output channel. The output channel from the IOP shall provide zone control words as a normal output data transfer and command words as an external function data transfer. The input channel to the IOP shall be used to provide video hit, target predetector, weather hit, clutter monitor, and azimuth sweep data to the IOP as a normal input data transfer. Provision shall be made to interface with two IOPs, of which only one will be active at a time. The digitizer shall put output data on the lines corresponding to the IOP from which the last command word was received. Data formats are shown in figures A-4 through A-7. The least significant bit of each field is assigned the lowest bit number of the field. The following paragraphs detail the handling of the data by the I/O group.

A.3.3.6.1 Parity Data.- The digitizer shall check parity on all words transferred from the IOP and shall generate parity data for all words transferred to the IOP.

Each 30-bit word transferred between the equipments shall be accompanied by the parity bits. One bit shall provide odd parity for the lower half word (bits 0 to 14) and the other bit shall provide odd parity for the half word (bits 15 to 29). The receipt of any word from the IOP with incorrect parity shall generate a parity error condition. The parity error shall set an indicator on the digitizer and shall be sent to the IOP in bit 16 of the azimuth sweep word. The data word received with bad parity shall be used by the digitizer until replaced with a new word from the IOP.

A.3.3.6.2 Command Words.- Command words shall be transmitted from the IOP on an output channel as an external function data transfer. Command words shall provide parameter and mode selection data for all variables that are controllable from the IOP but not selectable on a zone basis. The I/O group shall provide register storage for all data included in the command words. Command words shall be requested by the digitizer during dead time. The request shall be initiated each sweep at the beginning of dead time. The request shall be active until minus 1/2 nm before zero range of the next sweep. Command words shall be sent to the digitizer whenever the IOP determines it is necessary to update a parameter or select a different mode of operation. The I/O group shall accept a command word whenever it is transmitted from the IOP during this dead time period and shall immediately load the new command word into the



BIT	ALARM
12	Digitizer Service
13	Zone Service
14	Azimuth Alarm
15	Range Alarm
16	Parity

Figure A-4. IOP Input Format

COMMAND WORD 0

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MC	0	0	DVS										AC					PWNM			PWNN			PNN					
																		1/16	1/32	1/64	1/16	1/32	1/64	8	4	2	1	½	¼

MC = Master Clear
DVS = Display Video Select
AC = Alarm Control
PWNM = Minimum Pulse Width MTI
PWNN = Minimum Pulse Width Normal
PNN = Percent Noise Normal

BIT	ALARM CONTROL
12	Digitizer Service
13	Zone Service
14	Azimuth
15	Range
16	Parity

BIT		DISPLAY VIDEO SELECT
17		System Diagnostic Map
19	18	
0	0	Off
0	1	Amplitude Output Q1
1	0	Amplitude Output Q2
1	1	Amplitude Output Q3
20		MTI Limit
22	21	
0	0	Off
0	1	QS3 = 0, QS2 = 1
1	0	QS3 = 1, QS2 = 0
1	1	QS3 = 1, QS2 = 1
24	23	
0	0	Off
0	1	Clutter Monitor 1
1	0	Clutter Monitor 2
1	1	Selected Hit Processing Output
26	25	
0	0	Off
0	1	Weather Hit Output Normal
1	0	Weather Hit Output MTI
1	1	Enhanced Display Output

Figure A-5. IOP Output Format - Command Word 0

COMMAND WORD 1

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	DMRN			CDN	CT1					CIN	ST					DT				WTN				PT			
			4	2	1		16	8	4	2	1		16	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1

DMRN = Difference From Maximum Rank Normal Quantizer

CDN = Counter Decrement Normal (0 = Decrement of 1, 1 = Decrement of 2)

CT1 = Clutter Monitor Threshold 1

CIN = Counter Increment (0 = Increment of 2, 1 = Increment of 3)

ST = Strobe Threshold

DT = Display Threshold

WTN = Weather Threshold Normal

PT = Predetection Threshold

COMMAND WORD 2

29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	DMRM			CDM	CT2					CIM	CDS	CIS	NB	DH		0	0	0	0	WTM				0	0	0	0
			4	2	1		16	8	4	2	1											8	4	2	1				

DMRM = Difference From Maximum Rank MTI Quantizer

CDM = Counter Decrement MTI (0 = Decrement of 1, 1 = Decrement of 2)

CT2 = Clutter Monitor Threshold 2

CIM = Counter Increment MTI (0 = Increment of 2, 1 = Increment of 3)

CDS = Counter Decrement Selected

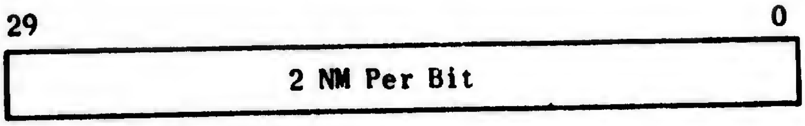
CIS = Counter Increment Selected

NB = Normal Bias (0 = Multiplicative bias for Q2,
1 = Subtractive bias for Q2)

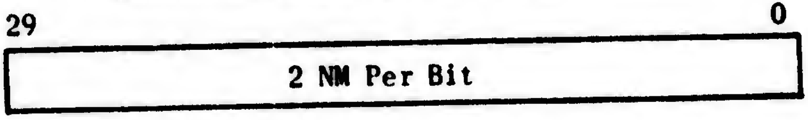
DH = Double Hit (00 = No double pulse generation
01 = Additional 1/64nm pulse adjacent to 1/64nm pulse output of TQ1,2,3.
10 = Additional 1/64nm pulse 2/64nm farther in range than 1/64nm output of TQ1,2,3.
11 = Additional 1/64nm pulse 4/64nm farther in range than 1/64nm output of TQ1,2,3)

WTM = Weather Threshold MTI

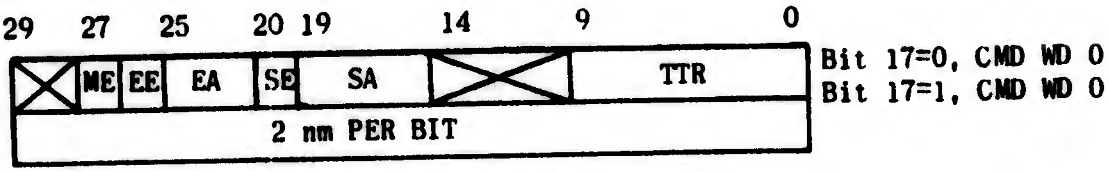
Figure A-6. IOP Output Format - Command Words 1 and 2



QUANTIZER SELECT 2 WORD (QS2)

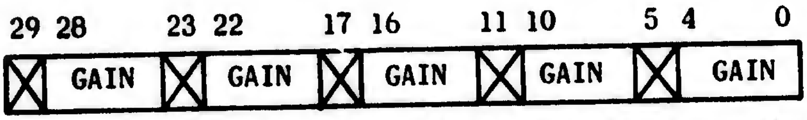


QUANTIZER SELECT 3 WORD (QS3)



SYSTEM DIAGNOSTIC WORD (SD)

ME = Mask Enable
EE = End Enable
EA = End Azimuth (LSB = 1 ACP)
SE = Start Enable
SA = Start Azimuth (LSB = 1 ACP)
TTR = Test Target Range (LSB = 1/16 nm)



GAIN WORDS (12 WORDS-6 NORMAL and 6 MTI)

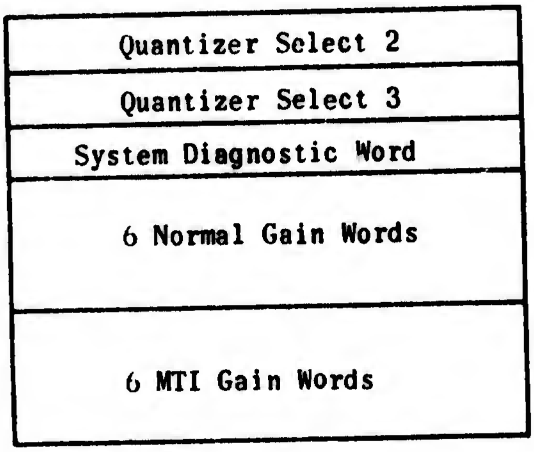


Figure A-7. IOP Output Format - Zone Control Words

A.3.3.6.2 (continued)

appropriate storage register. The outputs of the storage registers shall be provided to the various RDAS groups for use as the active values of the adjustable parameters. For proper on-line operation, all three command words shall be received after RDAS power has been off or the equipment has been off-line. See A.3.3.6.3.1, RDAS Initiation.

A.3.3.6.2.1 Command Word Data.- There shall be three different command words, identified by bits 27 and 28.

Command word ZERO shall contain the following data fields:

a) Master Clear (MC) - This 1-bit field, when set to ONE in Command Word 0, shall cause the RDAS to clear to an initial state and resynchronize. This will cause the RDAS to inhibit all data transfer. The RDAS is then given initial parameters by the transfer of the remaining command words. Finally, the RDAS is sent Command Word 0 with MC = 0. Upon receipt of this word, the RDAS will raise its Output Data Request (ODR) line and receive 15 words of nominal zone control data.
b) Display Video Select (DVS) - This 10-bit field shall select the data enabled on the synthetic video display output.
c) Alarm Control (AC) - This 5-bit field shall control the lighting of alarm indicators on the RDAS front panel. The indicator corresponding to a given bit shall be lit when the bit is set and off when the bit is not set.
d) Pulse Width Minimum-MTI (PWNM) - This 3-bit field shall provide the minimum pulse width limit used for time quantization in TQ3 of the MTI amplitude quantized video. [illegible] shall be selectable from 1/64 to 7/64 nm in increments of 1/64 nm.
e) Pulse Width Minimum-Normal (PWNN) - This 3-bit field shall provide the minimum pulse width limit used for time quantization in TQ0, TQ1, and TQ2 of the normal amplitude quantized video. It shall be selectable from 1/64 to 7/64 nm in increments of 1/64 nm.
f) Percentage Noise Normal (PNN) - This 6-bit field shall provide the percentage noise regulation value for the noise meter of normal quantizer Q1. The value shall be selectable from 0 to 15 3/4 percent in increments of 1/4 percent.

Command Word ONE shall contain the following data fields:

a) Difference From Maximum Rank Normal (DMRN) - This 3-bit field shall specify the number of delay line taps less than the maximum number which the target tap must exceed in amplitude for a hit declaration in the normal rank quantizer Q2.
b) Counter Decrement Normal (CDN) - This 1-bit field shall specify whether a missing hit entering the sequential normal weather hit integration counter shall cause it to be counted down by a value of 1 or a value of 2.

A.3.3.6.2.1 (continued)

c) Clutter Monitor Threshold 1 (CT1) - This 5-bit field shall specify the threshold which must be exceeded by the count in Clutter Density Counter 1 to enter a hit in Clutter Monitor Word 1.

d) Counter Increment Normal (CIN) - This 1-bit field shall specify whether a hit entering the sequential normal weather hit integration counter shall cause it to be counted up by a value of 2 or by a value of 3.

e) Strobe Threshold (ST) - This 5-bit field shall specify the threshold which must be exceeded by the count in clutter density counter 1 in order to generate a strobe signal to affect hit selection.

f) Display Threshold (DT) - This 4-bit field shall specify the threshold which the value in the hit integration counter must equal or exceed to allow display of enhanced display video.

g) Weather Threshold Normal (WTN) - This 4-bit field shall specify the threshold which the value in the normal weather hit integration counter must equal or exceed upon increasing from a lower value to cause a hit to be entered into the normal weather hit word.

h) Predetection Threshold (PT) - This 4-bit field shall specify the threshold which the value in the selected hit integration counter must equal or exceed upon increasing from a lower value to cause a hit to be entered into the target predetector word.

Command Word TWO shall contain the following data fields:

a) Difference From Maximum Rank MTI (DMRN) - This 3-bit field shall specify the number of delay line taps less than the maximum number which the target tap must exceed in amplitude for a hit declaration in the MTI rank quantizer Q3.

b) Counter Decrement MTI (CDM) - This 1-bit field shall specify whether a missing hit entering the sequential MTI weather hit integration counter shall cause it to be counted down by a value of 1 or a value of 2.

c) Clutter Monitor Threshold 2 (CT2) - This 5-bit field shall specify the threshold which must be exceeded by the count in Clutter Density Counter 2 to enter a hit in Clutter Monitor Word 2.

d) Counter Increment MTI (CIM) - This 1-bit field shall specify whether a bit entering the sequential MTI weather hit integration counter shall cause it to be counted up by a value of 2 or by a value of 3.

e) Weather Threshold MTI (WTM) - This 4-bit field shall specify the threshold which the value in the MTI weather hit integration counter must equal or exceed upon increasing from a lower value to cause a hit to be entered into the MTI weather hit word.

A.3.3.6.2.1 (continued)

f) Normal Bias (NB) - This 1-bit field shall specify whether the normal quantizer Q2 shall interpret the normal gain words as multiplicative or subtractive biases to be applied to the center tap. When NB is set to zero, a multiplicative bias shall be employed. When NB is set to one, a subtractive bias shall be used.

A.3.3.6.3 Zone Control Words.- Zone control information shall be transmitted from the IOP on the same output channel as the command words. The information shall be transmitted by normal output data transfer (while command words shall be transferred by an external function transfer). Zone control information shall be transmitted by five word types: Quantizer Select 2 Word, Quantizer Select 3 Word, a system diagnostic word, scan correlated feedback normal gain words (6 words required), and scan correlated feedback MTI gain words (6 words required). Zone control information shall be requested by the digitizer only in dead time.

A.3.3.6.3.1 RDAS Initiation.- Initiation (or re-initiation) of the RDAS shall be performed under IOP control via the following functional sequence:

a) The RDAS shall be sent Command Word 0 with the Master Clear (MC) bit set to ONE. Upon receipt of the external function word, the RDAS shall inhibit all data transfer to the IOP.
b) The RDAS shall be sent operating parameters via Command Words 1, and 2, and then shall be sent Command Word 0 (with MC = 0). Upon receipt of the latter word, the RDAS shall raise its Output Data Request (ODR) line to receive 15 words of nominal zone control data (two quantizer select words, one system diagnostic word, and twelve gain words). The RDAS shall begin processing at the next radar trigger following receipt of the 15 zone control words.
c) The first word placed in the computer's input buffer shall be the video hit word first assembled by the RDAS after the next range zero trigger.
d) The RDAS shall sense zone boundary crossings every 32 ACPs, and when one is detected shall raise its ODR to accept data for the next zone.
e) The RDAS shall have its External Function Request (EFR) line raised whenever it can accept new command words (from the beginning of dead time to -1/2 nautical miles before the next zero range).

A.3.3.6.3.2 Zone Control Data.- The fifteen zone control words shall contain data as explained in the following paragraphs.

A.3.3.6.3.2.1 Quantizer Select 2 and 3 Words.- The Quantizer Select 2 and 3 words shall each be divided into thirty 1-bit fields. Each field shall represent a zone range interval (2 NM), and a logic ONE shall indicate the selection of the respective quantizer (2 or 3) for the zone in the absence of strobe or limit conditions. When both QS2 and QS3 are set to logic ONE at a given bit position, Q3 shall be selected even if the limit condition exists. The least significant bit (bit 0) shall represent the earliest zone, and all others follow in increasing range order. The Quantizer Select 2 and 3 words shall be presented to the digitizer by the IOP at the beginning of each 32 ACP sector. The digitizer shall store the Quantizer Select 2 and 3 words at the beginning of the sector for use in zones within this sector.

A.3.3.6.3.2.2 System Diagnostic Word.- The system diagnostic word shall be interpreted by the RDAS in two distinct manners depending upon whether bit 17 in the display video select field of Command Word 0 is set to zero or one.

If Bit 17 in Command Word 0 is set to zero, the system diagnostic word shall be interpreted by the RDAS to determine the position and width of a Realtime Quality Control (RTQC) test target. When this word is received and a test target is not already being generated, the Start Enable (SE) field shall be checked to determine if an RTQC target should be generated at the range specified in Test Target Range (TTR) field (see figure A-7). If SE is set, bit 27, the Mask Enable (ME), will be checked to determine whether the masking of video is desired in the vicinity of the target to be generated. If ME is set, the RDAS will begin to mask video at the azimuth specified in the Start Azimuth (SA) field and extending in range from TTR - 1/4 nm to TR + 3/16 nm. Since the SA field is only 5 bits, the actual azimuth at which the mask starts will be the beginning azimuth for the zone sector (ZCA) to which the zone data corresponds plus SA. The test target will be generated at TTR in range and at ZCA+SA+16 ACP. If ME is not set, no mask will be generated but the target will still begin at ZCA+SA+16 ACP.

If a test target is already being generated, the RDAS will check bit 26, End Enable (EE), to determine whether the target should be ended. If EE is set, the target will be ended at ZCA+EA ACP and the mask (if enabled) will be ended at ZCA+EA+16 ACP.

If EE is not set, the target will be generated until the end of the 32 ACP zone sector and throughout the following sectors until a diagnostic word is received with the EE field set. When this occurs, the target will be ended at ZCA+EA ACP and the mask (if enabled) will be ended at ZCA+EA+16 ACP, where ZCA is the beginning azimuth for the zone sector to which the SD word containing the set EE field corresponds.

If bit 17 in Command Word 0 is set to one, the system diagnostic word shall be interpreted not as an RTQC test target word but as a word containing thirty 1-bit fields. Each field shall represent a zone range interval (2 nm). A logic one shall result in the RDAS display output being turned on for that 2 NM. The least significant bit (bit 0) in this zone word shall represent the

A.3.3.6.3.2.2 (continued)

earliest zone, and all others follow in increasing range order. The system diagnostic word shall be presented in the RDAS by the IOP following the transfer of the quantizer select words. The RDAS shall store the system diagnostic word at the beginning of the sweep in which the zones begin for use within those zones.

A.3.3.6.3.2.3 Normal Gain Words.- Each of the six normal gain words shall contain gain data for the normal rank quantizer, Q2, for five consecutive 2 NM zones. The 5-bit gain field shall provide 32 values used to bias the amplitude of the target tap output in the normal rank quantizer delay line within the zone. Zones of increasing range within the normal gain word are arranged in the order of increasing bit numbers. The normal gain words shall be transferred following transfer of the system diagnostic word. Successive normal gain words shall be transferred in the order of increasing range.

A.3.3.6.3.2.4 MTI Gain Words.- Each of the six MTI gain words shall contain gain data for the MTI rank quantizer, Q3, for five consecutive 2 NM zones. The 5-bit gain field shall provide 32 values used to bias the amplitude of the target tap output in the MTI rank quantizer delay line within the zone. Zones of increasing range within the MTI gain word are arranged in the order of increasing bit numbers. The MTI gain words shall be transferred following transfer of the normal gain words. Successive MTI gain words shall be transferred in the order of increasing range.

A.3.3.6.3.3 Zone Data Synchronization.- All zone data shall remain constant for the 32 ACPs defining a zone and shall be changed at the zone boundaries. A complete set of zone data (15 words) shall be available from the IOP at the beginning of each set of azimuth zone boundaries. All range delays within zones (in applying range control data) shall be provided by the RDAS.

A.3.3.6.3.4 Zone Service Alarm.- A zone service alarm condition shall be generated if the sixth (last) MTI gain word for a zone has not been received by the digitizer by the end of the dead time preceding the second sweep of the zone.

The zone service alarm condition shall be transferred to the IOP as bit 13 in the azimuth sweep word.

A.3.3.6.4 Output Word Processing.- The merging of all output words for transfer to the IOP shall be performed by the I/O group as follows:

a) Video hit word - transferred once every 1 14/16 NM (approximately 23 microseconds) starting after range zero and continuing to

A.3.3.6.4 (continued)

a) (continued)

maximum range. Video hit words shall be presented to the IOP in increasing range order.

b) Target predetector word - transferred once a sweep immediately following the last video hit word

c) Normal weather hit word - transferred once a sweep immediately following the target predetector word

d) MTI weather hit word - transferred once a sweep immediately following the normal weather hit word

e) Clutter Monitor Word 1 - transferred once a sweep immediately following the MTI weather hit word

f) Clutter Monitor Word 2 - transferred once a sweep immediately following the Clutter Monitor Word 1

g) Azimuth sweep word - transferred once a sweep immediately following the clutter monitor word.

All words shall be transferred as normal input data transfers. A two-word output buffer shall be provided for video hit words. The first buffer shall receive each complete video hit word from the hit logic and shall feed the second buffer when it becomes available. The second buffer shall feed the IOP.

A.3.3.6.4.1 RDAS Service Alarm.- An RDAS service alarm condition shall be generated when the video hit word in the second buffer has not been transferred before the next one is generated. For this condition, the unserviced video hit word shall be destroyed.

The RDAS service alarm condition shall be transferred as part of the azimuth sweep word.

A.3.3.6.4.2 Output Word Data.-

A.3.3.6.4.2.1 Video Hit Word.- The video hit word shall be divided into thirty 1-bit fields. Each field shall represent a 1/16 NM range interval and shall indicate whether a hit occurred during the interval. The least significant bit (bit 0) shall represent the earliest range and all others shall follow in increasing range order. A logic ONE shall represent a video hit. The complete 30-bit word shall represent 1 7/8 NM.

A.3.3.6.4.2.2 Target Predetector Word.- The target predetector word shall be divided into thirty 1-bit fields. Each field shall represent a range interval of 1 7/8 NM, and a logic ONE shall indicate that the count in the selected hit integration counter at one or more of the 1/16 NM cells of the corresponding 1 7/8 NM interval has increased to equal or exceed the Predetection Threshold (PT) on that sweep period. Each bit therefore shall cor-

A.3.3.6.4.2.2 (continued)

respond to one of the first 30 of the 32 video hit words with the least significant bit (bit 0) representing the earliest interval and all others following in increasing range order.

A.3.3.6.4.2.3 Normal Weather Hit Word.- The normal weather hit word shall be divided into thirty 1-bit fields. Each field shall represent a range interval of 2 NM and a logic ONE shall indicate that the count in the normal hit integration counter at one or more of the 1/16 NM cells of the corresponding 2 NM interval has increased to equal or exceed the Weather Threshold Normal (WTN) in Command Word 1 on that sweep period. Each bit therefore shall correspond to one of the thirty 2 NM zones with the least significant bit (bit 0) representing the earliest zone and all others following in increasing range order.

A.3.3.6.4.2.4 MTI Weather Hit Word.- The MTI weather hit word shall be similar to the normal weather hit word except that the count in the MTI hit integration counter shall be compared with the Weather Threshold MTI (WTM) in Command Word 2.

A.3.3.6.4.2.5 Clutter Monitor Word 1.- The Clutter Monitor Word 1 shall be divided into thirty 1-bit fields. Each field shall represent a zone range interval (2 NM) and a logic ONE shall indicate that the selected Clutter Monitor Threshold 1 (CT1) in Command Word 1 has been exceeded within the zone by the value in Clutter Density Counter 1. The least significant bit (bit 0) shall represent the earliest zone and all others follow in increasing range order.

A.3.3.6.4.2.6 Clutter Monitor Word 2.- The Clutter Monitor Word 2 shall be similar to Clutter Monitor Word 1 except that the count in Clutter Density Counter 2 shall be compared with Clutter Monitor Threshold 2 (CT2) in Command Word 2.

A.3.3.6.4.2.7 Azimuth Sweep Word.- The azimuth sweep word shall be divided into three fields:

a) Azimuth - A 12-bit azimuth field shall indicate the azimuth (in ACPs) of the sweep.
b) Alarms - In this 5-bit field, a logic ONE shall indicate the presence of an alarm.

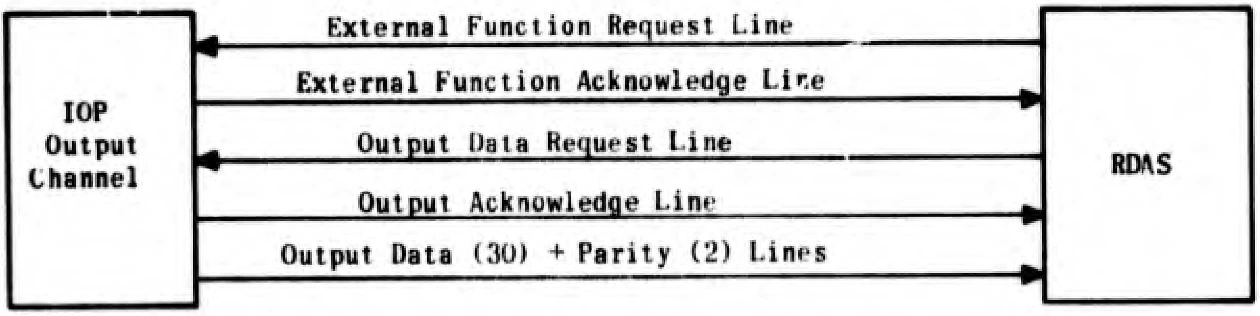
1) RDAS Service Alarm - This alarm shall indicate that data has been lost due to a failure in IOP service.
2) Zone Service Alarm - This alarm shall indicate that all zone control words were not transferred to the RDAS by the end of the dead time preceding the second sweep of a zone.
3) Azimuth Alarm - This alarm shall indicate loss of ACPs or loss of ACPs or loss or improper occurrence of ARPs.
4) Range Alarm - This alarm shall indicate loss or excessive jitter of radar triggers.
5) Parity Alarm - This alarm shall indicate a parity error in any message received from the IOP.

c) Sync Field Bits - The 13-bit sync field shall be a fixed field consisting of alternating "ones" and "zeros" with bit 29 set to ONE.

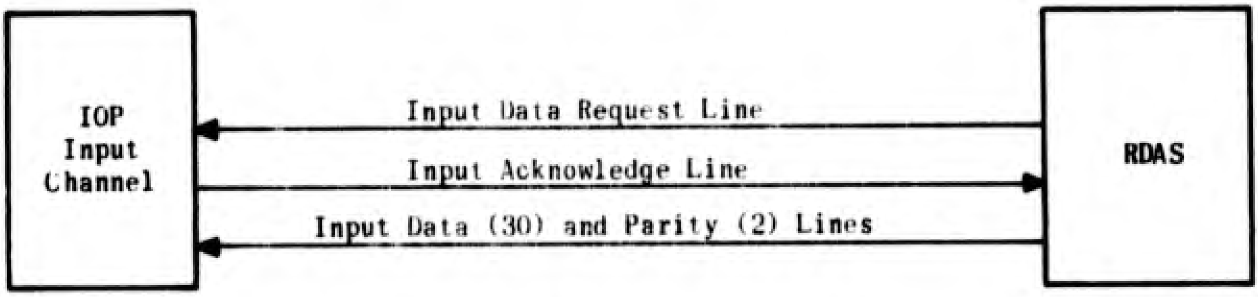
A.3.3.6.5 IOP Output Channel Communication Procedures.- The communication channel from the IOP (i.e., the IOP's output channel) to the RDAS shall contain the control and data lines illustrated in figure A-8. For reference, see "Univac SB-10205(A) Input/Output Channel Characteristics (IOP)." Two types of data transfer, an external function or a normal data transfer, shall occur on the channel. Figure A-9 illustrates a timing diagram of the interface. The following paragraphs detail the communication procedure for each type of data transfer.

A.3.3.6.5.1 External Function Transfer.-

a) The RDAS shall set the external function request line at the beginning of dead time.
b) The IOP shall place an external function code word on the output data lines.
c) The IOP shall set the external function acknowledge line (to indicate that the external function code word is on the output data lines).
d) The RDAS shall detect the setting of the external function acknowledge line and accept the external function code word which is on the output data line.
e) The RDAS shall clear the external function request line at -1/2 nautical mile and set it again when ready to accept another external function code word. The RDAS shall recognize and process correctly an external function transfer until 1/4 nautical mile.
f) The IOP shall clear the external function acknowledge line before it places the next word on the output data lines.

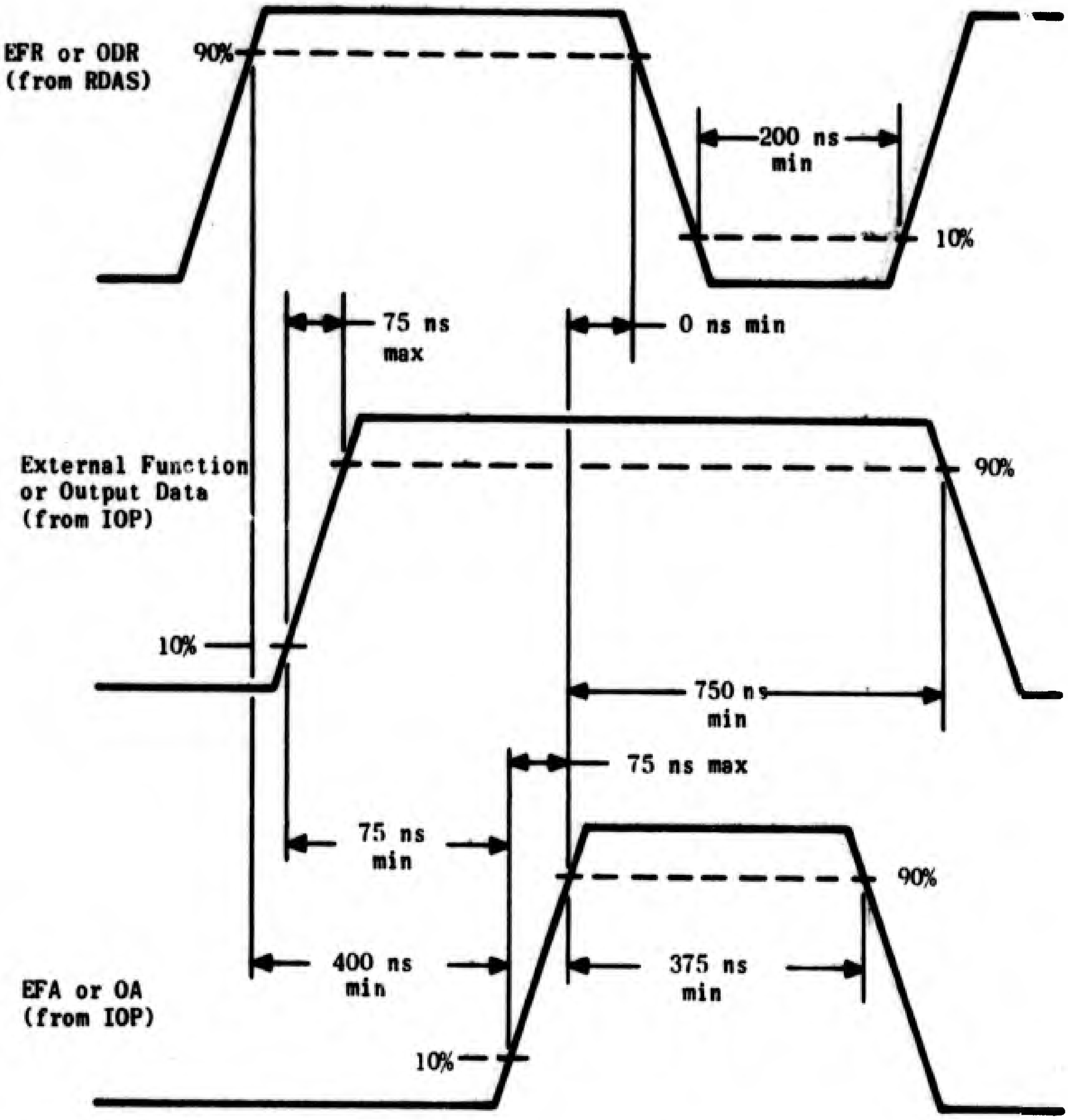


(a) IOP Output/Digitizer Communication Interface



(b) IOP Input/RDAS Communication Interface

Figure A-8. IOP/RDAS Communication Interface



Note: Upper levels are logical ONE; lower levels are logical ZERO

Figure A-9. Signal Timing, IOP Output Channel

A.3.3.6.5.2 Normal Data Transfer.-

a) When the RDAS requires data, it shall set the IOP's output data request line.
b) The IOP shall detect the setting of the output data request line and place a word of data on the IOP's output data lines.
c) The IOP shall set the output acknowledge line (to indicate that a word of data is on the output data lines).
d) The RDAS shall detect the setting of the output acknowledge line and accept the word of data on the output data lines.
e) The RDAS shall reset the output data request line after accepting the word of output data.
f) The IOP shall clear the output acknowledge line and detect the clearing of the output data request line by the RDAS before it places the next word on the output data lines.

A.3.3.6.6 IOP Input Channel Communication Procedures.- The communication channel to the IOP from the RDAS shall contain the control and data lines illustrated in figure A-8. For reference, see "Univac SB-10205(A) Input/Output Channel Characteristics (IOP)". Only one type of data transfer, a normal data transfer, shall occur on the channel. Figure A-10 is a timing diagram of the interface. The following details the communication procedure.

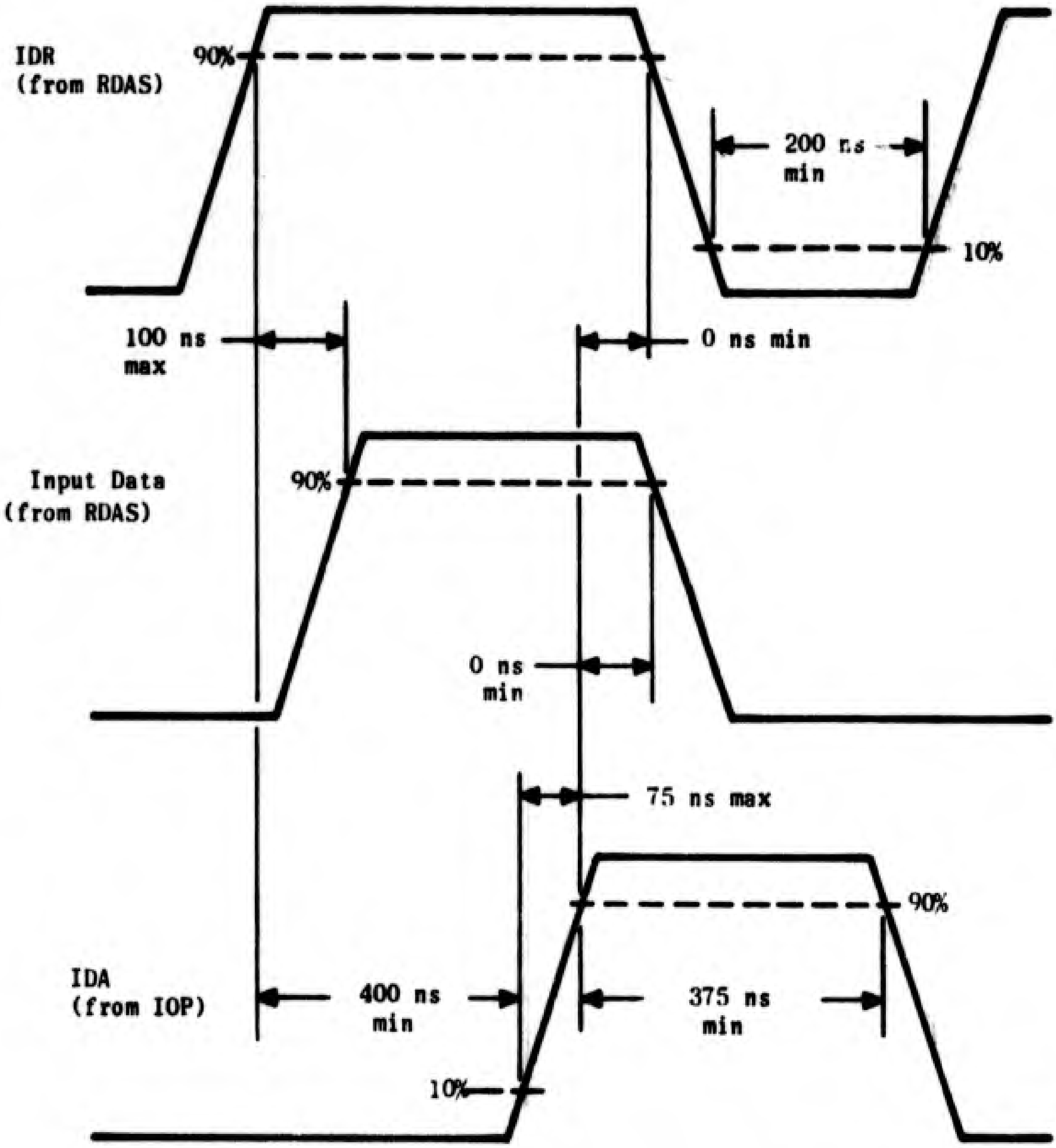
A.3.3.6.6.1 Normal Data Transfer.-

a) The RDAS shall place a word of data on the IOP's input data lines.
b) The RDAS shall set the input data request line (to indicate that a word of data is on the input data lines).
c) The IOP shall detect the setting of the input data request line and accept the input data word.
d) The IOP shall set the input acknowledge line (indicating that it has read the data word on the input data lines).
e) The RDAS shall detect the setting of the input acknowledge line and shall clear the input data request line.
f) The IOP shall clear the input acknowledge line before accepting another input data transfer.

A.3.3.7 Maintenance Provisions.-

A.3.3.7.1 General.- Provision for operational and maintenance testing of the RDAS alone and of the complete system shall be included in the equipment. Test capabilities shall be divided into the following categories:

a) Realtime, on-line system checking by use of a RealTime Quality Control (RTQC) test target. Generated with known parameters and inserted at the quantizer inputs, it shall permit the IOP to continually monitor system operation.



NOTE: Upper levels are logic ONE; lower levels are logic ZERO

Figure A-10. Signal Timing, IOP Input Channel

A.3.3.7.1 (continued)

b) On-line system testing in which the IOP transmits video hit patterns to both RDAS quantizers through the twelve zone control gain words. Checking of RDAS response to these patterns shall be performed in the IOP.
c) Off-line RDAS testing in which command word data and video hit patterns are set up and inserted manually at the RDAS with no communication required to the IOP.
d) Alarm monitoring, in the RDAS, of range and azimuth timing, IOP input message service, and IOP output message service and parity generation.

The RTQC and alarm functions shall be continuous and not require operator initiation. The off-line testing shall require set up and initiation by an operator at the RDAS.

A.3.3.7.2 RTQC Test Target.- The RDAS shall generate an RTQC test target once per scan under computer control to be inserted into the input of all quantizers. The range of this target shall be determined by the TTR field in the system diagnostic word. The azimuth shall be determined by the SA field and the Zone Crossing Azimuth (ZCA)(see A.3.3.6.3.2.2). If enabled, a mask area shall be generated in the area surrounding the test target and shall be applied to inhibit live video to eliminate interference with the RTQC target.

A.3.3.7.2.1 RTQC Mask Characteristics.- The RTQC mask shall have the following characteristics:

Azimuth Start:	ZCA + SA ACP
Azimuth Width:	Variable
Range Start:	TTR-1/4 NM
Range Width:	1/2 NM

A.3.3.7.2.2 RTQC Target Characteristics.- The RTQC test target shall have the following characteristics:

Azimuth Start:	ZCA+SA+16 ACP
Azimuth Width:	Variable
Range:	TTR NM

A.3.3.7.3 On-Line System Test.-

A.3.3.7.3.1 Test Initiation.- The on-line system test shall require a switch on the RDAS to be changed from the normal to the test position. It shall also require the IOP to send data patterns in the gain zone control words which represent 1/64 NM hits and to check the incoming data from the RDAS for accuracy. In this on-line test mode, the RDAS shall do the following:

a) The RDAS shall use a fixed value of gain of unity in the normal and MTI rank quantizers instead of the zone control word gain.
b) The RDAS shall raise the output data request signal each sweep in order to bring in "zone control" target data each sweep period.
c) The RDAS shall shift the test target data into the inputs of all quantizers at a 1/64 NM per bit rate. With all 30 bits used in each of the 12 gain words, a total of 360 bits covering from 0 through 5 5/8 NM may be inserted. The same 360-bit sequence shall be shifted into the inputs of all three quantizers every 6 nautical miles until maximum range.
d) All other RDAS functions shall perform normally.

A.3.3.7.3.2 Test Operation.- The IOP shall manipulate command word and zone control video select word parameters to the RDAS as well as the hit patterns to test dynamically the system operation.

A.3.3.7.4 Off-Line RDAS Test.-

A.3.3.7.4.1 Test Initiation.- The off-line RDAS test shall require a switch on the RDAS to be changed from the on-line to the off-line position. This action shall inhibit all data transfer between the RDAS and the IOP. Further, it shall enable the operation of the features of the off-line digitizer test described below.

A.3.3.7.4.2 Internal Timing.- The RDAS shall be capable of generating internal radar triggers for maintenance operation in the off-line mode. Internal radar triggers may be generated by allowing the range counter to free run and by using the maximum range decode as the radar trigger. When in this mode of operation, azimuth triggers may be taken from the normal external source or from the internal radar triggers. Manual single pulse generation of the radar triggers or azimuth triggers shall be permitted.

A.3.3.7.4.3 Manual Parameter and Data Loading.- The RDAS, when off-line, shall have the following capabilities:

a) Manual individual data selection and loading of Command Words 0, 1 and 2

A.3.3.7.4.3 (continued)

b) Manual individual data selection and loading of Quantizer Select 2 and 3 and system diagnostic zone control words
c) Manual individual data selection and loading of the six normal and the six MTI gain zone control words. These shall be interpreted as gain data if the Normal/Test switch is in the "Normal" position and hit data if the Normal/Test switch is in the "Test" position.
d) Manual selection of an automatic trigger stop at the end of the sweep preceding the first sweep of the RTQC target
e) Manual single sweep operation when in the trigger stop condition
f) Manual selection of a trigger stop at zero range with the capability of single stepping the range counter in either 1/64 or 1/16 nautical mile increments. A switch shall be provided to select the single step range increment.

A.3.3.7.4.4 Test Data Display.- The following data display and selection capability shall be provided in the RDAS to provide for operational and test checking.

a) Indicators for each bit of data in Command Words 0, 1 and 2
b) Indicators for display of 30-bits of zone control data and switch selection to permit choice of the Quantizer Select 2, the Quantizer Select 3, the system diagnostic, or any one of the 12 gain words at a time
c) Indicators for the display and holding of any message from the digitizer to the IOP (30 data plus 2 parity)
d) Switch selection to permit display and holding of any of the following messages on the indicators as referred to in d) above:
    1) Video hit word (only word 1 from 0 to 1 7/8 NM)
    2) Target predetector word
    3) Normal weather hit word
    4) MTI weather hit word
    5) Clutter Monitor Word 1
    6) Clutter Monitor Word 2
    7) Azimuth sweep word

e) Indicators for the hit density counter containing the count from zero to 1 15/16 nautical miles in range
f) Indicators for the normal weather, MTI weather, and selected hit integration counters
g) Indicators for the range counter
h) Indicators for the azimuth counter
i) Indicators for such other control logic as is deemed advisable for the achievement of a low mean time to repair.

A.3.3.7.5 Alarms.-

A.3.3.7.5.1 General.- Critical points in the RDAS shall be monitored to permit fault detection and correction. The RDAS shall provide visual indicators for alarm conditions which shall light on-line when the related alarm control bit in Command Word 0 is set. Off-line, the indicator shall light directly upon occurrence of the alarm condition. The alarm indicator lights shall be reset manually off-line and upon receipt of a reset alarm control field in Command Word 0 when on-line. The alarm conditions shall be sent to the IOP in the azimuth sweep word no more than once per scan. The azimuth and range alarms shall be isolated such that the conditions which cause one shall not of themselves cause the other. Off-line, an azimuth alarm indicator existing at the end of an antenna scan period shall be reset by the receipt of the next ARP.

A.3.3.7.5.2 Azimuth Alarm.- The azimuth alarm shall sense the following condition:

a) Loss of ACPs sensed by counting 4 radar triggers between ACPs
b) Loss or improper occurrence of ARPs sensed by noting a value in the azimuth counter other than 4095 when an ARP is received, or by not receiving an ARP when the count does equal 4095.

A.3.3.7.5.3 Range Alarm.- The range alarm shall sense the following conditions (see A.3.3.2.4):

a) Loss of radar triggers
b) Excessive jitter relative to the range counter.

A.3.3.7.5.4 Zone Service Alarm.- The zone service alarm shall detect and indicate that the IOP has not transferred all zone control data to the digitizer within two sweeps.

A.3.3.7.5.5 RDAS Service Alarm.- The RDAS service alarm shall detect that the IOP has not adequately serviced the RDAS output channel.

A.3.3.7.5.6 Parity Alarm.- The parity alarm shall detect parity error in any message received from the IOP.

A.3.3.7.5.7 Alarm Reporting.- The alarm conditions sensed by the RDAS shall be included in the status portion of the azimuth sweep word for reporting to the IOP. The alarms shall be reported or combined in the following manner: (also see figure A-4):

Bit No.	Alarms
12	RDAS service alarm
13	Zone service alarm
14	Azimuth alarm
15	Range alarm
16	Parity alarm

A.3.3.8 Outputs for Display.- The following outputs from the RDAS shall be available on a single output line for entry via the synthetic video input to the system display. The display of these signals is intended for either operational or maintenance purposes and, therefore, shall be supplied whether the digitizer is on-line or off-line. Each display signal shall be individually selected by decoding the Display Video Select (DVS) field of Command Word 0. The pulse width of each display signal shall depend upon the nature of the information contained within the signal. Signals indicating outlines or single range cell conditions (as opposed to mapped areas) shall be displayed with a standardized pulse width. The pulse width shall be selectable by wire strap from 1/32 to 1/8 NM in 1/32 NM increments. The mapped areas shall be displayed with a pulse width equal to the range extent of the map signal and with sweep interval modulation.

The modulation interval (non-displayed sweeps) shall be selectable by wire strap from zero to seven sweeps in increments of one sweep. Once selected, one pulse width strapping and one sweep modulation apply for all signals requiring those parameters.

A.3.3.8.1 System Diagnostic Map.- The system diagnostic map signal shall display the data received from the IOP in the system diagnostic map zone control data word. It shall be selected by bit 17 in the DVS field of Command Word 0. Sweep interval modulation shall follow the strapping described in A.3.3.8.

A.3.3.8.2 Amplitude Output-Normal Quantizer 1.- The output of Normal Quantizer 1 shall be available for display and shall be selected by bit 18 in the DVS field of Command Word 0. Pulse width shall follow the strapping described in A.3.3.8. The pulses shall be present on each sweep period.

A.3.3.8.3 Amplitude Output-Normal Quantizer 2.- The output of Normal (rank) Quantizer 2 shall be available for display and shall be selected by bit 19 in the DVS field of Command Word 0. Pulse width and repetition rate are the same as for the Normal Quantizer 1 above.

A.3.3.8.4 Amplitude Output-MTI Quantizer 3.- The output of MTI Quantizer 3 shall be available for display and shall be selected by bits 18 and 19 in the DVS field of Command Word 0. Pulse width and repetition rate are the same as for the normal quantizers above.

A.3.3.8.5 MTI Limit.- The MTI Limit signal shall be available for display and shall be selected by bit 20 in the DVS field of Command Word 0. Sweep interval modulation shall follow the strapping described in A.3.3.8.

A.3.3.8.6 Quantizer Select 2.- The Quantizer Select 2 zone data shall be available for display and shall be selected by bit 21 in the DVS field of Command Word 0. In the absence of strobe or MTI limit conditions, it shall represent the area in which Normal Quantizer 2 is selected for hit processing. Sweep modulation shall follow the strapping described in A.3.3.8.

A.3.3.8.7 Quantizer Select 3.- The Quantizer Select 3 zone data shall be available for display and shall be selected by bit 22 in the DVS field of Command Word 0. In the absence of strobe or MTI limit conditions, it shall represent the area in which MTI Quantizer 3 is selected for hit processing. Sweep modulation shall follow the strapping described in A.3.3.8.

A.3.3.8.8 Quantizer Select 2 and 3.- When both bits 21 and 22 are selected in the DVS field of Command Word 0, the signal shall always represent the area in which Quantizer 3 is selected for hit processing. Sweep modulation shall follow the strapping described in A.3.3.8.

A.3.3.8.9 Clutter Density 1 Map.- An output shall be available for display during the time that the Clutter Density Monitor 1 threshold is exceeded (see A.3.3.4.3.2.) It shall be selected by bit 23 in the DVS field of Command Word 0.

A.3.3.8.10 Clutter Density 2 Map.- An output shall be available for display during the time that the Clutter Density Monitor 2 threshold is exceeded (see A.3.3.4.3.2.) It shall be selected by bit 24 in the DVS field of Command Word 0.

A.3.3.8.11 Selected Hit Processing Output.- The processed hit output of the hit selection logic shall be available for display and shall be selected for display by bits 23 and 24 of the DVS field of Command Word 0. Pulse width shall follow the strapping of A.3.3.8. The pulses shall be present on each sweep period.

A.3.3.8.12 Weather Hit Output Normal.- A 1/16th nautical mile pulse output shall be available for display each time a normal weather hit is generated (see A.3.3.5.2.1). It shall be selected by bit 25 in the DVS field of Command Word 0.

A.3.3.8.13 Weather Hit Output MTI.- A 1/16th nautical mile pulse output shall be available for display each time an MTI weather hit is generated (see A.3.3.5.2.1). It shall be selected by bit 26 in the DVS field of Command Word 0.

A.3.3.8.14 Enhanced Video Display (Hit Processed).- The output of the hit processing logic after hit selection and display video hit integration (see A.3.3.5.3.2) shall be available for display. It shall be selected by bits 25 and 26 in the DVS field of Command Word 0. Pulse width shall follow the strapping of A.3.3.8. The pulses shall be present on each sweep period.

A.3.4 Design and Construction.-

A.3.4.1 General.-

The RDAS shall be built using the Contractor's standard construction techniques wherever possible. The RDAS shall be housed in a cabinet with self-contained power.

The cabinet shall not require rear access for either operation or maintenance purposes. The operational and maintenance indicators shall be mounted on plug-in printed circuit boards wherever possible. Switches shall also be mounted on plug-in printed circuit boards wherever possible. Operating modes and site options shall be selectable by changing wires on a wire strap board. Test points shall be provided for radar pretrigger, normal video, MTI video, ACP, ARP, normal hits and MTI hits. They shall be individually labeled and readily accessible.

Combination pushbutton/indicators shall be used wherever both display and manual data entry are required, such as for command and zone control word data.

A.3.4.2 Environmental Requirements.- The RDAS shall operate under the environmental conditions specified in FAA-G-2100/1a, Environment I, for equipment installed in an attended facility:

Temperature	+10°C to 50°C
Relative Humidity	10 to 80%

A.3.4.3 Cables.- The RDAS shall have the interface connectors mounted on it. The computer supplier shall supply the cabling between the RDAS and all other equipment. Cables shall enter the top of the digitizer cabinet and shall be connected within the cabinet.

A.3.4.4 Documentation.- Formal manuals and manufacturing drawings shall be provided with the RDAS. Section 3.10.13 of FAA-TD/S-120-801A shall apply.

A.3.4.5 Reliability.- This section specifies the reliability requirements for the Radar Data Acquisition Subsystem equipment.

A.3.4.5.1 Reliability Definitions.-

A.3.4.5.1.1 Mean Time Between Failure (MTBF).- Mean Time Between Failure is defined as the reciprocal of unit failure rate expressed in hours (MTBF = $1/\lambda$ where λ equals unit failure rate).

A.3.4.5.1.2 Unit Failure Rate (λ).- Unit failure rate is defined as the sum of the individual component density failure rates within a unit. The individual component density failure rate is the number of components times the expected failure rate for that component type.

A.3.4.5.1.3 Mean Time To Repair (MTTR).- Mean Time to Repair is defined as the mean time to effect repair of the unit to put the unit in an "up" condition.

A.3.4.5.1.4 Mean Up Time (MUT).- Mean Up Time is defined as the mean time to a failure of the system given that the system was performing its intended function at time zero.

A.3.4.5.1.5 Mean Down Time (MDT).- Mean Down Time is defined as the mean time to effect repair of the system sufficient to put the system in condition to perform its intended function.

A.3.4.5.1.6 Availability (A).- The intrinsic availability is expressed as follows:

a) For the system, MUT/ (MUT + MDT)
b) For the subsystem, MTBF/ (MTBF + MTTR).

A.3.4.5.1.7 Classes of Failures.-

a) Transient failure - Self-clearing transient disturbances, such as transient parity errors, which do not require deactivation of an active unit.
b) Non-transient failure - Non-clearing failures of an active unit requiring deactivation of this unit.

A.3.4.5.2 Subsystem Reliability.-

A.3.4.5.2.1 Radar Data Acquisition Subsystem (RDAS).- The RDAS shall exhibit an MTBF equal to or greater than 5 x 10^3 hours and an MTTR equal to or less than 0.5 hours (assuming spare part availability).

A.3.4.5.3 Component Reliability.- The reliability of control switches, indicator lights, and lamps shall be as specified in FAA-TD/S-120-801A.

A.3.4.6 Maintainability.- The software and hardware maintenance features shall provide the means to meet the MDT and MTTR requirements set forth in section A.3.4.5. The Contractor will be guided by section 3.9 of FAA-TD/S-120-801A in maintenance approach and maintenance features.

A.3.5 External Interfaces.- The electrical characteristics of the interface between the RDAS and external equipment shall be as indicated in the following paragraphs.

A.3.5.1 Input Power.- The RDAS shall require as a primary input power a 120-volt single phase source. The estimated requirements for input power are as delineated below.

A.3.5.1.1 Single Phase Power.-

Type	1 Phase, 2 Wire, 120 Volts
Power	1.8 KVA
Current	15A
Frequency	60 Hz ± 5%

A.3.5.2 Radar Sensor.-

The RDAS shall interface with radar sensors having the following system parameter and electrical characteristics:

A.3.5.2.1 System Parameters.-

PRF	713 to 1200 pps

The digitizer shall accept a staggered type PRF with up to six stagger periods that fall within the 713 to 1200 PRF range.

Transmitted radar pulse width	0.833 microseconds
Antenna scan rate	10 to 15 RPM
Maximum processing range	60 NM

A.3.5.2.2 Electrical Characteristics.-

A.3.5.2.2.1 Radar Pretrigger.-

The RDAS shall accept a radar pretrigger having the following characteristics:

Amplitude	25 ± 5 volts
Pulse width	1 to 10 microseconds
Pulse polarity	Unidirectional, positive polarity
Pulse rise time	Less than 0.2 microseconds
Pulse fall time	Less than 0.3 microseconds
Terminating impedance	75 ± 5% ohms
Pulse repetition time stability	Less than ± 4 microseconds

A.3.5.2.2.2 Azimuth Data.- The RDAS shall accept azimuth data in the form of Azimuth Change Pulses (ACPs) and Azimuth Reference Pulses (ARPs) from either an azimuth pulse generator or a pulse shaper amplifier. There shall be 4096 equally spaced ACPs and one ARP for each 360 degrees of antenna rotation. The ARP shall be positioned to fall within ± 20% of the ACP interval from the midpoint between two ACPs. The electrical characteristics of the ACPs and ARPs are as follows:

Azimuth pulse generator:

a) Pulse shape	Approximately sinusoidal
b) Amplitude	5 ± 1 volt peak-to-peak
c) Jitter	ACP 10% of nominal spacing ARP 20% of ACP spacing
d) Impedance	600 ohms (design center value)
e) Cable type	Shielded twisted pair

Pulse shaper amplifier:

a) Logic level "0"	0 to 0.5 volts DC
b) Logic level "1"	5.0 ± 1.0 volts DC (positive going)
c) Pulse width	23 ± 3 microseconds
d) Pulse rise time	1.0 microseconds maximum
e) Pulse decay time	1.0 microseconds maximum
f) Jitter	ACP 10% of nominal spacing ARP 20% of nominal spacing
g) Impedance	75 ohms (design center value)

A.3.5.2.2.3 Radar Video.- The RDAS shall accept two radar video types having the following electrical characteristics:

a) Signal amplitude	+4 volts maximum
b) Noise amplitude	0.1 to 2.0 volts average peak with variations at less than 0.25 Hz rate
c) Pulse width	Greater than 0.8 microseconds
d) Terminating impedance	75 ± 5 ohms

A.3.5.3 IOP.- The interface signals between the RDAS and the IOP shall meet the electrical characteristics described below. The interface is similar to an IOP Type A interface.

A.3.5.3.1 Line Drivers.- The output line driver shall have the following characteristics when driving a line with characteristic impedance between 120 ohms and 180 ohms and terminated in 160 ohms.

a) The binary states of a driver measured at the point of receiver termination are:

Logic ONE	0 to -0.5 volts
Logic ZERO	-3.0 to -4.5 volts

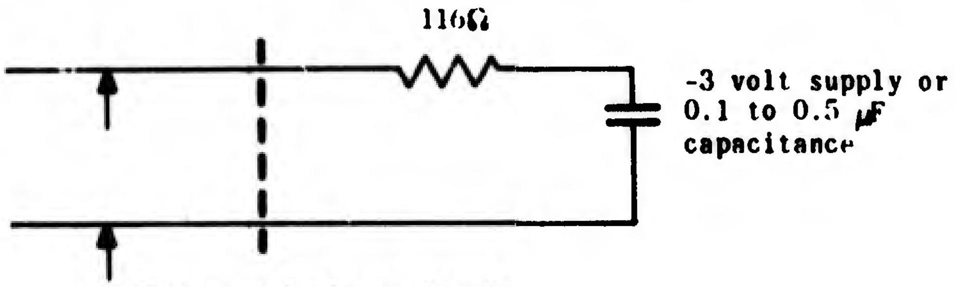
b) In the binary ONE state, the line driver shall provide the following maximum current to the line:

Data line driver	25 milliamperes
Control line driver	37 milliamperes

c) The driver shall be capable of switching the logic voltage levels at the point of receiver termination in 75 nanoseconds maximum (10% to 90%).

A.3.5.3.2 Line Receiver.-

a) The threshold level distinguishing the ONE state shall be a voltage at the input more positive than -1.1 volts. The threshold level distinguishing a ZERO state shall be a voltage level more negative than -2.5 volts.
b) The maximum steady state current drawn from a line by an input receiver shall not exceed 21 milliamperes when the input is in the ONE state at zero volts.
c) The input receiver shall be such that if the input line is disconnected, the effect shall be as though a ZERO were present at the input.
d) The equivalent circuit as seen across the input to the receiver shall be as illustrated below. The receiver shall present a 160 ohm terminating resistance for a twisted pair cable and provide common mode noise rejection.



Input equivalent circuit

A.3.5.3.3 Provision for Duplex Computer Operation.- The RDAS shall contain space for a second set of IOP cables. The necessary connectors, isolating receivers and drivers, and steering logic for use with duplex computers shall be provided. When connected to two IOPs, the RDAS shall put output data on the lines corresponding to the IOP from which the last command word data was received.

A.3.5.3.3.1 Connector Pin Assignment.- The computer supplier shall specify the connectors for mounting on the RDAS. Signals shall be assigned to the connector pins in accordance with table A.1 (which was extracted from Univac Specification SB-10205, Rev, A, Table IV).

A.3.5.4 Display Interface.- The RDAS shall provide synthetic video input for display having the following characteristics:

a) Signal amplitude	0 to +4.0 volts
b) Pulse width	1/32 NM (0.4 us) minimum
c) Terminating impedance	75 ± 5 ohms

A.3.6 Interchangeability of Spares.- The RDAS shall be designed wherever possible to use parts also used in the Beacon Data Acquisition Subsystem (BDAS) to minimize spares requirements.

A.4 QUALITY ASSURANCE PROVISIONS .- The Contractor shall verify the performance of the RDAS by comprehensive testing. Quality assurance provisions specified in FAA-TD/S-120-801 form a part of this specification and shall be complied with. Where FAA-TD/S-120-801 is not applicable, the Contractor shall be guided by the contract for ARTS III equipment (DOT-FA69WA-2071). All items shall be designed and constructed in a manner similar to that used for ARTS III equipment and shall resemble ARTS III equipment in workmanship, quality, design, and general appearance.

A.4.1 Design Qualification Tests.- The Contractor shall conduct or assist in design qualification tests to demonstrate that the requirements of this specification have been met. These tests shall be conducted in the Contractor's factory or at a government-approved test facility or some combination thereof. Design qualification testing shall consist of:

Unit tests
Subsystem tests
System tests
Reliability tests
Maintainability and system availability tests
Implementation tests.

Table A-1. Connector Pin Assignment, Input/Output Channel

*Signal	Return	IOP Output Channel Connector	IOP Input Channel Connector
B1	-	Shield Ground	Shield Ground
B3	A3	Lower Half Word Parity	Lower Half Word Parity
B4	A4	Upper Half Word Parity	Upper Half Word Parity
B5	A5	Output Data Acknowledge	Input Data Request
B6	A6	Output Data Request	Input Data Acknowledge
B7	A7	External Function Acknowledge	External Interrupt Request
B8	B8	External Function Request	External Interrupt Enable
D1	C1	Data Bit 0	Data Bit 0
↕	↕	↕	↕
D12	C12	Data Bit 11	Data Bit 11
G1	H1	Data Bit 12	Data Bit 12
↕	↕	↕	↕
G12	H12	Data Bit 23	Data Bit 23
J1	K1	Data Bit 24	Data Bit 24
↕	↕	↕	↕
J6	K6	Data Bit 29	Data Bit 29

*Each signal and the corresponding return, except shield ground, require a twisted pair.

A.4.1.1 Unit Tests.- The Contractor shall conduct unit tests to verify that each individual piece of hardware meets the performance requirements as specified herein as well as the performance requirements delineated in this design specification.

A.4.1.2 Subsystem Tests.- Subsystem tests are tests of equipment combinations and/or equipment and operational software combinations. The Contractor shall assist the prime contractor in the conduct of subsystem tests as necessary to verify proper operation of the subsystems and to provide confidence that the system tests will have a high probability of success.

A.4.1.3 System Tests.- The Contractor shall assist the prime contractor in the conduct of system tests to verify that all requirements of the system specification have been met.

A.4.1.3.1 Confidence/Stability Test.- As part of each system test, a continuous confidence/stability test shall be performed using video inputs with the operational program running. Manual inputs from the display data entry devices shall also be used. Measurements shall be made at the beginning of the test and at specified intervals which shall be indicative of the stability of the system. All system adjustments shall be made prior to the start of the test and no further adjustments will be allowed for the duration of the test. During the last half-hour of the test, a simulated power failure test shall be made. This test shall be made by interrupting all AC power to the system for a period of at least 15 seconds. When power is restored, all malfunctions or errors shall be recorded. The test shall be resumed without any equipment adjustments. If manual adjustments or intervention is required to reinitiate operation, these shall be fully documented in the test report. The digitizer contractor shall assist the prime contractor in the conduct of this test.

A.4.1.4 Reliability Tests.- The Contractor shall conduct reliability tests on the RDAS to verify that the equipment meets the reliability requirements of this specification and to obtain the necessary data to assist in verifying that the system availability requirements are met. The reliability tests shall be conducted in accordance with MIL-STD-781.

A.4.2 Acceptance Tests.- The Contractor shall conduct acceptance tests on all units and shall assist the prime contractor, as necessary, with the acceptance tests of subsystems and systems that are delivered to the government. Acceptance tests are a combination of factory and site tests.

A.4.2.1 Factory Tests.- Factory tests are those unit tests conducted within the Contractor's plant to ensure that each unit meets the requirements of this specification prior to delivery.

A.4.2.1.1 Factory Inspection.- The quality assurance provisions specified in FAA-G-2100 and MIL-I-45208A form a part of this specification and shall be complied with. All inspections and tests at the Contractor's plant shall be performed by the Contractor, and may be witnessed by FAA inspectors; these tests and inspections are subject to approval by FAA inspectors. The Government reserves the right to waive the requirements of any portion of the inspections and tests.

A.4.2.1.2 Incoming Inspection.- The Government may elect to make an incoming inspection of all or any portion of the components and materials used in construction of the equipment to determine compliance with the specifications covering component procurement.

A.4.2.1.3 Unit Inspection.- Each completed unit supplied as an integral part (or spare unit) of each system under the contract shall be given a mechanical and an electrical examination. The mechanical examination shall be used to determine compliance with the applicable specifications covering fabrication requirements such as strength and rigidity, accessibility, type of components and meterials, choice of insulation, layout of chassis, panel, and wiring, finish, and so forth. The Contractor shall perform an electrical inspection to determine compliance with the applicable specifications covering electrical requirements and performance such as electrical continuity, leakage resistance, power supply voltages and regulation, signal to noise ratio, pulse and wave shapes, resolution, storage characteristics, and so on. Units built, tested, and approved in accordance with the applicable specifications may be retained temporarily by the Contractor in order to facilitate testing of associated units; however, such units used for test purposes shall be given a mechanical and electrical re-inspection prior to Government acceptance if required by the Contracting Officer.

A.4.2.2 Site Tests.- The Contractor shall assist the prime contractor as necessary in the conduct of site tests for every system installation. Site tests shall be conducted at the unit, the subsystem, and the system level. Site tests shall be organized so that the implementation requirements of Section 3.1.4 are met. Each site test shall be designed to meet the following objectives:

a) To verify that the installed unit, subsystem, or system meets the requirement of this specification
b) To verify that the basic ARTS III function can be performed with the unit, subsystem, or system installed
c) To provide the required certification procedures to enable the FAA to operate with the installed unit, subsystem, or system.

A.4.3 Test Conduct.-

A.4.3.1 General.- The Contractor shall be responsible for conducting all tests. Whenever testing is scheduled, the Contractor shall ascertain that all necessary personnel are available, and that contractor-provided procedures, test scripts, and test data sheets have been distributed. All test personnel shall normally be provided by the Contractor. However, the FAA reserves the right to use FAA personnel in lieu of Contractor personnel to man any operating position in the equipment configuration under test. The Contractor shall conduct a test briefing and debriefing for each test and shall assure that all personnel have been properly instructed in their duties. The Contractor shall make any and all additional tests necessary to demonstrate compliance to the required system performance. If, during the course of any tests, errors or malfunctions occur, the Contractor shall make entries in the appropriate logs. In addition, the Contractor shall document each error or malfunction indicating the type of error, the procedures taken, and the time required to circumvent, and the assignment to the appropriate equipment or software element.

A.4.3.2 Test Procedures.- The Contractor shall provide all test procedures and/or scripts to be used during the conduct of a test. These procedures shall include all test record forms to be used as test data sheets, test operator logs, and reports. The documents shall be provided by the Contractor and submitted for review and approval 30 days prior to the scheduled performance of a test.

A.4.3.3 Test Reports.- Upon conducting the applicable tests in accordance with the approved test plan, the results shall be recorded for submission to the FAA. The test report shall contain a complete description of the test results and shall be certified and submitted within 15 days after completion of each test. One reproducible and 10 copies shall be submitted for FAA acceptance.

The test report shall contain, as a minimum, the information specified below:

a) Indicate the performance of each equipment under test and whether or not it meets the system limits
b) Functions that were tested
c) Information as to whether the results of the test are in agreement with the required reliability of the unit or system
d) The quantity and type of spare parts needed to correct the errors and malfunctions
e) A record of any engineering changes found necessary to correct design deficiencies.

A.4.3.4 Failure Accountability.- There are two major classes of failure: relevant (countable) failures and non-relevant failures. Relevant failures are defined as:

a) Manufacturing defects
b) Parts defects
c) Design defects
d) Unknown.

Failures due to other causes shall be classified non-relevant. This class includes failures due to:

a) Accident or mishandling
b) Operator (where not due to improper design)
c) Failure of part not supplied by the Contractor
d) Test equipment or facility failure
e) Maintenance induced failure
f) Installation error
g) Drawing specification or procedure error.

The burden shall be on the Contractor to show that a failure should be classified non-relevant.

A.4.3.4.1 Failure Recording and Reporting.- Failures shall be recorded in accordance with the "Facility Outage and Equipment Failure Report" (FAA Handbook SMP 6040.1B). Maintenance logs shall utilize FAA Form 406C.

A.4.3.4.2 Additional Tests.- The FAA may require the Contractor to repeat tests, or portions therof, if the original tests fail to demonstrate compliance with the specification.

A.4.3.4.3 Problem Areas.- The Contractor shall be responsible for solving problems encountered in providing a system to the requirements of this document. He shall notify the FAA promptly of any problems beyond his jurisdiction.

A.4.3.4.4 Equipment Module or Subsystem Modification.- The Contractor shall be responsible for incorporating and testing any modifications to his design that are necessary to meet the specification requirements. Resulting modifications to equipment shall be incorporated into each system delivered at no additional cost to the Government.

A.4.3.4.5 Docmentation Updating.- The Contractor shall update the system documentation of block diagrams, electrical and mechanical drawings, installation drawings, parts lists, wire lists, logic flow charts, and all associated descriptive materials.

A.4.4 Test Plans.- The Contractor shall prepare and submit, in draft form, ten copies of a recommended test plan within six months from date of contract, for review and approval by the Government. The Government will review, approve, and/or direct necessary changes to the test plan within 60 days after receipt. The Contractor shall incorporate such directed changes and resubmit one reproducible and ten copies of the final test plan at least 15 days prior to any equipment tests.

A.4.4.1 Test Plan(s) Content.- The test plan(s) shall be comprehensive, including all details necessary to assure that the test procedures and testing will satisfactorily demonstrate equipment compliance with all requirements specified herein.

The test plan(s) shall include, as a minimum, the following:

a) Test description and its purpose. The description shall include a block diagram showing the system configuration and interfacing and procedures for conducting each test of the series, together with the personnel necessary to perform the test.
b) Designation of all inputs that are required to test each function
c) Test output records, including a description of required outputs, the types of equipment used to observe or provide the outputs, etc.
d) A complete time sequenced schedule of events
e) A detailed description of analysis or combination of analysis and test results which may be offered in lieu of testing, where complete test results may be difficult or impractical to obtain.

A.5 PREPARATION FOR DELIVERY.- Preparation for delivery shall be in accordance with FAA-R-1030d, unless air ride padded van shipment is used. Equipment delivered under this specification shall be F.O.B. destination, within consignee's premises, including delivery to specific rooms within a building. Transportation charges shall be billed as separate invoice item.

APPENDIX B

AN APPROACH TO

DUAL AUGMENTED RBTL DESIGN

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B.1 SCOPE

Contained in this appendix is a functional approach to the implementation of the Augmented RBTL system in a dual radar/beacon configuration. This appendix makes references to the document to which it is attached, i.e., "Design Specification, Augmented Radar Beacon Tracking Level System", and discusses only the additions and modifications to the Augmented RBTL system which are necessary to expand it to a dual system, hereafter called the Dual Augmented RBTL system. The design assumes that the video inputs to the system originate from two radar/beacon systems wherein the radar and beacon antennas for each system are co-located. The system is designed to operate essentially as two independent Augmented RBTL systems. The Dual Augmented RBTL is not a so-called multisensor system, since the report data from one Augmented RBTL system is not used by the tracking function in the other Augmented RBTL system. Each display is assigned to only one of the radar/beacon sensors, and aircraft are controlled on a given display using track data received from the radar/beacon sensor associated with that display. The system makes use of multiprocessing executive scheduling, but does not contain a full multiprocessing failsoft executive. The system provides backup in case of the loss of radar or beacon sensors.

The expansion is achieved by the addition of a second Beacon Data Acquisition Subsystem (BDAS), a second Radar Data Acquisition Subsystem (RDAS), two Input/Output Processors (IOPS), and an additional 40K of memory to the Augmented RBTL system. In addition, several modifications to operational software are required. These modifications are discussed in later paragraphs.

Two efforts within the ARTS Enhancement development will provide information on alternative approaches to the implementation of Augmented RBTL at a dual site. One effort will recommend an approach to Dual Augmented RBTL implementation wherein alternate sensor position and altitude fill-in are used to provide display continuity during temporary dropouts in local sensor data. The other effort will recommend an approach to Dual Augmented RBTL implementation wherein full use is made of inputs from both sensor systems. This is commonly called the multisensor tracking effort.

B.2 GENERAL SYSTEM DESCRIPTION

B.2.1 Purpose.- The Dual Augmented RBTL system shall provide for the expansion of the Augmented RBTL system to accept the inputs of sensor data from two non-co-located radar/beacon sensor systems. The primary purpose of this system shall be to provide backup in case of the loss of one or more sensor(s). Under normal operating conditions, i.e., prior to the loss of a sensor, the system provides for redundant coverage of aircraft in those regions wherein the surveillance areas of the two radar/beacon systems overlap and provides also for extended coverage where there is no overlap.

B.2.2 System Hardware.- The Dual Augmented RBTL system shall contain the following hardware subsystems:

a) A Data Processing Subsystem (DPS)
b) Two Beacon Data Acquisition Subsystems (BDAS)
c) Two Radar Data Acquisition Subsystems (RDAS)
d) Two Data Entry and Display Subsystems (DEDS).

Figure B-1 shows the functional relationship of the hardware subsystems and identifies the principal paths of data flow.

B.2.2.1 Data Processing Subsystem.- The Dual Augmented RBTL Data Processing Subsystem (DPS) shall consist of the following modules:

a) Four Input/Output Processors (IOP)
b) Five 16K memory modules
c) One Peripheral adapter Module (PAM)
d) One magnetic tape handler
e) One console typewriter.

For a description of the various DPS modules, refer to the Augmented RBTL Design Specification or the appropriate ARTS III technical manuals. Figure B-2 is a block diagram of the DPS configuration, and table B-1 shows the IOP input/output channel assignments.

B.2.2.2 Beacon Data Acquisition Subsystems.- The Beacon Data Acquisition Subsystems (BDAS) shall be as described in the Augmented RBTL Design Specification and the ARTS III BDAS technical manual.

B.2.2.3 Radar Data Acquisition Subsystems.- The Radar Data Acquisition Subsystem (RDAS) shall be as described in the Augmented RBTL Design Specification and appendix A, RDAS Design Specification.

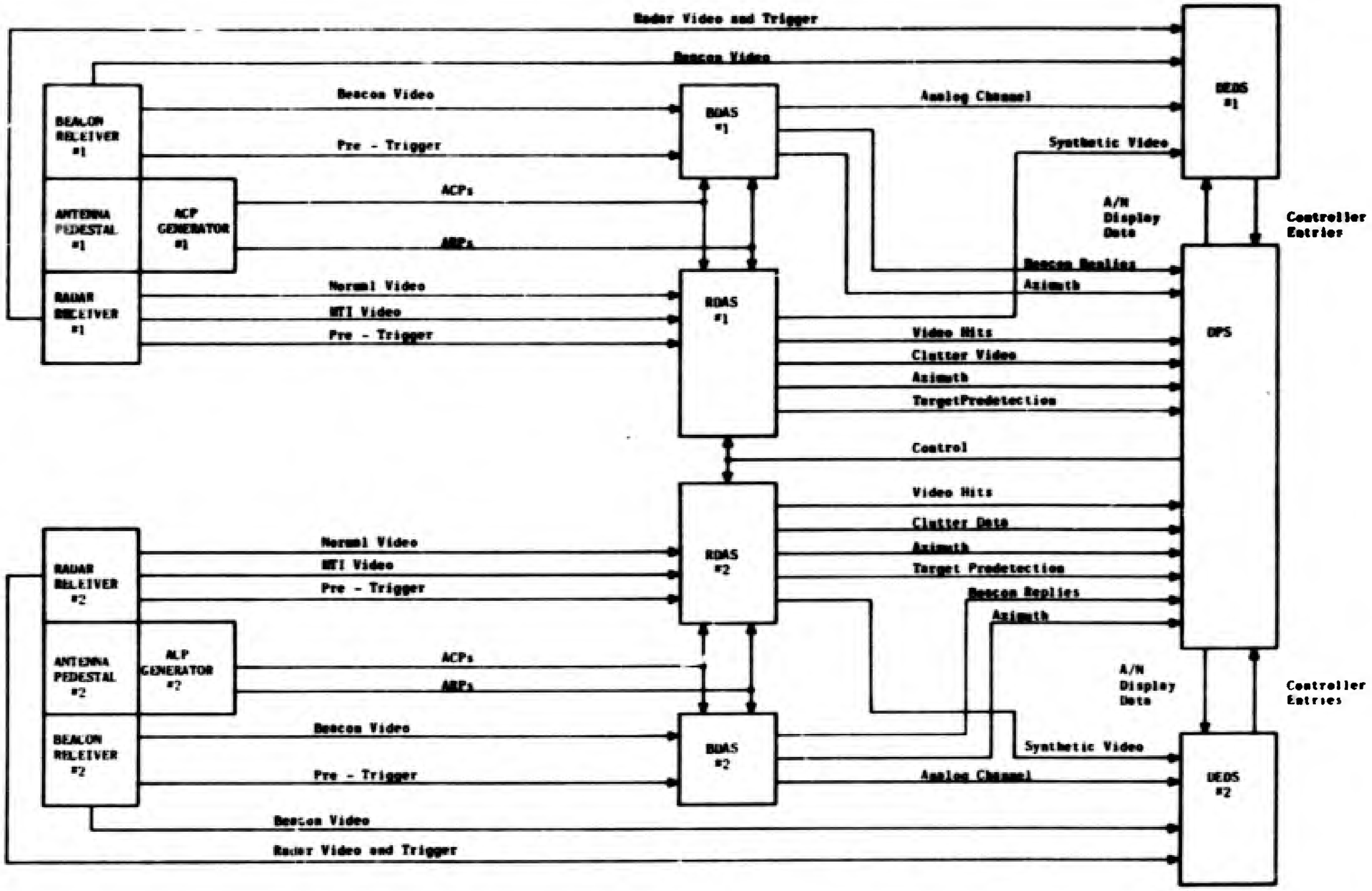


Figure B-1. Block Diagram of the Dual Augmented Radar Beacon Tracking Level System

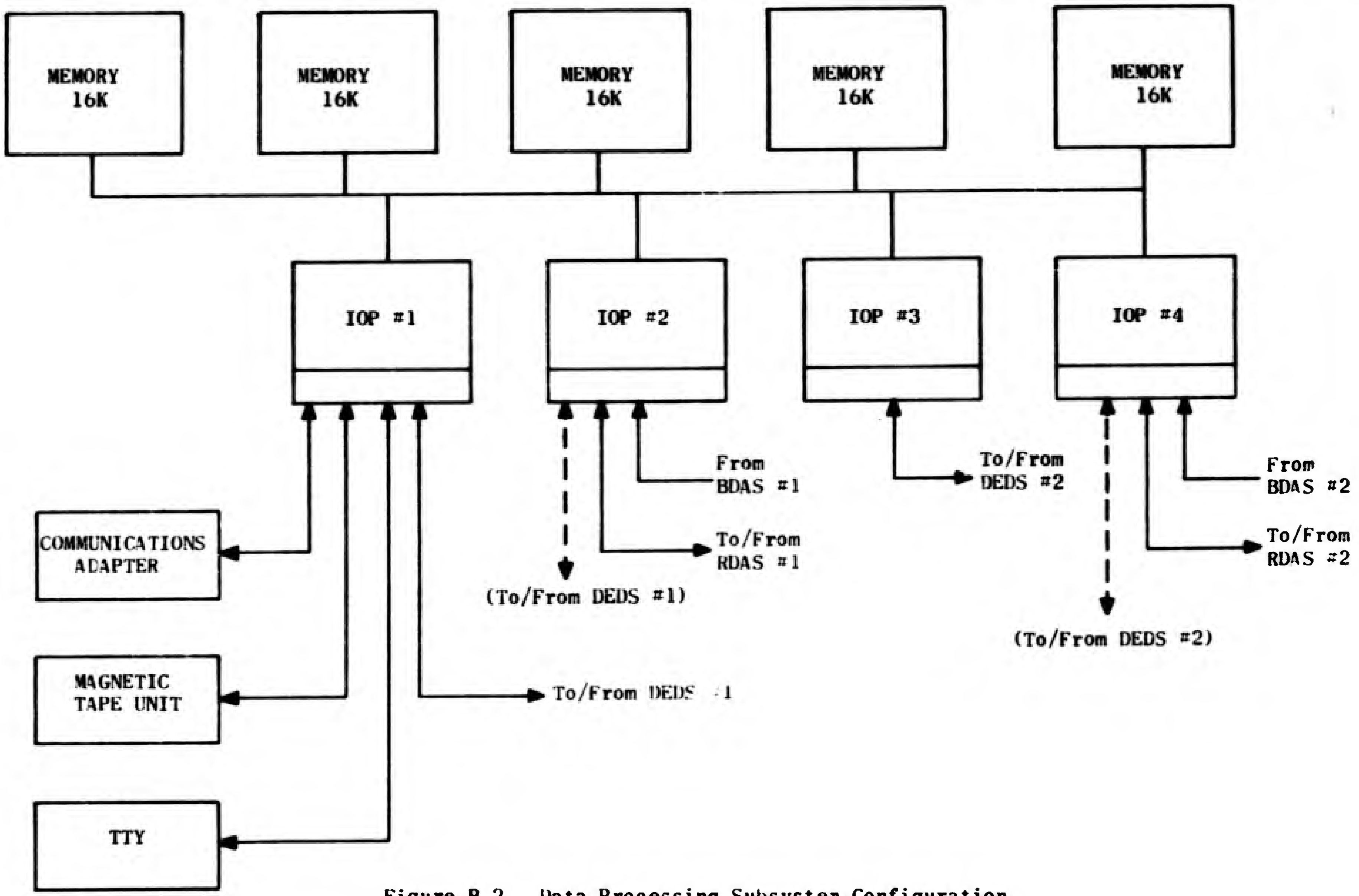


Figure B-2. Data Processing Subsystem Configuration

TABLE B-1. IOP INPUT/OUTPUT CHANNEL ASSIGNMENT

<table>
<tr><th colspan="3">IOP-1</th></tr>
<tr><th>IOP Channel Number</th><th>Peripheral Equipment or Subsystem</th><th>Relative Priority</th></tr>
<tr><td>0</td><td></td><td>Highest</td></tr>
<tr><td>1</td><td>Interfacility Comm. Adapter</td><td></td></tr>
<tr><td>2</td><td>Magnetic Tape Unit</td><td></td></tr>
<tr><td>3</td><td>Console Typewriter Adapter</td><td></td></tr>
<tr><td>4</td><td>UNISERVO V-IC</td><td></td></tr>
<tr><td>5</td><td>9300 Processor</td><td></td></tr>
<tr><td>6-15</td><td>DEDS #1 Consoles</td><td>Lowest</td></tr>
<tr><th colspan="3">IOP-2</th></tr>
<tr><td>0</td><td>BDAS #1 (Input only)</td><td>Highest</td></tr>
<tr><td>1-3</td><td></td><td></td></tr>
<tr><td>4</td><td>RDAS #1</td><td></td></tr>
<tr><td>5-15</td><td>(DEDS #1 Consoles)</td><td>Lowest</td></tr>
<tr><th colspan="3">IOP-3</th></tr>
<tr><td>0-3</td><td></td><td>Highest</td></tr>
<tr><td>4-15</td><td>DEDS #2 Consoles</td><td>Lowest</td></tr>
<tr><th colspan="3">IOP-4</th></tr>
<tr><td>0</td><td>BDAS #2 (Input only)</td><td>Highest</td></tr>
<tr><td>1-3</td><td></td><td></td></tr>
<tr><td>4</td><td>RDAS #2</td><td></td></tr>
<tr><td>5-15</td><td>(DEDS #2 Consoles)</td><td>Lowest</td></tr>
</table>

B.2.2.4 Data Entry and Display Subsystems.- The Data Entry and Display Subsystems (DEDS) shall be as described in the Augmented RBTL Design Specification and the ARTS III DEDS technical manual.

B.2.3 System Software.- The Dual Augmented RBTL system will contain the following software modules:

a) One executive module
b) Two radar input processing modules
c) Two beacon input processing modules
d) Two beacon/radar correlation modules
e) One keyboard interrupt processing module
f) One keyboard functional processing module
g) One interfacility I/O processing module
h) Two tracking modules
i) One display output processing module
j) One automatic offset processing module
k) One console typewriter output processing module
l) Four system timeout processing modules
m) One magnetic tape flight plan input processing module.

B.2.3.1 Unmodified Software Modules.- The following software modules shall be left unchanged in the expansion of the Augmented RBTL system to the Dual Augmented RBTL system and shall be as described in the design specification for the former:

a) Radar input processing
b) Beacon input processing
c) Beacon/radar correlation
d) Keyboard interrupt processing
e) Interfacility I/O processing
f) Automatic offset processing
g) Console typewriter output processing
h) Magnetic tape flight plan input processing.

B.2.3.2 Modified Software Modules.- The following software modules will undergo modification in the expansion of the Augmented RBTL system to the Dual Augmented RBTL system:

a) Executive
b) Tracking
c) Keyboard functional processing
d) Display output processing
e) System timeout processing.

B.2.3.2.1 Executive Modifications.- Although the basic structure to the executive will not be changed in the expansion to the Dual Augmented system, several areas will undergo expansion or redefinition. The power failure recovery logic will be expanded to handle four IOPs. In addition, the thread update function will be expanded and modified because the dual system will contain two central track stores and track number pointer tables. Finally, the structure of the lattices will be redefined to minimize executive overhead and inactive time while preventing data loss.

B.2.3.2.2 Tracking Modifications.- The modifications to the tracking routines for the two Augmented RBTL systems which make up the Dual system come about because of a desire to link the controlled tracks in one system with their corresponding uncontrolled tracks in the other system. Track linking will be performed in the manner described below.

When a track attains controlled status in one system either through a keyboard entry or an automatic acquisition (re-acquisition), a link will be established between the controlled track and its associated uncontrolled track in the other system. First, the position of the controlled track will be checked to determine whether it lies in the coverage area of the other system. If the position is not within the coverage area of the other system, the 10-bit linked track number field in Word 13 of the controlled track's file (figure B-3) will be set to 1777_8 to indicate that no link with an uncontrolled track in the other system has been established. This will cause the tracking routine to attempt to establish the link on the next scan. If the controlled track position is within the coverage of the other system, an attempt will be made to link the controlled track with its corresponding uncontrolled track. The X, Y coordinates of the controlled track will be translated to the other system. The azimuth of the translated position will then be computed and the sector wherein the position falls will be determined.

If the controlled track is a beacon track, the uncontrolled beacon tracks in the sector on either side of and including the sector containing the translated position will be checked. If one uncontrolled beacon track is found whose beacon code is equal to the beacon code of the controlled track and if certain distance criteria are met, a link will be established between the controlled track in one system and the uncontrolled track in the other. This is accomplished by putting the track number of the uncontrolled track in the linked track number field of the controlled track file and the track number of the controlled track in the linked track number field of the uncontrolled track file (figure B-3).

If the controlled track is a radar track, the uncontrolled radar tracks in the sectors on either side of and including the sector containing the translated position will be checked. If one uncontrolled radar track is found whose position satisfies certain distance criteria, a link will be established between the controlled radar track in one system and the uncontrolled radar track in the other system in the same manner as is done with the beacon tracks.

29	19	0
LINKED TRACK NUMBER	PRESENT AS LDB ON DISPLAYS DESIGNATED BY BIT SETTINGS 0-19	

WORD 13

Figure B-3. Modification to Central Track Store
For Dual Augmented RBTL System

B.2.3.2.2 (continued)

In either the radar or beacon case, if a link cannot be established either because no uncontrolled track satisfies the criteria or because an ambiguous situation exists, the linked track number field in the controlled track's file will be set to 1777_8, which will cause the tracking to attempt to establish the link on the next scan.

When the controlled track is dropped, either by keyboard entry or automatically, the link between the controlled track in one system and the uncontrolled in the other system will be broken.

B.2.3.2.3 Keyboard Functional Processing Modifications.- The changes to the keyboard functional processing module shall be required to add the capability of intersystem handoff, i.e., handoff from one Augmented RBTL system to the other one.

If such a handoff is from one Augmented RBTL system to the other, the uncontrolled track in the receiver's system which has been linked to the controlled track in the sender's system will be changed to controlled status in the receiver's system upon acceptance by the receiving controller. The controller track in the sender's system will become uncontrolled.

If no link has been established, an open track file in the receiver's system will be found and a track will be initiated.

B.2.3.2.4 Display Output Processing Modifications.- The display output processing modifications can be divided into two categories. The first has to do with the display of single symbols for uncontrolled linked tracks; the second is related to changes because of the inter-system handoff capability.

B.2.3.2.4.1 Linked Track Single Symbols.- When a controlled track in one system has been linked with an uncontrolled track in the other system (see B.2.3.2.2), the uncontrolled track single symbol will be replaced by the symbol of the controller who is controlling the track in the other system. The symbol will be displayed at the reported position of the uncontrolled track.

If no link has been established, the controller's symbol will be displayed on the other system's displays at the translated position of the controlled track.

B.2.3.2.4.2 Intersystem Handoff Display.- When a handoff/initiate function is entered, the track format from the controlled track will be force displayed on the receiving controller's scope and blinked. The data will be displayed at the position of the linked track if one exists.

When the handoff-accept function is entered, the controlled track symbol on the receiver's scope shall be changed to the receiving controller's symbol and the track data on the sender's scope shall be blinked for a parametric number of scans and then replaced by the appropriate uncontrolled track single symbol.

B.2.3.2.4 System Timeout Processing Modifications.- The system timeout functions which are performed in each of the two Augmented RBTL systems will be divided into four common routines. This is required so each IOP can timeout its own I/O channels.

B.3 PROGRAM STORAGE AND TIMING ESTIMATES

B.3.1 Memory Requirements.- Tables B-2 and B-3 shows the storage requirements for the Dual Augmented RBTL subprograms, including all tables and buffers.

B.3.2 Program Timing Estimates.- The Dual Augmented RBTL timing analysis is summarized in table B-4.

B.4 DUAL AUGMENTED RBTL RELIABILITY MODEL

B.4.1 System Reliability. - The reliability of the Dual Augmented RBTL System is dependent on site reliability definition. Using the methods of calculating serial and parallel reliability, respectively, two assumptions are made, first, if one module in the total model fails, the system has failed, and second, if one module in one subsystem model fails, the model will be considered in an "up" condition since the other subsystem model is still operational in the system.

The following reliability models assume that each equipment or module is a basic ARTS III unmodified module, i.e., no modifications have been made to account for failsafe, failsoft, multiprocessing, etc. Therefore, the reliability model figures will change if any modified equipments are used.

SERIAL RELIABILITY MODEL

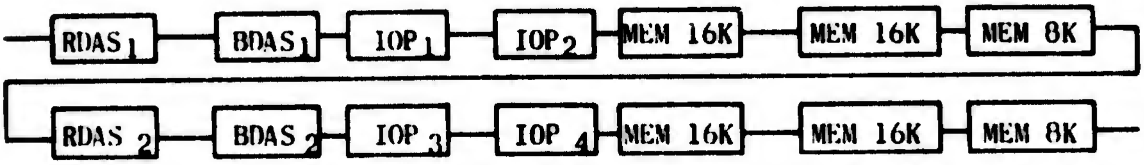


TABLE B-2. PROGRAM STORAGE FOR DUAL AUGMENTED RBTL SYSTEM

Program	Storage Estimate
Executive	650
Thread Update	200
Beacon Input Processing	1800
Radar Input Processing	2000
Radar/Beacon Correlation	600
Quantizer Control	700
Tracking	6000
Unused Report Processing	1200
Keyboard Input Processing	5000
Display Output Processing	1000
Interfacility I/O Processing	1500
Auto Offset	250
Console Typewriter Output	650
System Timeout Processing	1200
Magnetic Tape Flight Plan Input	500
Common Subroutines	2000
Miscellaneous	200
TOTAL PROGRAM STORAGE	25,450

TABLE B-3. DATA BASE FOR DUAL AUGMENTED RBTL SYSTEM

DATA BASE	STORAGE ESTIMATE (Words)
Beacon Input Buffers and Records	1600
Beacon Data Stores and Parameters	400
Beacon Target Report Store (3B/2)	750
Central Track Store (14.125T)	7560
Tracking Tables and Parameters	2600
Parameters 600	
RAT (3T) 1500	
TNP (1T) 500	
Beacon Only Tables	200
Radar Only Tables	300
Display/Keyboard Tables (32D+28K+100)	1244
Display Output Chain List (3Ti (Di+1)+100), i=1,2	11450
Common Active Track Buffer (5T)	2500
Fixed Chain List (25D+10K)	585
Console Tyepwriter Tables and Buffers	400
Configuration Tables	500
Interfacility Tables and Buffers	375
Minor Tables (VFR/IFR, Selected Codes, Etc.)	650
Literals, Flags, Chains, Pointers, Etc.	700
Radar Input Store	5472
Zone Control Map	3840
Input Process Masks and Zone Maps	900
Radar Record Stores	240
Radar Report Stores	180
Clutter Map Store	1536
Target Report Store (B+R)	1000
Mag Tape Flight Plan Data Base (3FP)	600
Executive Data Base	350
Miscellaneous Data and Working Storage	400
TOTAL	46,332

NOTE: B = Number of Beacon Reports/Scan = 500 (250 ea. System)
R = Number of Radar Reports/Scan = 500 (250 ea. System)
T = Present Number of Tracks in System = 500 (250 ea. System)
K = Number of Keyboards = 26
D_1 = System 1 Displays = 6
D_2 = System 2 Displays = 7
$D = D_1 + D_2 = 13$
T_1 = Tracks in System 1
T_2 = Tracks in System 2
$T = T_1 + T_2$
FP = Flight Plans

TABLE B-4. PROGRAM TIME ESTIMATES

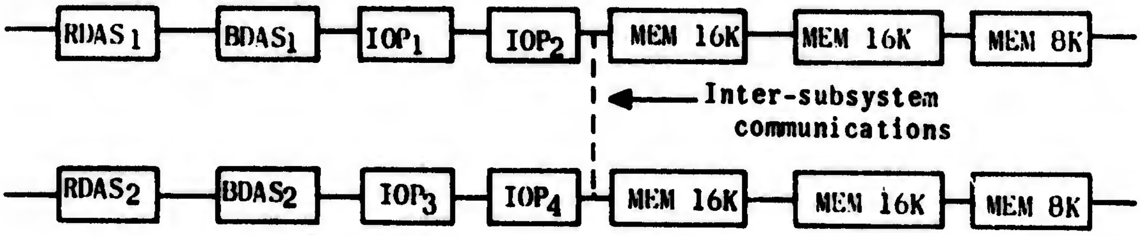
Subprogram	TIME (%)			
	IOP1	IOP2	IOP3	IOP4
Executive Control	3.0	3.0	3.0	3.0
Beacon Input Processing $(11.8N_i+.06B_i+.0031P_b+ 2.2)$ $i = 1,2$	19.7		19.7	
Keyboard Input Processing $(.4D_i)$ $i = 1, 2$		2.4		2.8
Keyboard Funtional Processing		0.1		0.1
Interfacility I/O Processing		1.6		
Tracking $(1.0+0.13T_i+,004T_iD_i)$, $i = 1, 2$		35.9		36.3
Tracking Feedback		1.5		
Process Unused Reports $(.04U)$		4.0		4.0
Display Output Chain Preparation $(.1+.01F_c+.002S_c+ .07TB + .013S_u + .026L_u)D$		13.4		15.6
Console Typewriter Output Processing		0.1		0.1
Magnetic Tape Input Processing		0.3		
System Timeout Processing	1.8	1.8	1.8	1.8
Input/Output Requirements $(.5+1.2D_i)$, $i = 1,2$	1.5	7.7	1.5	8.9
Beacon/Radar Correlation$((37.5P_c+20B_i+72.5R_i+400) \cdot 10^{-4})$ $i = 1, 2$	3.0		3.0	
Radar Target Detection $(.00375P+.038R_i+.005P_r+1.25)$ $i = 1, 2$	18.8		18.8	
Radar I/O Control	4.0		4.0	
Quantizer Control $(f+4000)/320$	16.2		16.2	
Automatic Offset $(.4+.1D_i)$, $i = 1, 2$		1.0		1.0
TOTAL	68.0	72.8	68.0	73.6

NOTE: R_i = Radar Target in System i = 350
B1 = Beacon Targets System 1 = 250
B2 = Beacon Targets System 2 = 250
B = B1+B2
T1 = Tracks in System 1 = Tu1 + Tc1 = 250
Tu1 = Uncontrolled Tracks in System 1 = 100
Tc1 = Controlled Tracks in System 1 = 50
T2 = Tracks in System 2 = Tu2 + Tc2 = 250
Tu2 = Uncontrolled Tracks in System 2 = 100
Tc2 = Controlled Tracks in System 2 = 150
T = T1 + T2 = 500
D1 = Displays in System 1 = 6
D2 = Displays in System 2 = 7
D = D1 + D2 = 13
U = Unused Reports = 200 (100 each system)
N1 = Fruit/Swp in System 1 = .25
N2 = Fruit/Swp in System 2 = .25
K = Keyboards = 26
Fc = Controlled Track FDBs/Display = 25
Sc = Controlled Track SS/Display = 125

TB = Tabular Tracks/Display = 0
Su = Uncontrolled Track SS/Display = 75
Lu = Uncontrolled Track LDB/Display = 25
P_b = Entries/Scan for Beacon Proc. (64)
P_c = Entries/Scan for Beacon/Radar Corr (64)
f = Prf (1200 pps)
P = Radar Predetections (850)
Pr = Entries/Scan for Radar Tgt. Detection

B.4.1 (continued)

PARALLEL RELIABILITY MODEL



EQUIPMENT	FPMH $\lambda(10^{-6})$ hours	MTBF Hours
RDAS*	200	5000*
BDAS	268	3740
IOP 12 Chan.	160	6250
IOP 8 Chan.	150	6667
MEM 16K	168	5943
MEM 8K	89	11223
Dual System (Serial)	2400	417**
Dual System (Parallel)	760	1320**

* RDAS design goal.

** System MTBF's are based on component modules being basic ARTS III containing no modification except the current ARTS III BDAS.

B.4.2 Reliability Requirements.- The reliability requirements for the Dual Augmented RBTL system will be the same as in a single radar/beacon system (see Augmented RBTL System Design Specification, 3.4).