

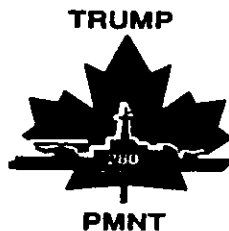
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COMBAT SYSTEM FAMILIARIZATION COURSE

STUDENT HANDOUT

FOREGROUND TECHNICAL DATA

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PREFACE

This document, CBS-H0001 REV N/C Combat System Familiarization Course Trainee Handout is based on the information available to the TRUMP ILS Training as of 5 April 1989, and as such, is subject to change, without notice, as the TRUMP Combat System undergoes design refinements.

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Table I
Glossary of Terms

AA	Anti-Air
AAW	Anti-Air Warfare
ACB	Audio Control Box
ACB	Audio Control Box
AGC	Automatic Gain Control
AIP	Anti-Icing Panel
ASSMs	Anti-Surface Ship Missiles
ASW	Anti Submarine Warfare
ATMS	Automatic Track Management System
AWW	Above-Water Warfare
BAM	Bus Access Module
BAS	Bus Access System
BIS	Bus Interface Set
BIT	Built-in-Test
BITE	Built-in-Test Equipment
BM	Bridge Module
CANEWS	Canadian Electronic Warfare System
CCS	Command and Control System
CIWS	Close-In Weapon System
COMM	Communication
CM	Command Module
CMTU	Cartridge Magnetic Tape Unit
CORSO	Conical Scan
COT	Captain-of-Turret
CPU	Central Processing Unit
CRACOM	Encrypted Radio Interface
CRT	Cathode Ray Tube
CRTM	Cathode Ray Tube Monitor
CTG	Commander Task Group

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Table I
Glossary of Terms

CWI	Continuous Wave Illuminator
DCJB	Damage Control Junction Box
DCU	Data Converter Unit
DCS	Data Converter Subsystem
DOS	Distributed Operating System
DTS	Digital Terminal Set
ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
EQUIP	Equipment
EPM	Emergency Power Module
ESM	Electronic Support Measures
EW	Electronic Warfare
EWIS	Integrated Electronic Warfare System
EWSI	Electronic Warfare System Interface
EXCOM	External Trunk Interface
FCS	Fire Control System
FCRS	Fire Control Radar System
FCU	Frequency Control Unit
FREQ	Frequency
FM	Frequency Modulation
GMFCS	Guided Missile Fire Control System
GMLS	Guided Missile Launching System
GWS	Gun Weapon System
HE	High Explosive
HF	High Frequency
HMS	Hull-Mounted Sonar
HSP	High Speed Printer
HV	High Voltage
Hz	Hertz

Table I
Glossary of Terms

ICI	Inter Computer Interface
ICP	Interface Control Panel
ICS	Interior Communication System
IFF	Identification Friend or Foe
IOCC	Input/Output Control Console
IMU	Inertial Measurement Unit
INDB	Inertial Navigation Data Bus
INS	Integrated Navigation System
ITE	Integrated Test Equipment
Kw	Kilo Watt
LCC	LIROD Control Console
LCC	Launch Control Console
LCM	Launcher Control Module
LCP	Local Control Panel
LCU	LIROD Control Unit
LCU	Launch Control Unit
LED	Light Emitting Diode
LF	Low Frequency
LORO	Lobe on Receive Only
LIROD	Lightweight Radar/Optronic Director
LNTA	Low-Noise Transistor Amplifier
LRR	Long Range Radar
LSEQ	Launch Sequencer
MAI	Maintenance/Administration Interface
MCP	Motor Control Panel
MDF	Main Distribution Frame
MF	Medium Frequency
MHz	Mega Hertz
MLJB	Module Lighting Junction Box

Table I
Glossary of Terms

mm	Millimeter
MOD	Modification
MOM	Multirole OTO Munition
MRR	Medium Range Radar
MTI	Moving Target Indication
MTTU	Multi-Task Tracker Unit
MTP	Module Transformer Platform
NAV	Navigation
NGS	Naval Gunfire Support
NIXIE	Acoustic Warfare Countermeasure System
OMEGA	Radio Navigation System
PACOM	Public Address Interface
PCP	Processor Control Panel
PD	Point Detonation
PDP	Power Distribution Panel
Ph	Phase
PRF	Pulse Repetition Frequency
PTT	Press To Talk
QOT	Quick Operability Test
RACOM	Radio Interface
RAM	Random Access Memory
RECOM	Recorder Interface
RCP	Remote Control Panel
RCU	Remote Control Unit
RDDS	Radar Data Distribution Switchboard
RDF	Radio Direction Finder
RIG	Radar Integration Group
RLEP	Remote Launch Enable Panel
R/R	Recorder/Reproducer Set

Table I
Glossary of Terms

RS	Radar Description
RTU	Radar Track Unit
SAM	Surface-to-Air Missile
SATCOM	Satalite Communications
SATNAV	Satalite Navigation
SM	Standard Missile
SAMS	Surface-to-Air Missile System
SAU	Search and Attack Unit
SAWS	Surface and Air Weapons System
SAPOM	Semi-armour Piercing Surface Rounds
SBPS	Sonobuoy Processor and Keyboard
SCC	STIR Control Console
SCR	Silicon Controlled Rectifier
SDB	Serial Data Bus
SDC	Signal Data Converter
SHINCOM	Shipboard Integrated Communications System
SHINPADS	Shipboard Integrated Processing And Display System
SLJB	System Lighting Junction Box
SLS	Side Lobe Suppression
SMRI	SMR Interface
SP	Status Panel
SPS	Sonobuoy Processing System
SOCOM	Sound Powered Telephone Interface
SOT	System Operability Test
SRGM	Super Rapid Gun Mounting
STC	Sensitivity Time Control
STIR	Signaal Tracking/Illumination Radar
STP	System Transformer Platform
SSD	SHINPADS Standard Display

Table I
Glossary of Terms

SSM	Surface-to-Surface Missile
SSW	Surface-to-Surface Warfare
SU	Surface
TACAN	Tactical Aircraft Navigation
TCC	Tracker Control Cabinet
TCG	Time Code/Remote Unit
TEWA	Threat Evaluation Weapon Assignment
THSS	Torpedo Handling and Stowage System
TPSU	Test Point Selector Unit
TWT	Travelling Wave Tube
UCS	Underwater Combat System
UHF	Ultra High Frequency
USN	United States Navy
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VDS	Variable Depth Sonar
VHF	Very High Frequency
VLS	Vertical Launch System
μs	Microsecond
VT	Proximity fused
WI	Watchdog Interface
WIC	Weapon Interface Cabinet
WDS	Weapon Direction System

1. INTRODUCTION

1.1 This handout describes the Combat System fitted to four DDH 280 (Tribal) class destroyers during the Tribal Class Update and Modernization Project (TRUMP) in support of the Canadian Navy.

1.2 The four destroyers were built between June 1972 and September 1973 and designated as follows:

- a. DDH 280 - HMCS IROQUOIS
- b. DDH 281 - HMCS HURON
- c. DDH 282 - HMCS ATHABASKAN
- d. DDH 283 - HMCS ALGONQUIN

1.3 Each ship has an overall length of 425' 9", a beam of 50' 0", and a current displacement of 4633 tons.

2. PRESENT CONFIGURATION

2.1 Introduction

2.1.1 The Tribal Class ships were designed primarily for Anti-Submarine Warfare (ASW) operations. As such, each ship was equipped as follows:

- a. Two Sea King/CH 124A helicopters
- b. Medium range hull mounted sonar
- c. Variable depth sonar
- d. Dual Point Defence Missile System
- e. 5"/54 surface gun
- f. Triple barrel mortar MK NC-10 mounting
- g. Two triple MK 32 torpedo tubes for MK 44/46 torpedoes.

2.1.2 The Combat System also included:

- a. Integrated Electronic Warfare System

- b. Computerized Underwater Combat System (UCS)
- c. Command and Control System (CCS 280)

2.2 Helicopters. - The prime functions of the helicopters were:

- a. To operate as an extension of the ship's anti-submarine weapon range;
- b. To operate as an extension of the ship's Underwater Combat System.

2.3 Sonar Systems. - The primary sonar system is the AN/SQS-505. This consists of two electronically identical units where one has a hull mounted transducer and the other encloses the transducer in a variable depth towed body. The secondary sonar system, the AN/SQS-505, is used for classifying bottomed targets.

2.4 Point Defence Missile System. - The DDH 280 Class was fitted with the Sea Sparrow Point Defence Missile System. The system comprised of four basic elements:

- a. The Sea Sparrow Missile (RIM-7E) featuring semiautomatic radar homing;
- b. A dual (port and starboard) Guided Missile Launching System (GMLS) made by Raytheon Canada, capable of firing four missiles from each launcher, either singly or in rapid succession, with reload capability;
- c. The M22 Gun Missile Fire Control System (GMFCS)
- d. The Command and Control Interface Group which interfaces the GMLS, GMFCS and the ship's Command and Control System (CCS 280).

2.5 Gun Weapon System (GWS). - The Gun Weapon System (GWS) consisted of a single OTO Melara 5"/54 gun. The gun was normally operated by remote control via the GMFCS. Manual control was achieved from a Captain-of-Turret (COT) console. In addition, the turret had instrumentation for local control.

2.6 Integrated Electronic Warfare System (EWIS). - The EWIS was designed to detect and combat the threat of Anti-Surface Ship Missiles (ASSMs). Electromagnetic emissions are detected, analyzed and identified and this information is manually passed on to the Command and Control System. The EWIS also comprised of two active weapons - a Chaff launcher and a jamming device to counter incoming missiles.

2.7 Radar System and Navigation.-

2.7.1 Primary detection of air and surface targets was accomplished by the radar system, which comprised the AN/SPS-501 Long Range Radar and the SPQ-2D Radar System.

2.7.2 Navigational aids included the AN/URN-20A(V) TACAN Navigation System, which provides range and bearing information to helicopters from the ship; the Sperry Mk 127E Navigation Radar; and the SATNAV/OMEGA Navigation System which provides world wide position fixing to an accuracy of 1 mile by day and 2 miles by night.

2.8 Command and Control System.- The Command and Control System (CCS 280) interfaced with the radar, sonar, fire control, electronic warfare, log and gyro systems as well as seven operator's consoles to integrate and communicate all sensor data to the operators and to permit operator direction of most of the ship's weapons (see Figure 1). Radar video and IFF video are also available for display and the tactical picture can be transmitted to co-operating forces via automatic Digital Data Links (LINK 11, LINK 14). The pre-TRUMP CCS 280 employed a centralized architecture, with the CCS 280 (L304F) processor, the Underwater Combat System (UCS 280) processor and the FCS processor were each capable of autonomous operation.

2.9 Communications.- The communications facilities on-board permitted communications with other ships in company and shore stations throughout the world. The following systems comprised the communications suite:

- a. LF/MF/HF receiving system to copy various fleet broadcasts.
- b. MF/HF transmit/receive system for long range (i.e. ship-to-shore) communications.
- c. UHF transmit/receive group to provide a local operational communications link between ships and aircraft in company.
- d. VHF transmit/receive group to provide communications with land units ashore to assist in naval gunfire support activities.
- e. UHF SATCOM compatible (with USN Fleet SATCOM).

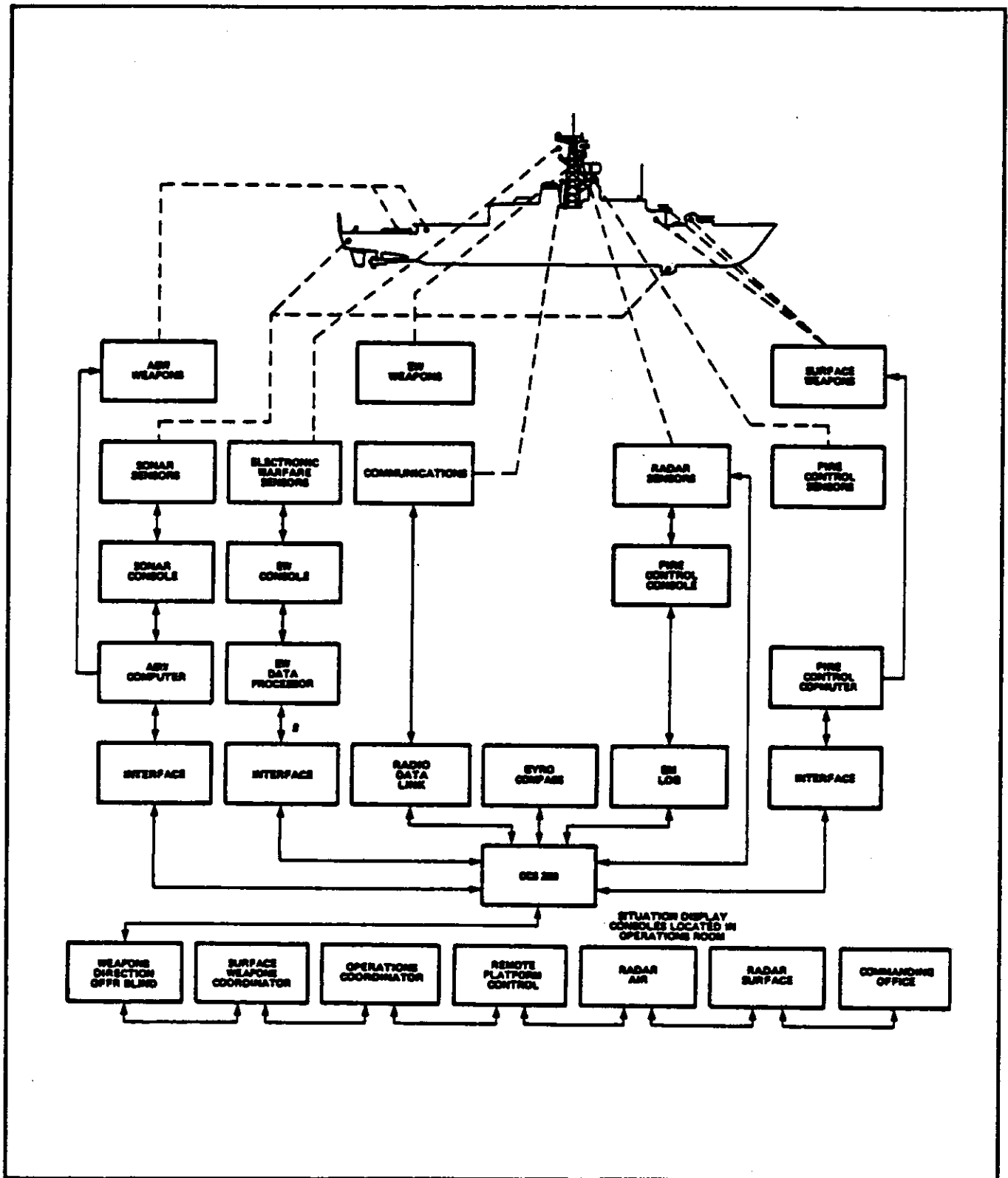


Figure 1 Pre-TRUMP CCS 280 Configuration

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3. TRUMP

3.1 Introduction.-

3.1.1 The primary objective of TRUMP, is to reconfigure the Tribal Class destroyers from ASW ships having only a point air defence system for self defence, to Anti-Air Warfare (AAW) ships, having supportive or area air defence systems, capable of undertaking long-range air defence, protecting both the DDH 280s and ships in company; as well as retaining self defence capabilities against surface and subsurface attack.

3.1.2 TRUMP, in addition to the DDH 280 mid-life refit, modernizes and equips the ships with area air defence systems to meet the threat of the 1990s. The project also provides the ships with the ability to embark a Task Group Commander. The modernized ships' have retained their anti-surface and anti-submarine warfare capabilities, along with integrating major systems purchased for the ships prior to modernization.

3.1.3 The Combat System consists of new Surface and Air Weapons, Command, Control and Communications Systems, Electronic Warfare Systems, Surveillance and Detection Systems and a new Navigation System.

3.1.4 Surface and Air Weapons include:

- a. Mk 41 Vertical Launch Missile System;
- b. Standard Missile 2 Block II;
- c. 76/62 mm Super Rapid Gun System;
- d. Phalanx Close-In Weapon System;
- e. Fire Control Radars and Weapon Direction System;
- f. Torpedo Handling and Stowage System;
- g. Retention of Hull and Variable Depth Sonar and UWCS.
- h. Retention of two existing Sea King Helicopters and homing torpedoes, and removal of the obsolete ASW mortars.

3.1.5 New Command, Control and Communications Systems include:

- a. Integrated command, control, processing and display system;
- b. Dual Switch Redundant Interior Communications System, adapted for secure voice;
- c. Retention and improvement of Secure Data Link (LINK 11, LINK 14) Systems;

3.1.6 New Electronic Warfare Systems include:

- a. Canadian Electronic Warfare System (CANEWS);
- b. SHIELD Chaff and Infrared Decoy Launching System
- c. Retention of existing Electronic Warfare (EW) Systems;

3.1.7 New Surveillance and Detection Systems include:

- a. Long-Range Radar;
- b. Medium-Range Radar;
- c. Identification Friend or Foe (IFF);
- d. Automated Track Management System (ATMS);
- e. Torpedo Countermeasure Systems (NIXIE)
- f. Integration of existing Sonar into the Command and Control System;

3.1.8 In addition, two Inertial Navigation Systems will be added.

3.2 TRUMP Combat System Primary Functions. - The primary functions of the TRUMP Combat System include Above Water Warfare functions, Commander Task Group functions and Anti-Submarine Warfare functions.

3.2.1 Above-Water Warfare. - Above-Water Warfare functions of the TRUMP Combat System include the capability to detect and destroy Anti-Surface Ship Missiles, aircraft and surface vessels (independently, and in cooperation with other Allied Forces). The Combat System provides supportive air defence and surface protection for escorted units and for self defence. These functions are grouped into two categories: Anti-Air Warfare and Surface-to-Surface Warfare.

3.2.1.1 Anti-Air Warfare (AAW). - AAW functions involve the following:

- a. Radar and Fire Control Systems provide air search and surveillance; target detection, classification, illumination and tracking; IFF/SIF (Mark XII) interrogation and response; electronic counter-countermeasures (ECCM) and direction and fire control of armament.
- b. Command, control and communications provide target data processing and display of sensor and weapon status; Threat Evaluation and Weapon Assignment (TEWA); interior communications; data link capability; weapon firing safety and veto capabilities.
- c. Weapon systems enable interception of incoming and crossing air targets and denial of airspace surrounding a defended area to hostile air launch through deterrence. These requirements are met by a combination of the Surface-to-Air Missile System (SAMS), the Gun Weapon System (GWS) and the Close-In Weapon System (CIWS).
- d. Electronic warfare capabilities for on-board and off-board Electronic Countermeasures (ECM) and on-board Electronic Support Measures (ESM).

3.2.1.2 Surface-to-Surface Warfare (SSW).- SSW functions involve the following:

- a. Radar and Fire Control Systems provide surface surveillance; target detection, classification, illumination and tracking; IFF/SIF (Mark XII) interrogation and response; ECCM and direction and fire control of armament.
- b. Command, control and communications provide target data processing and display of sensor and weapon status, TEWA, interior communications, data link capability, weapon firing safety and veto capabilities.
- c. Weapon systems enable engagement of hostile surface vessels and policing of sovereign waters. These requirements are met by a combination of SAMS and GWS.
- d. Electronic warfare capabilities for off-board ECM, electronic surveillance, classification and identification.

3.2.2 Commander Task Group Functions.- The Combat System is able to support an embarked Commander Task Group (CTG) in execution of his duties. In this regard, the following functions are provided:

- a. A dedicated tactical display driven by the CCS.
- b. Commander Task Group access to exterior communications and interior communications.

3.2.3 Anti-Submarine Warfare (ASW).-

3.2.3.1 ASW functions are provided for independent operation, or as a member of an ASW screen, barrier, or Search and Attack Unit (SAU). The following systems are involved with ASW functions:

- a. Radar, ESM, active and passive acoustic sensing to provide surface and subsurface search and surveillance; target detection, classification, tracking, and acoustic range prediction.
- b. Acoustic Warfare Countermeasures System (NIXIE).

3.2.3.2 Engagement of hostile submarine targets may be accomplished independently or in conjunction with other units including ASW aircraft and helicopters.

3.3 Secondary Functions.- Secondary functions of the Combat System include the following:

- a. Collection of electronic warfare (EW) and underwater acoustic information,
- b. Surveillance and reconnaissance,
- c. Protection of fixed submarine sensor systems,
- d. Search and rescue,
- e. Year-round inspection, boarding and enforcement of Government regulations,
- f. Hydrographic and oceanographic data collection.

3.4 System Definition.-

3.4.1 General.-

3.4.1.1 The Combat System comprises the following warfare and functional elements:

- a. Anti-Air Warfare (AAW),

- b. Surface-to-Surface Warfare (SSW),
- c. Anti-Submarine Warfare (ASW),
- d. Command and Control,
- e. Electronic Warfare (EW),
- f. Communication (COMM),
- g. Navigation (NAV).

3.4.1.2 The Combat System employs a combination of federated and distributed architecture to provide the most efficient distribution of information between the Command and Control System and Weapon Systems, while reducing the impact of interface changes on the mature subsystems to be procured for the TRUMP Combat System. A pictorial block diagram of the TRUMP Combat System is shown in Figure 2.

3.4.2 Anti-Air Warfare (AAW).- The AAW systems provide supportive air defence to a Task Group as well as self-defence for own ship. The main AAW weapon is the semi-active homing Standard Missile SM2 Block II and self-defence is supported by the OTO Melara 76/62 Super Rapid Gun Mounting (SRGM) and the Phalanx Close-In Weapon System, collectively providing a 360 degree arc of fire. AAW functions are supplemented by the Electronic Warfare (EW) System.

3.4.3 Surface-to-Surface Warfare (SSW).-The SSW systems provide a sovereignty assertion and horizon limited anti-ship warfare capability. SSW weapons include the semi-active radar homing Standard Missile SM2 Block II in the surface mode and the 76/62 SRGM. SSW functions are supplemented by the EW System and supported by the Radar System, the Fire Control System and the MK 41 VLS.

3.4.4 Anti-Submarine Warfare (ASW).- ASW capability is provided by retaining the existing MK 32 torpedo tubes with a new Torpedo Handling and Stowage System. The Acoustic Warfare Countermeasures System (NIXIE) has been provided by the Government as a stand alone project. The existing Hull-Mounted Sonar (HMS), Variable Depth Sonar (VDS) and AN/SQS-505(V), have been retained complete with the associated display and processing system. The Command and Control System (CCS) provides an interface to the Sonar System SMR processor. ASW capability is complemented by the addition of a new Sonobuoy Processing System (SPS).

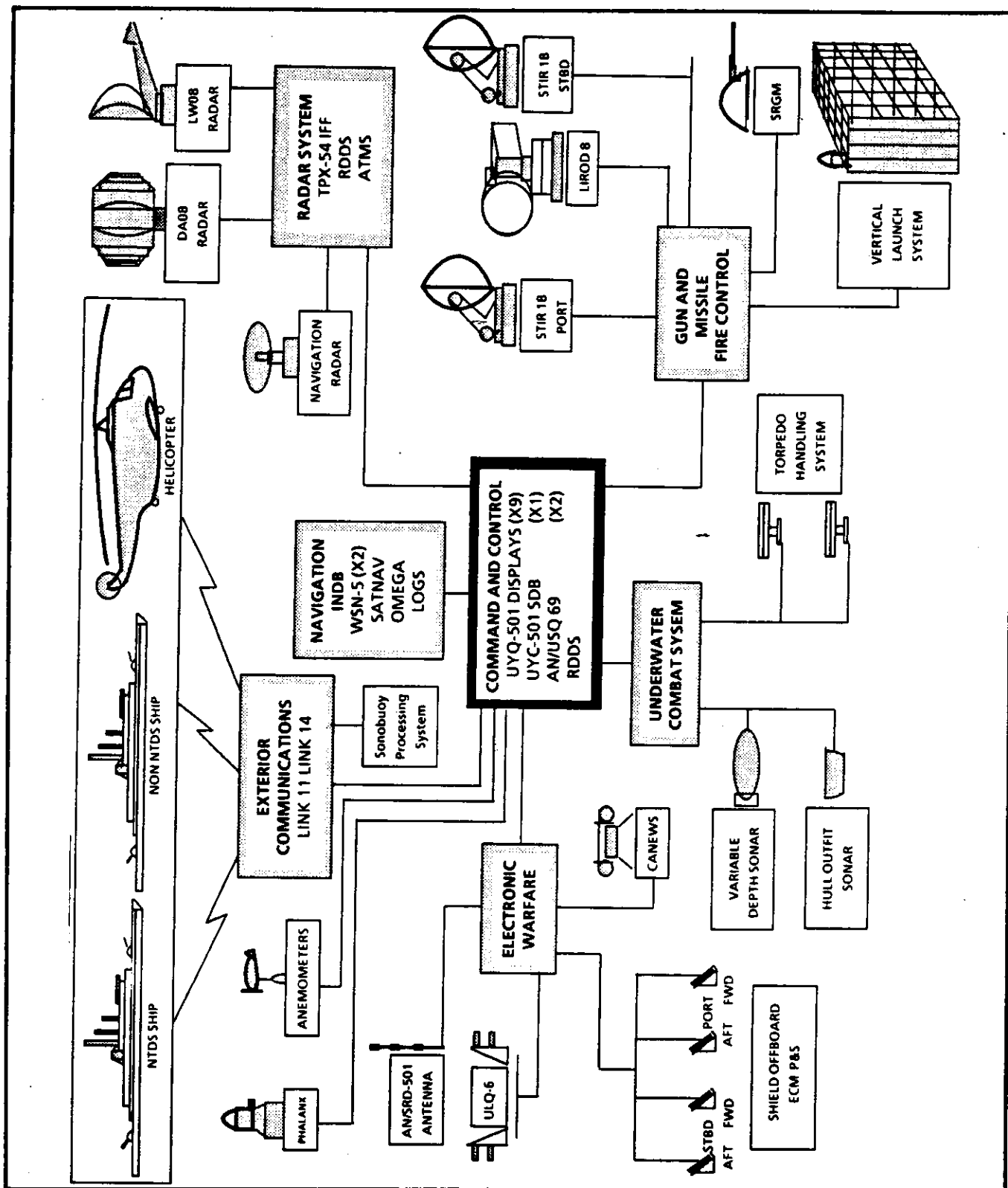


Figure 2 TRUMP Combat System Configuration

3.4.5 Command and Control System (CCS). - The CCS uses a distributed architecture based on the SHINPADS Serial Data Bus (SDB) AN/UYC-501(V), and comprises the following major elements:

- a. SHINPADS AN/UYC-501(V),
- b. System Control Processors,
- c. Data Processing Group,
- d. Data Display Group,
- e. Data Links,
- f. Electronic Warfare System Interface (EWSI) Processor,
- g. Software.

3.4.5.1 The subsystems associated with the sensor and warfare areas are federated to the CCS data processing group and EWSI processor. A functional block diagram identifying the interfaces between the CCS and other elements of the Combat System is shown in Figure 2.

3.4.6 Electronic Warfare System (EWS). - The EWS comprises the following components:

- a. CANEWS Electronic Support Measures (ESM) System has been supplied by the Government as a standalone project,
- b. SHIELD-2 Chaff and Infrared Decoy System
- c. The existing AN/ULQ-6 Electronic Countermeasures (ECM) System
- d. The existing AN/SRD-501 Radio Direction Finder (RDF) System.

3.4.7 Communication. - The existing ship's exterior communications system has been retained. The new Interior Communications System is based on the AN/SCC-503 (V) in a dual switch configuration.

3.4.8 Navigation. - The Combat System requirements for ship's attitude data (roll, pitch, heading) and the navigation requirements of position data (latitude, longitude) is provided by two AN/WSN-5(MOD) stabilized gyrocompass/inertial navigation systems in a primary/secondary relationship. The AN/WSN-5(MOD) equipment interface directly to the CCS data processor group and the Weapon Direction System.

4. SYSTEM DESCRIPTION

4.1 General.- For the purpose of this handout, the TRUMP Combat System is classified into eleven subsystems as follows:

- a. Command and Control System (CCS)
- b. Radar System (RS)
- c. Fire Control System (FCS)
- d. Surface-to-Air Missiles System (SAMS)
- e. Gun Weapon System (GWS)
- f. Close-In Weapon System (CIWS)
- g. Electronic Warfare System (EWS)
- h. Sonobuoy Processing System (SPS)
- j. Torpedo Handling and Stowage System (THSS)
- k. Interior Communication System (ICS)
- m. Integrated Navigation System (INS).

4.2 Command and Control System (CCS).- The Command and Control System (CCS) supports the Combat System in conducting Anti-Air Warfare, Surface-to-Surface Warfare, Anti-Submarine Warfare and Command Task Group operations for the TRUMP ship. The CCS operating in conjunction with the other subsystems provides the functions of ownship and data link sensor compilation and correlation, threat evaluation and assignment to weapon systems, interactive interface with operators, command support in tactical planning and navigation computations. The CCS provides overall coordination and control of data management to all other subsystems as shown in Figure 3. The CCS consists of the following functional groups of equipments:

- a. Serial data bus (SDB),
- b. CCS processors,
- c. Operator displays,
- d. Command Task Group display and slave monitor,
- e. System controller group,
- f. Electronic warfare system interface,

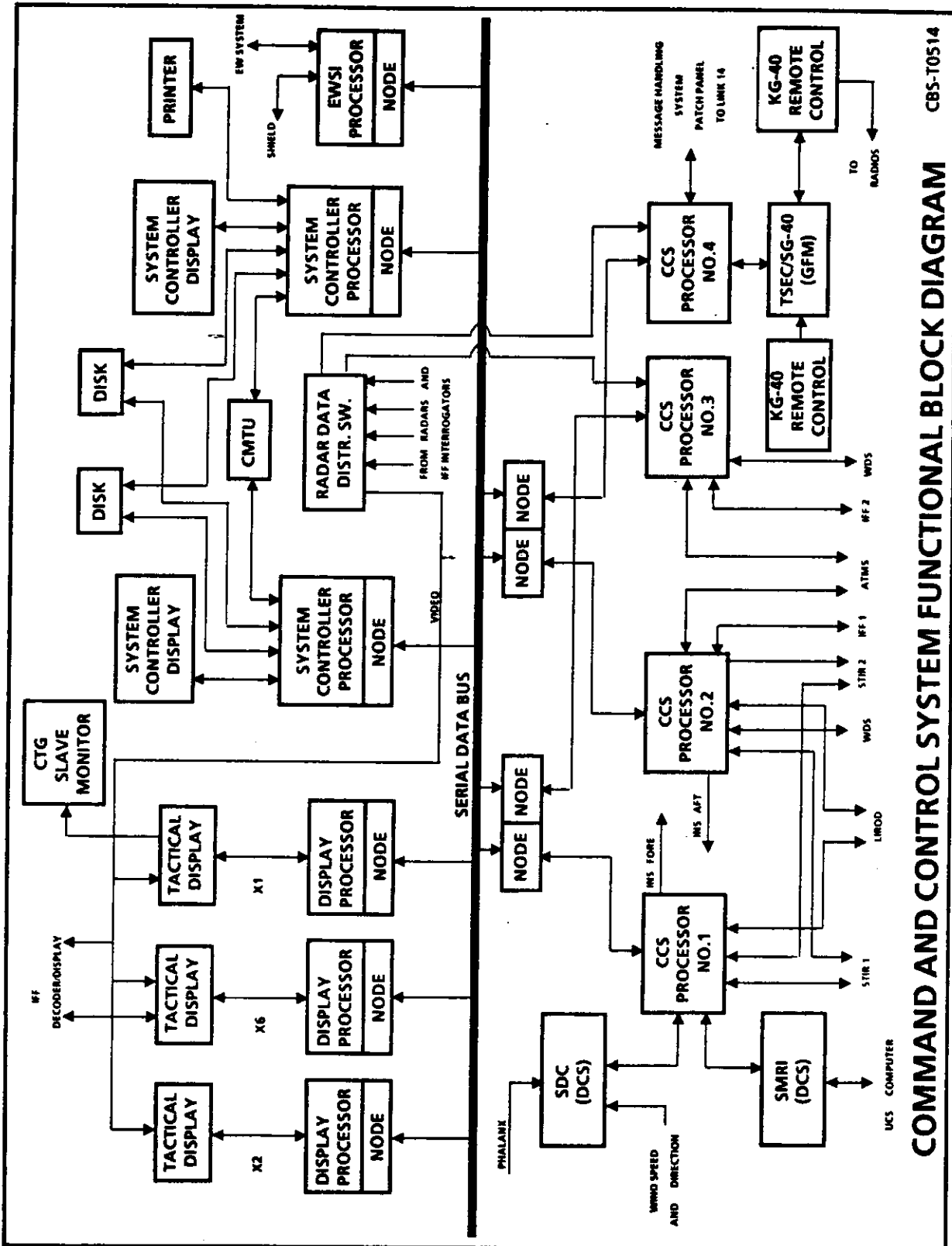


Figure 3 Command and Control System Functional Block Diagram

- g. Data processing sets,
- h. Data storage devices,
- j. Data link equipments,
- k. Printer,
- m. Data Converter Subsystem (DCS),
- n. IFF Mk. XII Decoders,
- o. Radar data distribution switchboard (RDDS).

4.2.1 Serial data bus (SDB). - A SHINPADS Serial Data Bus, type AN/UYC-501(V), serves as the transmission mechanism for the digital data and control signals between the CCS processors, the display processors and the EW system. Communications between any equipment is accomplished by the use of any two of the four bus channels. One channel is designated as a command channel and another channel is designated as a data channel. The remaining two channels are spares. Control of communications between equipment is maintained by the control channel and all data is transferred by the data channel.

Equipment is interfaced to the serial data bus by nodes. The node transfers data between the equipment and the bus. In so doing, it uses the equipment protocol to communicate with the equipment and the bus protocol to communicate with the bus. The nodes access the bus by means of a bus access module (BAM) which allows access to the bus while preventing failure of the whole bus when any problem within the node occurs.

The SDB equipment consists of the following:

- a. Bus Access Set (BAS/BAM) AN/UYC-504(V) (quantity 20). - The BASs are self-contained, shielded, bulkhead mountable units approximately 3" by 7" by 14". Each BAS includes a Bus Access Module (BAM) with active components and power supply, and a bus tap unit with 4 bus connection stubs and 2 connections to connect into a main bus cable.
- b. Data bus node card set with bus arbitration (quantity 2). - These card sets are installed within the System Controller Processor cabinets, AN/UYQ-504 (see 4.2.5).

- c. Data bus node card set without bus arbitration (quantity 10). - These card sets are installed within the Display Processors and the EWI Processor cabinets, AN/UYQ-504 (see 4.2.3, 4.2.4, and 4.2.6).
- d. Bus Interface Set (BIS) or dual data bus node card set without bus arbitration, AN/UYC-503 (quantity 2). - These card sets are packaged in dual-node cabinets with independent power supplies.
- e. Main bus terminators, 7515355 (quantity 8). - The bus terminators terminate the BASs at each end of the four main bus cables.
- f. Node stub cables, TRF 58 (quantity 64). - The node stub cables connect the nodes to the BAS stubs.
- g. Main bus cables, TRF 8 (quantity 4). - The main bus cables are the cables that carry the data/control signals between BASs from one end of the bus to the other.

4.2.2 CCS processors. - Four AN/UYK-505(V) processors provide the central processing associated with the CCS, interfacing with the Radar Sensors via the Fire Control System, the Automatic Track Management System (ATMS), the Underwater Combat System via the DCS, the LINK 11 modem, the LINK 14 transmission equipment, the Inertial Navigation System, the Weapon Direction System (WDS), and the Serial Data Bus. Each CCS processor is configured with:

- a. 256 K-words RAM,
- b. 1024 Hz RTC/monitor clock,
- c. NTDS SLOW interface - 8 channels,
- d. NTDS FAST interface - 4 channels,
- e. NATO 4153 serial interface - one channel,
- f. MIL-STD-188C serial interface - 2 channels,
- g. SDB bootstrap in memory.

4.2.3 Operator displays. - Nine SHINPADS Standard Displays (SSD), type AN/UYQ-501(V) consisting of a display driver assembly, a control unit display and a high-resolution television monitor in a single console provide graphics and radar functions as well as various operator interface functions to the CCS. Each SSD is interfaced to the SDB with one AN/UYQ-504 computer (see 4.2.7) which provides display processing application functions under user-generated software control.

4.2.4 Command task group display and slave monitor. - One SSD serving as a Command Task Group Display is interfaced to the SDB via an AN/UYQ-504 Display Processor (see 4.2.7). The CTG display is interfaced to the Radar Data Distribution Switchboard to provide radar video. A separate high resolution colour monitor, HSD 7030, mounted remotely from the CTG is interfaced in parallel to the CTG display.

4.2.5 System controller group. - Two System Controller groups, each comprising of an AN/UYQ-504 processor (see 4.2.7), AN/USQ-69 Data Terminal Set, and an AN/UYH-3(V) magnetic disk to provide short-term data storage; operating in primary and fallback modes of operation perform the SDB control functions necessary for the initialization, maintenance, and reconfiguration of the SDB communications paths, and for the loading and initialization of software in CCS processors which interface with the SDB. The AN/USQ-69s are configured with an ASCII keyboard with special function keys, three-page internal memory, MIL-STD-188C interface and rack-mounting interface.

4.2.6 Electronic warfare system interface (EWSI). - An EWSI processor, type AN/UYQ-504 (see 4.2.7) interfaces the EW system and the SHIELD offboard ECM.

4.2.7 Data processing set, AN/UYQ-504. - The data processing sets are configured with a backplane providing two electrically-isolated, separately powered sections, with a 21/7 split of card mounting slots. The 21-slot section contains the AN/UYK-502(V) card set and the other section contains the SDB node card set. There are three different configurations of the AN/UYQ-504 as delineated below:

a. Display processors (see 1.2.3 and 1.2.4). - Each display processor is configured with:

- i 256 K-words RAM,
- ii NDRO bootstrap for AN/USH-26 CMTU and for the SHINPADS SDB,
- iii CPU No. 1 and No. 2 cards,
- iv Maintenance panel,
- v NTDS FAST Interface (16 bit) - one channel,
- vi RMF interface to integral node card set.

- b. System processors (see 4.2.5). - Each system processor is configured with:
 - i RAM, CPU, and maintenance panel as specified for the display processors
 - ii NDRO bootstrap for AN/USH-26 CMTU, AN/UYH-3(V) Disk and SHINPADS SDB
 - iii NTDS FAST Interface (16 bit) - four channels
 - iv MIL-STD-188C Serial interface - one channel
 - v RMF interface to integral node card set.
- c. EWS processor (see 4.2.6). - The EWS processor is configured with:
 - i RAM, CPU, and maintenance panel as specified for the display processors
 - ii NDRO bootstrap for AN/USH-26(V) CMTU and SHINPADS SDB
 - iii NTDS SLOW Interface (16 bit) - one channel
 - iv NTDS FAST Interface (16 bit) - one channel
 - v EIA RS-232C Serial Interface - one channel
 - vi RMF interface to integral node card set.

4.2.8 Data storage devices. - In addition to the AN/UYH-3(V) magnetic disks (referenced in 4.2.5), a Cartridge Magnetic Tape Unit (CMTU), type AN/USH-26, interfaced to both System Controller processors provides long-term data storage capability and initial software program loading.

4.2.9 Data link equipments. - Data Link capability is provided by a LINK 11 Data Terminal Set, AN/USQ-76, and LINK 14 equipment. The LINK 11 equipment is interfaced to one CCS processor (via Government furnished KG-40 crypto) which provides computer control over transmission and reception. LINK 14 equipment is interfaced to one CCS processor for automatic transmission of data under operator initiation. LINK 14 receptions are printed on a teletypewriter.

4.2.10 Printer. - A high-speed line printer, type HSP 3609-212A, is interfaced to a system processor to provide hard copy of programs, tests, and operational analyses.

4.2.11 Data Converter Subsystem. - The DCS, CV 5140 (V) USQ, is comprised of the Data Converter Unit (DCU) and the DCS Power Supply Unit. The DCU consists of the Signal Data Converter (SDC) and the SMR Interface (SMRI). The SDC provides

synchro-to-digital and digital-to-synchro conversion, discrete i/o interfacing, multiplexing of inputs to the CCS computer and BIT capability. The SMRI provides a bidirectional data link between the Underwater Combat System SMR computer and the CCS computer, and a BIT capability. The SMRI interfaces to one CCS processor via an NTDS Slow interface. The DCU interfaces the Close In Weapon System, and the wind speed direction sensors to a CCS processor.

4.2.12 IFF Mk XII decoders. - Six of the tactical SSDs interface to the Radar Data Distribution Switchboard via four active and two passive AN/UPA-59B IFF decoders. These decoders provide integrated IFF/Radar video to the SSD as well as a capability for digital display of IFF codes. TRUMP modifications to the AN/UPA-59B decoders include the removal of the light pen from the active decoders with the subsequent range-azimuth gate for active decoding acquired through a data interface with the trackball input of the SSD. Additionally, a Remote Alarm Monitor [BZ-173A/UPA-59A(V)] providing an audible signal via a loudspeaker and visual cues from flashing lights is added to each decoder. An active intratarget indicator [ID-1844A/UPA-59A(V)] displaying four channels of active code via LEDs is added to each passive-only video decoder [KY-761A(P)/UPA-59A(V)], thereby bringing the complement of IFF decoders to the same active/passive configuration.

4.2.13 Radar Data Distribution Switchboard (RDDS). - The RDDS (Figure 4) permits the switching and distribution of radar video from each of the sources to any of the operator displays within the CCS. The sources of radar data are:

- a. Navigation Radar Video via Radar Integration Group (RIG)
- b. MRR air track, MTI plot video
- c. MRR air track, Non-MTI plot video
- d. MRR surface track plot video
- e. LRR air track, MTI plot video
- f. LRR air track, Non-MTI plot video
- g. LRR surface track plot video
- h. Spare video input
- j. Information pertaining to the associated IFF video is selectable to supplement any of the medium and long range radar videos.

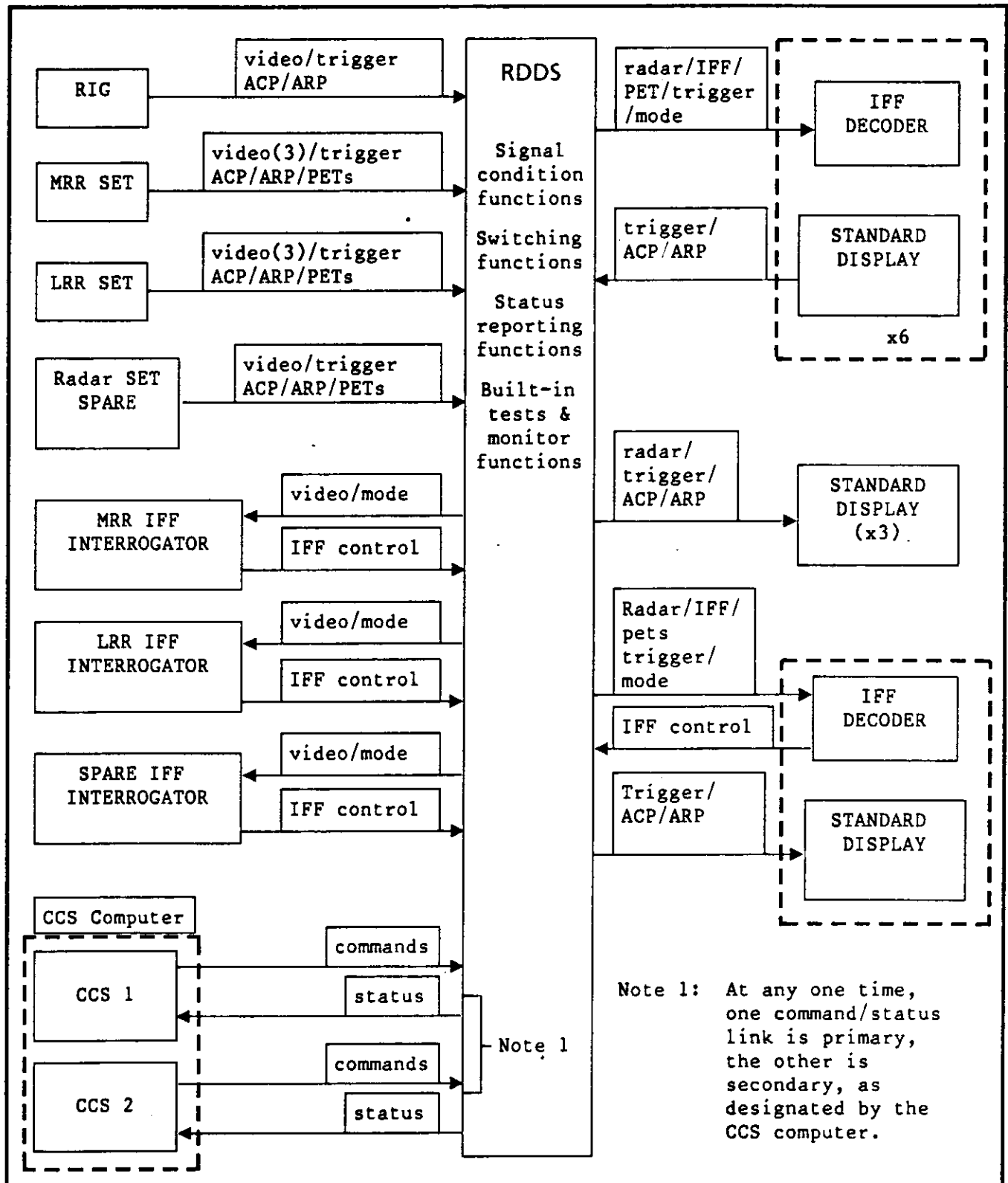


Figure 4 Radar Data Distribution Switchboard Interface Block Diagram

The RDDS is mounted in a standard 19" equipment rack containing the following:

- a. Dual redundant power supplies with independent power ON indicators and supply fault indicators;
- b. A dual blower, each capable of providing sufficient cooling for the unit;
- c. A 22 key keypad and 48 Character alphanumeric display for control and BIT functions; and
- d. A cardcage containing 1 CPU card, 1 Primary Radar Interface card, 2 Radar Interface cards, 5 Display Interface cards, and 1 spare CPU card.

4.2.14 CCS Software.— The CCS software consists of the programs resident in the CCS processors, the EWSI processor, the System Controller processors and the Display processors. The programs operate in the distributed environment provided by the SDB and the TRUMP Operating System (TOS). Redundancy of software functions is provided to the maximum extent possible.

4.2.14.1 The TOS provides the following functions:

- a. System Initialization,
- b. Application task scheduling,
- c. SDB message routing,
- d. System status monitoring,
- e. System reconfiguration,
- f. Peripheral management applications.

4.2.14.2 The CCS software provides the following functions:

- a. Electronic Warfare System interface,
- b. LINK 11 and LINK 14 interfaces,
- c. Navigation System interface,
- d. Surface and Air Weapons interface,
- e. Sonar System interface,
- f. Radar System interface,
- g. Display management,
- h. Data management,

- j. Track management,
- k. Threat Evaluation and Weapon Assignment,
- m. Tactics,
- n. Diagnostics/Error handler,
- p. Utility routine,
- q. Shipboard training,
- r. History management.

4.3 Radar System. - The Radar System provides early warning of air and surface threats and will present accurate surveillance data to the CCS for threat evaluation and weapon assignment. The radar system (Figure 5) for the modernized 280 class ship comprises the following major elements:

- a. LW08/2LS Long Range Radar (LRR),
- b. DA08/2LS Medium Range Radar (MRR),
- c. Automated Track Management System (ATMS),
- d. IFF MARK XII (IFF).

4.3.1 LW08 Long Range Radar. - The coherent D-band LW08/2LS radar (Figure 6) serves to supply video information of real targets, with a minimum of non-target information, such as stationary or slow moving precipitation clutter and intentional or unintentional interference. The radar system comprises:

4.3.1.1 Antenna system. - The antenna contains a horn-fed reflector radiating a cosec² beam. The polarization is circular. An omnidirectional antenna for Side Lobe Suppression (SLS) is fitted on top of the reflector. The reflector is mounted on a lightweight roll/pitch-stabilized platform (hydraulically driven), and rotates at two rotation speeds, VIZ. 7.5 or 15 RPM (locally and remotely selectable). An integral IFF interrogator antenna is colocated with the antenna to provide a high degree of correlation between the interrogator and the LW08 system.

4.3.1.2 Antenna control cabinet. - The antenna control cabinet controls the flow of oil to the two stabilization actuators and contains electronic protection circuits for the stabilized platform. The oil pressure in the system is dependent on circumstances like weather and sea state. The required oil pressure is

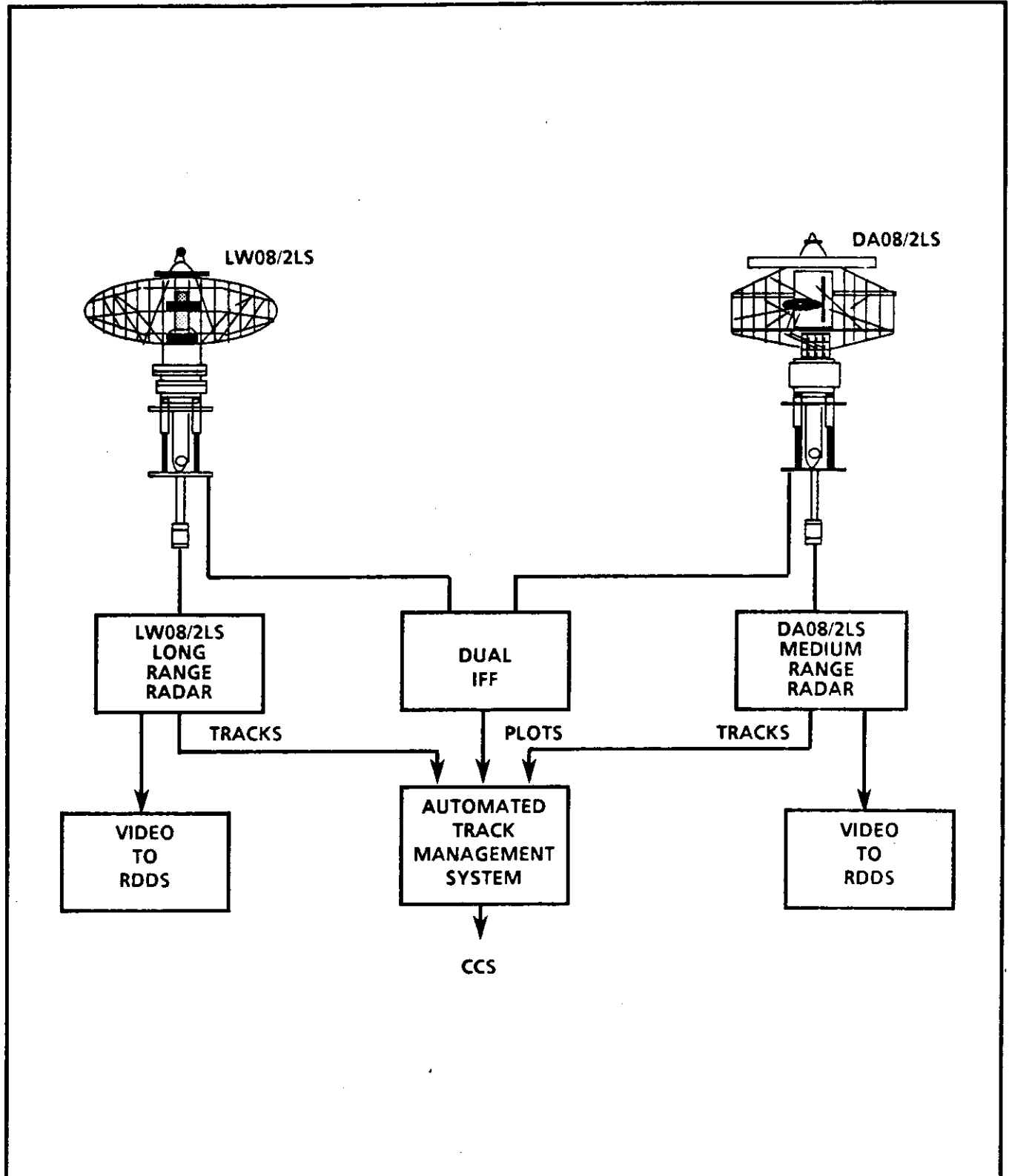


Figure 5 Radar System Functional Block Diagram

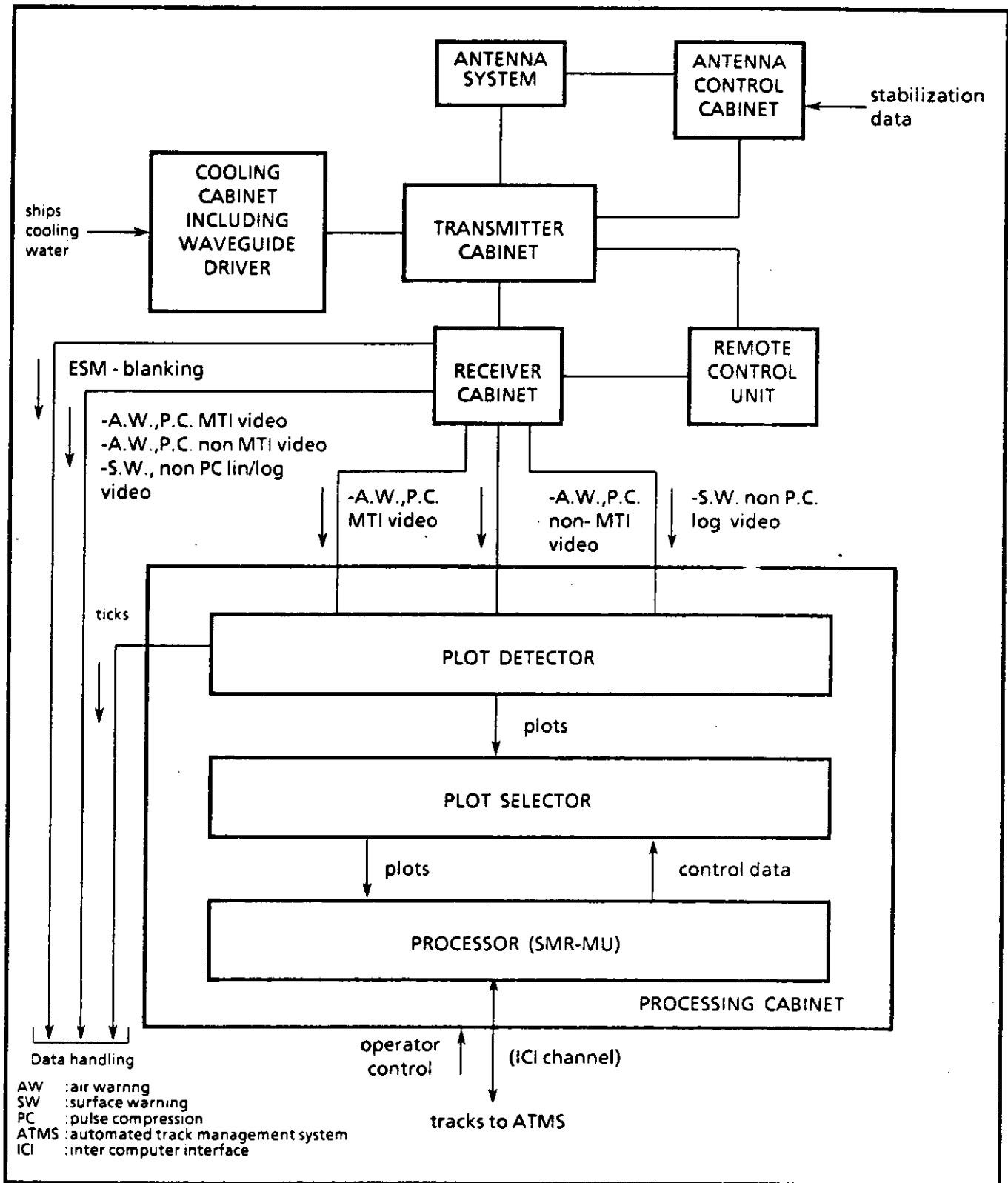


Figure 6 LW08 Long Range Radar Functional Block Diagram

controlled in the antenna control cabinet by microprocessor controlled servo valves. In case of a drop off of the oil pressure, the platform is automatically locked by means of a mechanical clamping device. Provisions are available for a zero positioning of the platform by means of a manually controlled pump. The stabilization input data is obtained from AN/WSN-5 MOD Inertial Navigation System (INS) in the form of synchro inputs. In the event of a loss of these external stabilization values the platform is automatically steered to the zero position. The man-aloft switch disables the antenna drive motor, stabilization actuators, the transmitter H.V. circuit and IFF interrogator when maintenance work is to be done on or near the antenna. A waveguide drier supplies dry air to the waveguide to avoid moisture and corrosion.

4.3.1.3 Transmitter cabinet. - The transmitter is a coherent amplifier chain, driven by a crystal-controlled frequency control unit (FCU). The transmitter operates in the band of 1200 - 1400 MHz. Fixed frequency operation or frequency agility can be selected. The output stage is a D-band travelling wave tube (TWT) with a peak output power of approximately 150 kW. The total transmitter pulse length is 35 μ s with a pulse repetition frequency (PRF) of 1000 Hz or 69 μ s with a PRF of 500 Hz. The transmitter pulse consists of a frequency-modulated 34 μ s or 68 μ s "chirp" pulse for air warning followed by a 1 μ s pulse which is not frequency modulated for surface warning. The transmitter is connected to the waveguide system via circulators to ensure sufficient isolation and optimum matching. The waveguide system outside the transmitter cabinet is provided with a waveguide switch with dummy load to perform measurements under high-voltage conditions, without radiating energy. In the transmitter cabinet, the TWT, the high-voltage power supply, the circulators with load and the external transmitter load, are water-cooled. This water is supplied by the cooling unit which transfers the heat to the ship's cooling water by means of a water-to-water heat exchanger.

4.3.1.4 Receiver cabinet. - The input signal for the transmitter is generated in an FCU which is housed in the receiver cabinet. The centre frequency of the chirp signal for the long pulses can be remotely selected, i.e. in the transmitter band from 1207.5 to 1400 MHz:- six different frequencies are available. In addition, random frequency jumping through the entire band can be selected. The frequency of the 1 μ s pulse is always 7.5 MHz from the centre frequency of the chirp pulse. The

FCU also generates the local oscillator signals for the receiver, the reference signals for the moving target indication (MTI), and the synchronization signals. The signals received are first amplified in a low-noise transistor amplifier (LNTA) before being supplied to a double-conversion mixer stage. The receiver contains two separate channels:- a pulse compression channel for the 34 μ s pulse (or the 68 μ s pulse) for air warning, and a linear/logarithmic channel for the 1 μ s pulse for surface warning. In order to obtain a good minimum range for air warning, non-compressed 1 μ s video is used for the first few miles of the range, while compressed video is used for the remaining part. The air warning receiver channel is extended with a SLS circuit to suppress noise jamming signals from one direction, received via the side lobes of the antenna. The receiver also contains the MTI circuit with digital quadrature canceller, interference suppression units, a video correlator and a pulse-length discriminator. To increase the dynamic range, a sensitivity time control (STC) provision has been incorporated, controlling not only the IFF amplifiers but also the LNTA. The STC is combined with an automatic gain control (AGC) resulting in a constant false alarm rate at the receiver output. The receiver output signals are input to the ATMS and the data handling system, after which it is distributed to all users. The video signals available at the receiver are:

- a. Long-range air warning pulse-compressed MTI video, including 1 μ s pulse MTI video for the first few miles of range to improve minimum range capability.
- b. Long-range air warning pulse-compressed non-MTI video, including 1 μ s pulse non-MTI video for the first few miles of the range to improve minimum range capability.
- c. Surface warning 1 μ s lin or log non-pulse-compressed video.

4.3.1.5 Remote control unit. - The LRR can be remotely controlled by means of an RCU. Local control is possible with the LCP on the transmitter cabinet. Besides the operational control facilities on the RCU, a monitoring function is available. This function includes a number of indication lamps showing a failure in one of the cabinets. A detailed failure indication per cabinet is presented on the cabinet itself.

4.3.2 DA08 Medium Range Radar. - The function of the coherent F-band DA08/2LS radar (Figure 7) is to supply video information of real targets which are free as possible of non-target information such as stationary or slow-moving precipitation clutter and intentional or nonintentional interferences. The major units of the system are as follows:

4.3.2.1 Antenna system. - The antenna system consists of a reflector with an active and passive feed horn, shaping a cosecant squared beam up to an elevation of 75°. Polarization can be either linear or circular and is selectable from either the LCP or the RCU. On top of the reflector is located an omni directional antenna for side lobe jamming suppression. The reflector of the antenna is mounted on a lightweight platform stabilized for roll and pitch. The servo motors of the stabilized platform are controlled by the amplifiers in the antenna control cabinet. An integral IFF interrogator antenna is colocated with the antenna to provide a high degree of correlation between the interrogator and the DA08 system.

4.3.2.2 Antenna control Cabinet. - The antenna control cabinet controls the flow of oil to the two stabilization actuators and contains electronic protection circuits for the stabilized platform. The oil pressure in the system is dependent on circumstances like weather and sea state. The required oil pressure is controlled in the antenna control cabinet by microprocessor controlled servo valves. In case of a drop off of the oil pressure the platform is automatically locked by means of a mechanical clamping device. In case of a failure in the hydraulic system, provisions are also available for a manual zero positioning of the platform by means of a manually controlled pump. The stabilization input data is obtained from the AN/WSN-5 MOD INS in the form of synchro inputs. In the event of a loss of these external stabilization values the platform is automatically steered to the zero position. The man-aloft switch disables the antenna drive motor, stabilization actuators, the transmitter H.V. circuit and IFF interrogator when maintenance work is to be done on or near the antenna. A waveguide drier supplies dry air to the waveguide to avoid moisture and corrosion.

4.3.2.3 Transmitter cabinet. - The transmitter is a coherent amplifier chain, driven by a frequency synthesizer. Two transmission modes are available:- normal transmission mode and sector scan mode. In the "normal transmission mode", the

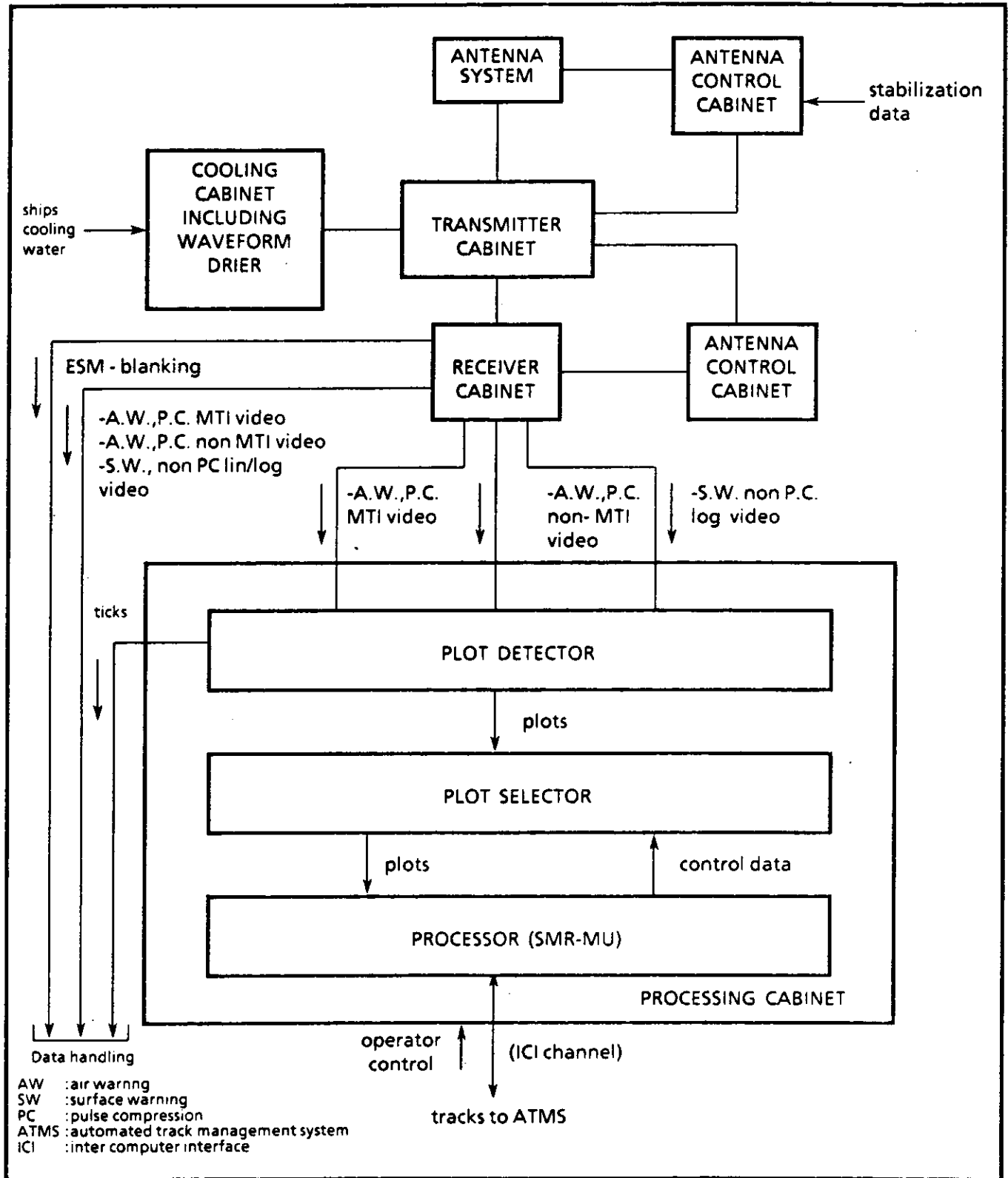


Figure 7 DA08 Medium Range Radar Functional Block Diagram

transmission periods are normally determined by the duty cycle of the radar. In the "sector scan" mode, radar silence occurs within an azimuth sector of which the direction can be set from 0°- 360° steps of 1° and sectors within steps of 10°. Transmitter interruption for the sector scan mode is obtained by ground pulse blocking of the TWT. The R.F. frequency modes can be selected in each transmission mode. These frequency modes are: fixed frequency mode, pseudo frequency jumping mode, and random frequency jumping mode. The output stage of the transmitter is a F-band TWT with a peak power of approximately 145 kw and a mean power of approximately 3.8 kw. The transmitter is connected to the waveguide system via a circulator to provide sufficient isolation and optimum matching. The waveguide system inside the transmitter cabinet is provided with a waveguide switch with dummy load to perform measurements under high voltage, without energy radiation. The transmitter cabinet, the TWT, the high voltage power supply, and the circulator with load are water-cooled. The cooling unit comprises various components. The cooling is by means of a water-to-water heat exchanger to the ship's water supply.

4.3.2.4 Receiver cabinet. - The input signal to the transmitter is generated in a frequency synthesizer as part of an FCU housed in the receiver cabinet. The FCU also generates the local oscillator signals for the receiver and reference signal for the MTI, and supplies the synchronization signals. The video processor, following the receiver, handles the combination and distribution of video signals to the users. The receiver output signals are inputs for the processing system. The extractor processor consists of a video extractor and a dedicated processor. The extractor is capable of detection and position determination of air and surface targets in the whole radar coverage. The processor transfers air and surface TRACKS to the ATMS via an inter computer interface (ICI). The operator can select certain areas of interest for transfer to the ATMS.

4.3.2.5 Remote control unit. - The MRR can be remotely controlled by means of the RCU. Local control is also possible with a LCP on the transmitter cabinet. Besides the operational control facilities on the RCU, a monitoring function is available. This function includes a number of indication lamps indicating a failure of one of the cabinets. A detailed failure indication per cabinet can be found on the cabinet itself.

4.3.3 Automated Track Management System. - The ATMS processor (Figure 8) accepts tracks from the LW08/2LS and the DA08/2LS as well as contact reports from the associated IFF equipment. The ATMS provides the function of correlation of the radar tracks, where the coverage of the radars provide overlap, and uses the IFF data for automatic confirmation of the tracks. The confirmed and correlated track data is output to the Command and Control System (CCS) for establishing a track file, threat evaluation, and weapon assignment. This is achieved within a single cabinet which contains two identical video extractors and a track plot combiner as follows:

4.3.3.1 Video extractors. - The video extractors, located in the ATMS cabinet, serve the LRR and MRR respectively and each is capable of detecting and selecting both air and surface tracks within the total envelope of radar coverage. Processing within each video extractor is carried out by an SMR-MU general purpose computer.

4.3.3.2 Track plot combiner. - The track plot combiner functions are implemented in software which is executed by an SMR-MU computer. These functions are the correlation and combination of radar track data and IFF target data and the subsequent interface of this data to the CCS.

4.3.3.3 Upper panel. - The upper panel of the ATMS cabinet provides control of power supplies, basic system switching, and system status/failure indications. A Remote Control Panel (RCP) is also provided for testing and maintenance of the SMR-MU processors.

4.3.3.4 Front panel. - The front panel of each extractor and the track plot combiner have plug-in facilities for maintenance testing using the Remote Control Panel and interface equipment.

4.4 Fire Control System (FCS). - The FCS provides for the acquisition and tracking of air and surface targets as well as fire control for the Standard (SM2 Block II) Missile and the 76/62 SRGM. It provides a horizon surveillance mode to supplement

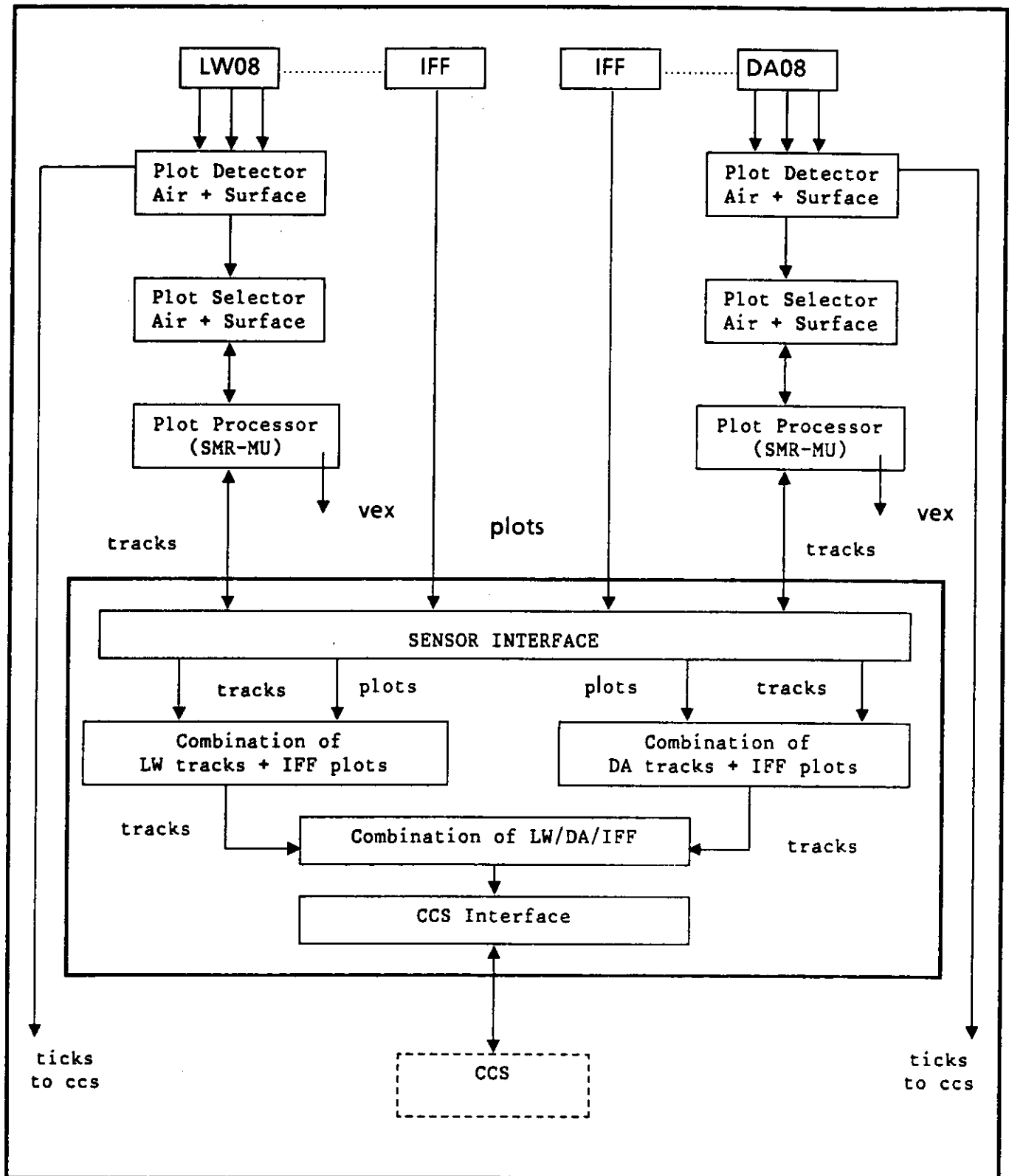


Figure 8 Automated Track Management System Block Diagram

the radar system against "pop-up" targets and in ECM environments. The FCS consists of the following:

- a. Two Signal Tracking/Illuminating Radars (STIR)
- b. Lightweight Radar/Optronic Director(LIROD) System
- c. Two Continuous Wave Illuminators (CWI) transmitters
- d. WDS MK 14(V) Weapon Direction System (WDS)
- e. Weapon Interface Cabinet (WIC)
- f. Control Consoles for the LIROD and each of the STIR radars.

4.4.1 STIR System description. - The dual STIR configuration (Figure 9) provides target illumination and tracking for gun and missile direction. The system is capable of simultaneous, independent engagement of two air or surface targets. The main elements in the system are two identical directors. The above deck tracking equipment on each director consists of a cassegrain antenna, I-band monopulse receiver and a TV camera. The camera is remotely controlled from the STIR Control Console (SCC). The TV camera is equipped with a zoom lens and is used for target observation and 'kill assessment'.

Below deck tracking equipment consists of two Tracker Control Cabinets (TCC) and two Transmitter Cabinets. The transmitter cabinets house the I-band TWT and associated High Voltage (HV) circuitry. Synthesized RF drive for the TWT is generated by a Frequency Control Unit (FCU) which is housed in the TCC. High power RF energy is routed to the director or a Dummy Load via a Waveguide Switch. Operation of the Waveguide Switch interrupts the transmitter HV circuit. A self contained cooling unit in the transmitter supplies coolant to the TWT, circulator, load and HV components.

The TCC contains the FCU, Power Supplies, Multi-Task Tracker Unit (MTTU) and the Sensor Computer. The FCU supplies the local oscillator signals and radar system clock pulses. The MTTU uses a Fast Fourier Transformation technique to process the tracking and acquisition video. The sensor computer, SMR-MU, functions include track filtering, director servo control and range gate positioning for the MTTU. The computer software incorporates the system proving program and operational programs.

The SCC is the central operator control point for the FCS. It provides remote control of all the system elements and manual intervention of system and weapon

functions, e.g. Track/Acquisition process and gun firing. The SCC has a 15" monitor which displays TV video, radar video and alphanumeric data. The monitor has a lightpen which initiates system switching and controls the various modes of operation of the FCS.

The remaining elements of the STIR system are the Weapon Interface Cabinet (WIC) which is the primary gun interface medium, two maintenance switches for 'man aloft' safety, and a monitor typewriter for on-line data transfer. The principal functions of the system are:

- a. Data exchange. - The CCS provides the remote target designation and weapon assignments.
- b. Display. - The display of TV, radar and synthetic information on the monitors and indicators of the control console is represented by the Display Functional Block Diagram (Figure 10).
- c. Tracking. - Air or surface target tracking depends on the CCS for detection, identification, evaluation and designation. On receipt of this data, target acquisition is initiated.
- d. Weapon control. - Weapon Control (Figure 11) is achieved by software resident in the Weapon Direction System and Weapon Interface Cabinet. The WDS software, controlled by the CCS, provides for target engageability computations, missile initialization and in-flight commands. The Weapon Interface Cabinet software, resident in the SMR-MU processor, provides gun control calculations for air and surface engagements.
- e. System monitoring. - On-line monitoring includes test functions and failure indications.
- f. Testing. - Static and dynamic testing is an operator controlled function which is initiated when the system is in standby mode. Results are displayed on the selected control console.
- g. Automatic calibration. - A built-in facility for automatic calibration of the monopulse receiving system is provided.

All functions are monitored by the STIR/LIROD CONTROL CONSOLES (SCC/LCC) and are available to the operators.

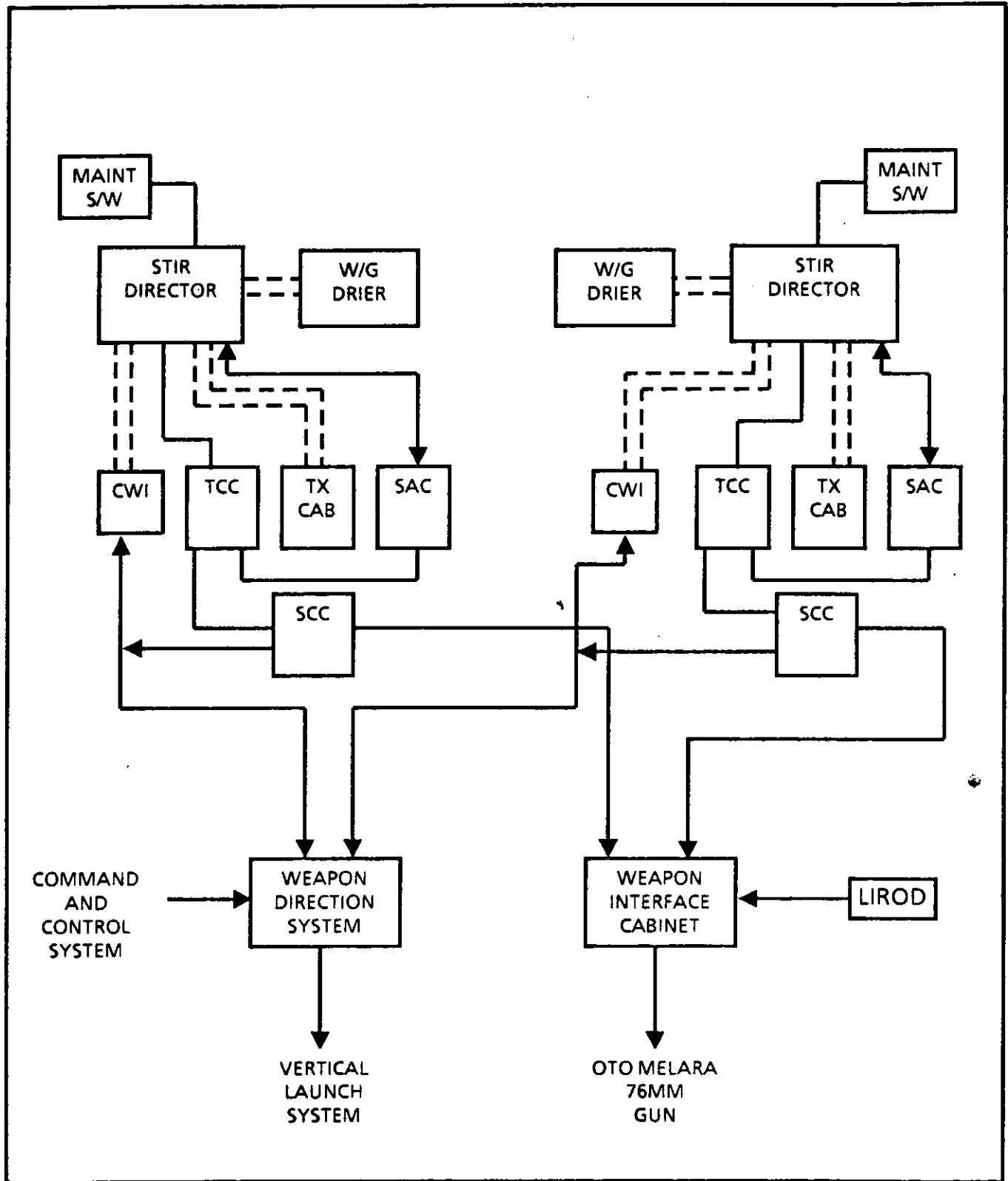


Figure 9 DUAL STIR Block Diagram

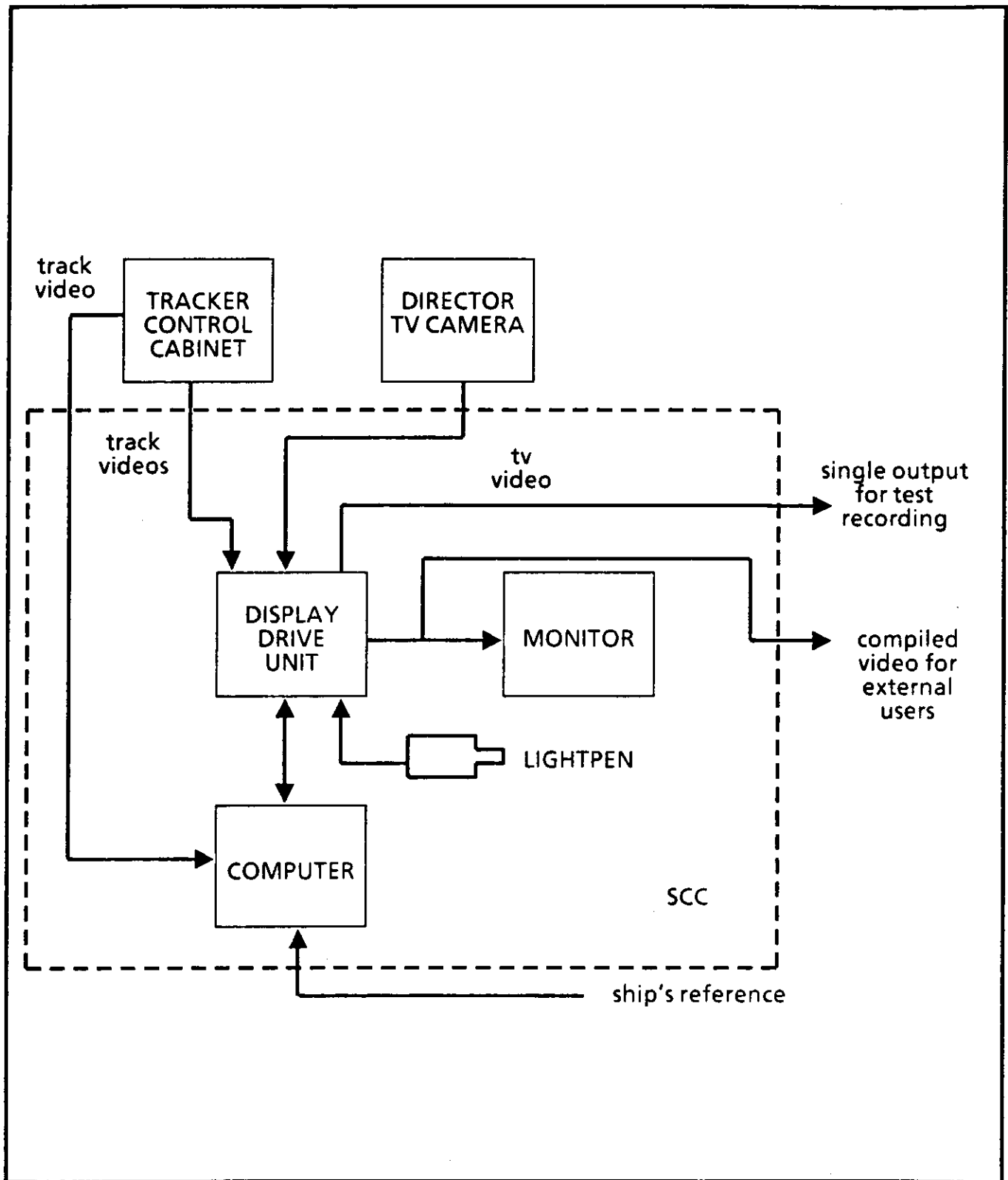


Figure 10 Display Functional Block Diagram

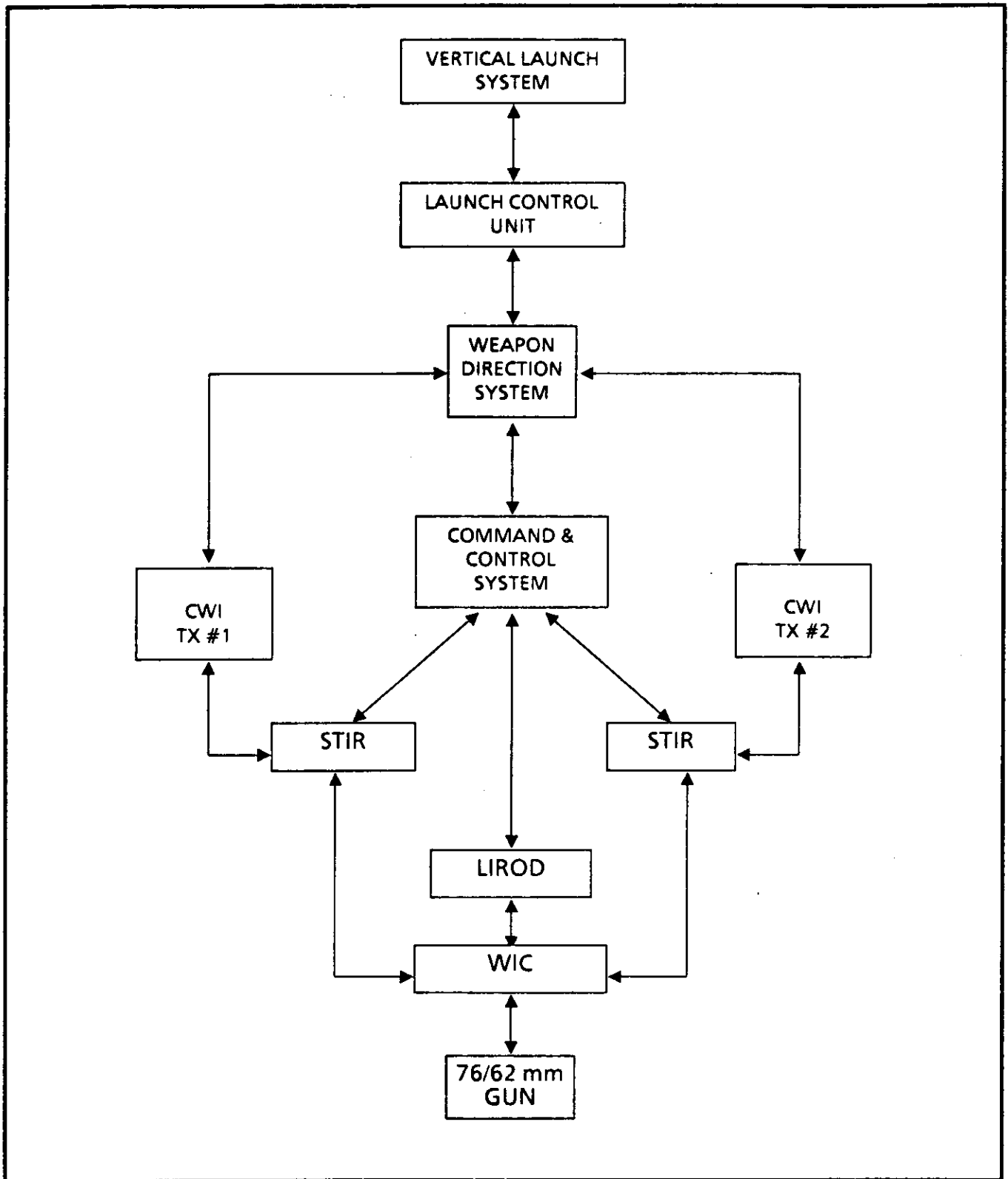


Figure 11 Weapon Control Functional Block Diagram

4.4.1.1 STIR maintenance characteristics. - The STIR system has been designed for minimum maintenance and maximum operational availability. Generally maintenance is assisted by equipment status displays, BITE and diagnostic software. The BITE incorporated in the system is:

- a. diagnostic self test of the processors
- b. on-line parity check of the memories of each processor
- c. on-line monitoring of the main system functions by means of special hardware features (e.g. loop tests, status requests, timing tests) and a background test in the operational program.

4.4.1.2 STIR maintenance test tools. - A test package will be used consisting of:

- a. remote control panel (RCP)
- b. processor control panel (PCP)
- c. interface control panel (ICP)
- d. monitor typewriter (part of the system)
- e. computer test program for confidence testing and troubleshooting.

4.4.2 LIROD system description. - The LIROD (Figure 12) is the primary Fire Control Radar for the 76/62mm Gun. The LIROD is a high accuracy, monopulse/pulse doppler radar and TV tracking director, capable of single target engagement in an autonomous mode or integrated within the overall TRUMP system. The main functions of the system are:

- a. display TV video, track radar video and alphanumeric information
- b. target acquisition (self detected or designated by CCS)
- c. engageability calculations for air and surface targets.

A computer interface within the LIROD system provides a flexible data exchange with the CCS. The LIROD will accept target designation, weapon assignment and fire commands from the CCS and will output director bearing, elevation, track position and velocity data to the CCS. The LIROD has a separate access to the gun interface. Above deck equipment include the director pedestal carrying the 8mm radar, TV camera, bearing and elevation drive motors as well as associated servo amplifiers.

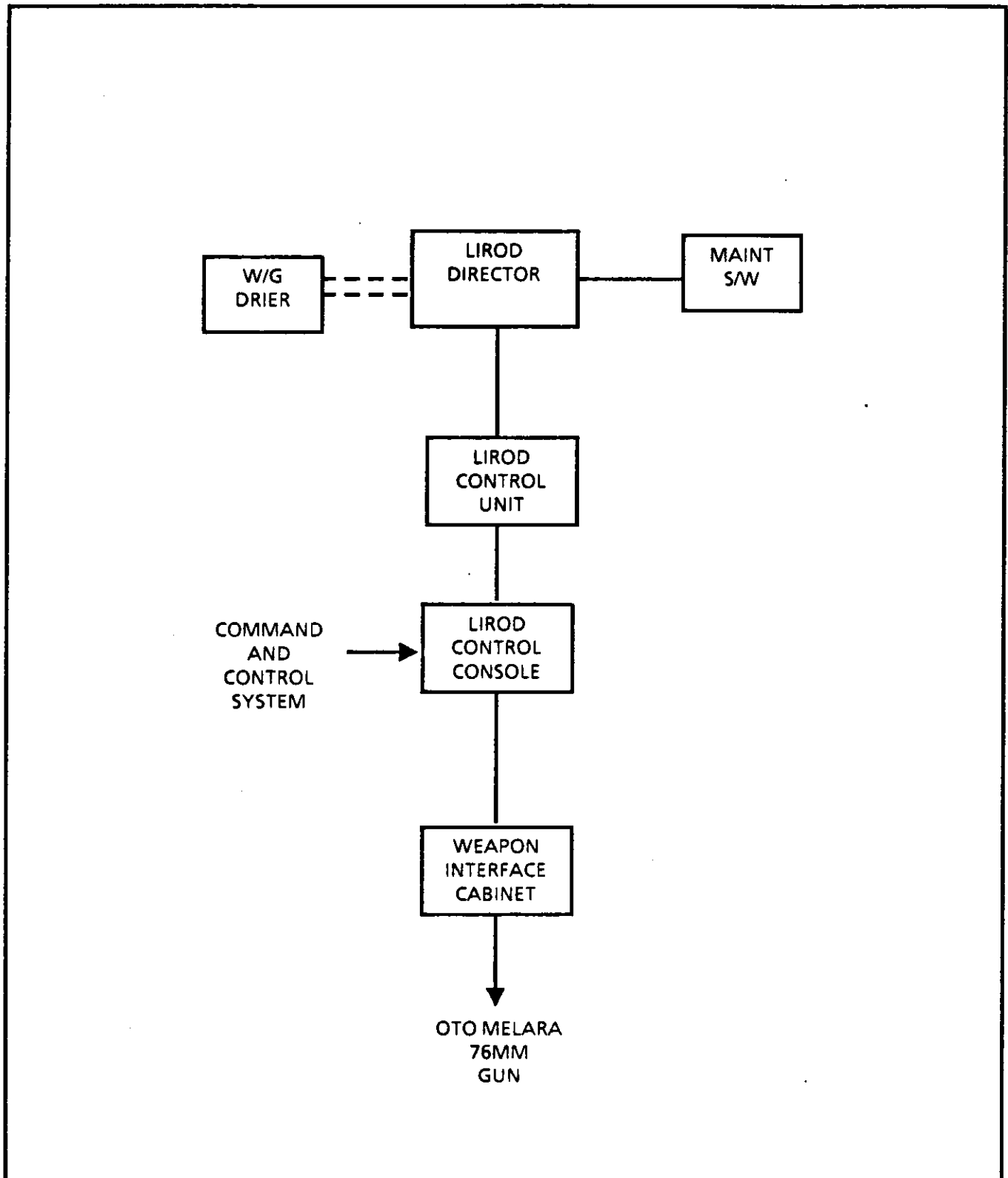


Figure 12 LIROD Fire Control System Block Diagram

A maintenance switch is provided which will de-energise the radar and disable the servo drives for maintenance purposes. A waveguide drier is incorporated within the system in order to keep the waveguide dry and free from potential corrosion. Below deck equipment consists of the LIROD Control Unit (LCU) and LIROD Control Console (LCC). The LCU is the link between the computer and the track radar. The LCU contains the antenna scanning control circuits and the Radar Track Unit (RTU). The LCC contains the SMR-MU computer, peripherals and the system control panels. The LCC monitor has a lightpen for control of system functions. The TV track unit provides TV video for angular tracking, picture generation and compilation. The interface section of the LCC provides the connection between the SMR-MU computer and pedestal drives and, where required, performs A/D and D/A conversions of system signals.

System status and failure indications are located on the Technical Control Panel of the LCC and the LIROD system may be activated or deactivated from this position.

4.4.2.1 LIROD maintenance characteristics. - BITE is provided for the LIROD system as a maintenance aid. The test equipment and programs are designed to allow fault isolation to LRU level. System fault and status indications are displayed at the Technical Control panel of the LCC. Diagnostic and self test software are controlled from the LCC and consist of the following:

- a. System Operability Test (SOT) - 'static on-line' tests, parity checks and processor self tests.
- b. Quick Operability Test (QOT) - dynamic test for the operator to check the operational availability.

4.4.3 Continuous Wave Illuminator system description. - Each CWI is physically connected to a STIR antenna system via waveguide to provide uplink commands and terminal homing illumination for the SM2 Block II missile. The Continuous Wave Illuminator (CWI) is a subsystem of the FCS and consists of four major components (Figure 13):

- a. radar transmitter
- b. control power supply
- c. cooling

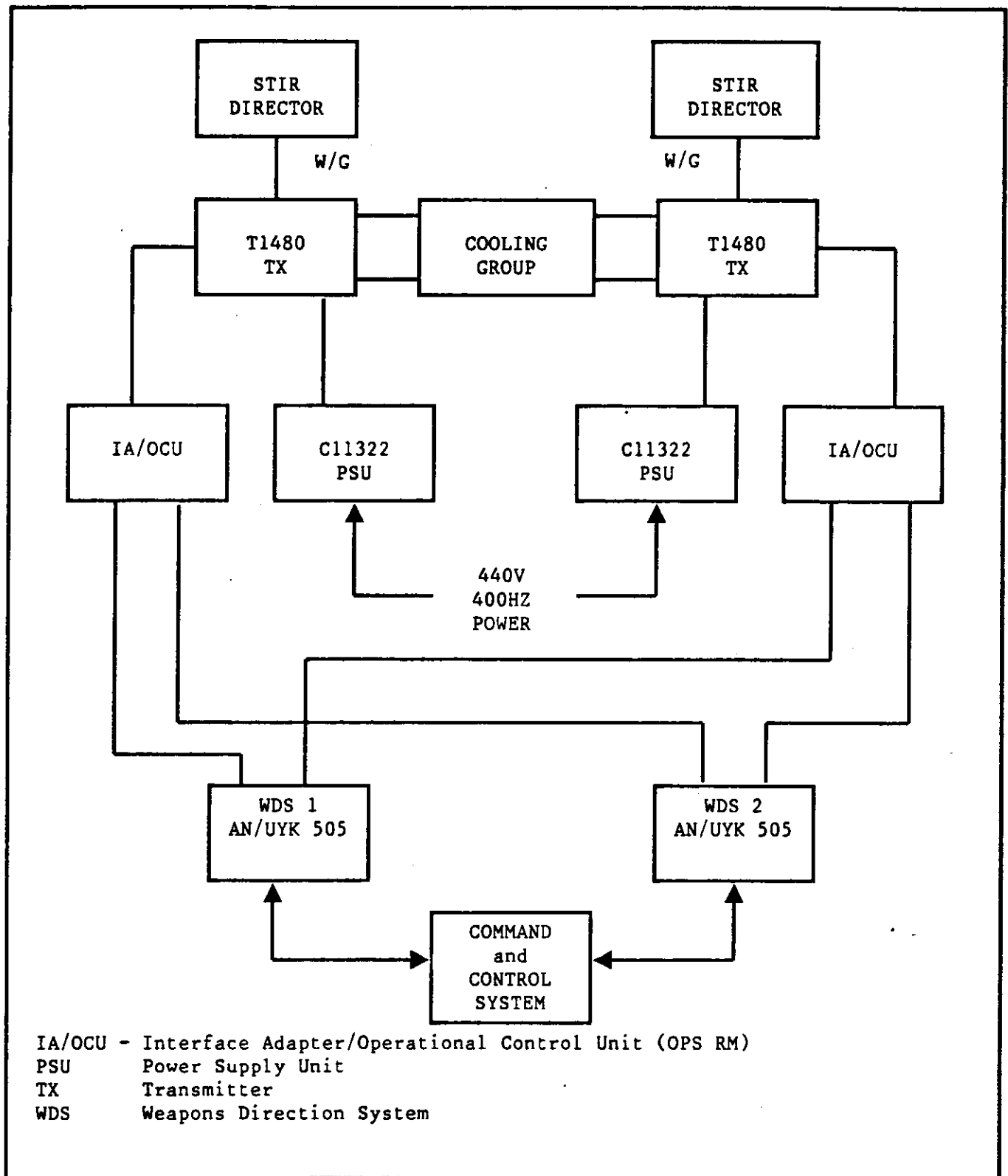


Figure 13 CWI System Block Diagram

d. remote control unit.

The CWI generates and radiates J band energy for semi-active homing by the SM 2 missile. A nominal 50 percent of the rf energy is radiated in a narrow beam for target illumination and a nominal 50 percent is radiated in a broader beam for uplink information to the missile. CWI radiation is initiated and terminated by commands from the CWI Remote Control Panel and Weapon Direction System. The CWI transmitter is basically a three state transmitter consisting of an rf oscillator, multiplier and power amplifier. The oscillator and multiplier are contained in the same assembly. Provision of low voltage DC and monitoring performance and protection are included in the transmitter. The Control Power Supply provides high voltage (-15KVDC) and 115VAC 400Hz to the transmitter.

The CWI-CV 134 will be a modified version of the USN OT-17D system with frequency modulation of the RF oscillator, cooling and power requirements not changing significantly.

4.4.4 Weapon Direction System (WDS).-- The WDS MK 14(V) consists of a computer program residing in two AN/UYK-505 processors to provide the following functions:

- a. Compute target engageability for the SM2 Block II missile
- b. Compute missile firing time
- c. Provide SM2 Block II initialization commands to VLS MK 41
- d. Interface with the CWI transmitter for control of the CWI and generate signals as required for an uplink to the SM2 Block II missile in flight.

4.4.5 Weapon Interface Cabinet (WIC).-- The WIC will provide all necessary interface signals between the FCS and the 76/62 SRGM. The program, to be resident in one SMR-MU computer, converts target track data from the LIROD or assigned STIR 18 director and generates a fire control solution and all appropriate gun control commands. The WIC will also pass gun status reports back to the FCS. The LIROD is the primary gun fire control radar and the gun panel is located on the LIROD console.

4.4.6 Control Console.-- Each STIR 18 will have associated with it a control console, which includes a TV monitor with a light pen. The TV monitor allows for

initialization and switching between various modes of operation using the light pen. The functions to be performed at the control console are as follows:

- a. Remote control of the STIR director, transmitter, Supply and Amplifier Cabinet and Weapon Interface Cabinet
- b. Monitoring of STIR equipment status
- c. Monitoring of the automatic acquisition and tracking process (allowing for manual intervention if necessary)
- d. 76/62 SRGM status monitoring and control
- e. Data input and display for pre-action gunfire and correction, kill assessment and splash spotting.

4.5 Surface-to-Air Missile System (SAMS). - The SAMS will serve as the primary anti-air and anti-surface weapon system for TRUMP. It consists of the MK 41 Vertical Launching System (VLS) and the Standard Missile 2 Block II (SM2 Block II).

4.5.1 MK 41 Vertical Launch System (VLS). - The MK 41 MOD (T) Vertical Launch System (VLS) (Figure 14) is a general purpose launching system comprised of four integrated modules which provides the capability for the storage, launching and strikedown of up to 29 SM2 Block II, Medium Range, Standard Missiles. The system design and architecture of the MK 41 VLS has produced a launcher characterized by safety, modularity, reliability and multiple warfare capability which permits rapid missile launching into a 360 degree hemispherical volume. At the same time, the simplicity of the MK 41 design drastically reduces the manning required for maintenance. The principle elements of the VLS are:

- a. single MK 159 MOD 0 29 cell vertical launcher consisting of:
 - i 1 system module (8 cell)
 - ii 2 standard modules (8 cell)
 - iii 1 strikedown module (5 cell)
- b. 2 launch control units with supporting components
- c. 1 status panel
- d. 1 remote launch enable panel
- e. 29 canister adapter assemblies
- f. 29 plenum cell covers

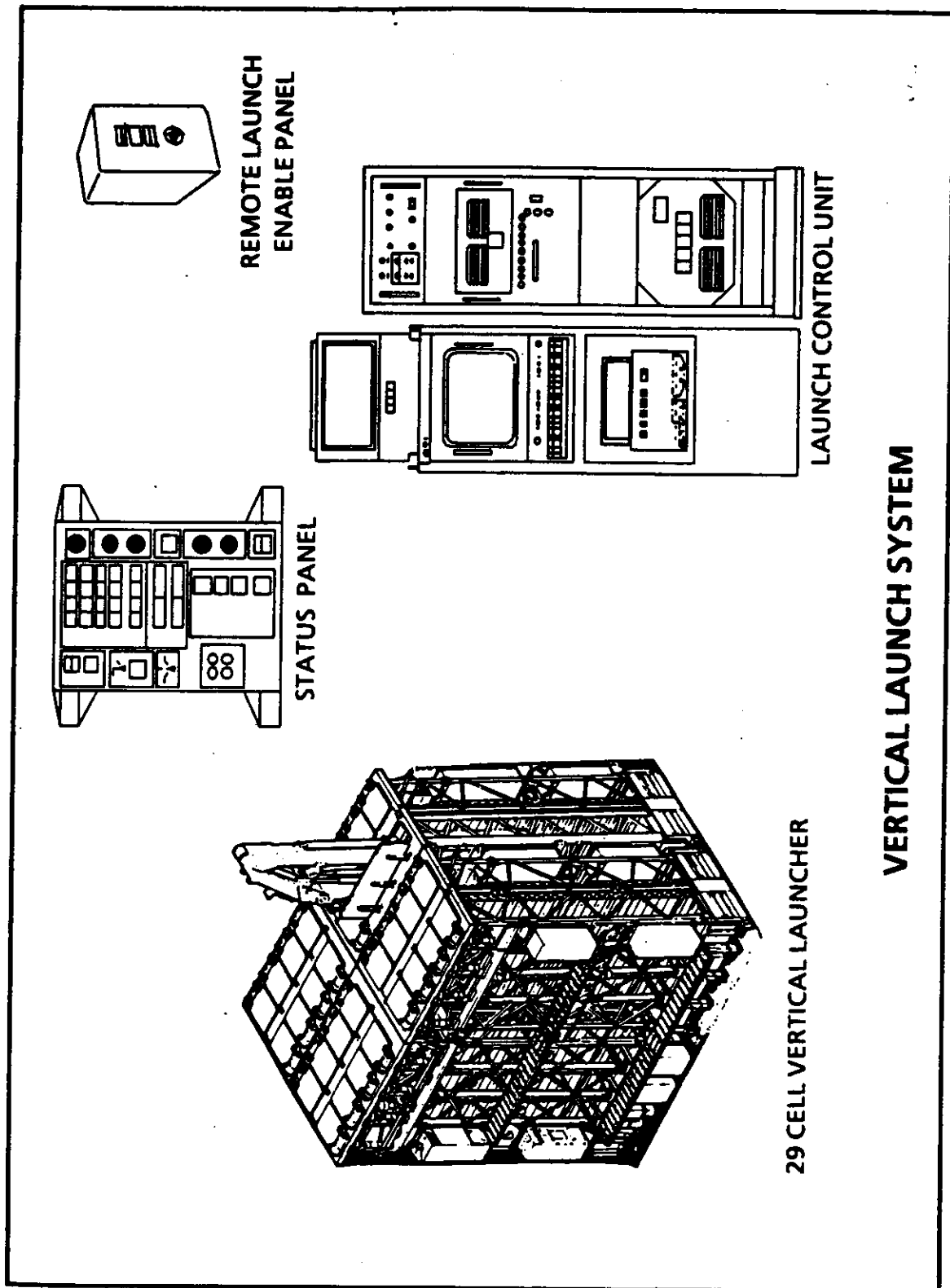


Figure 14 Vertical Launch System

- g. 1 training canister
- h. 1 set of packaging, handling, storage and transportation (PHST) equipment.

The VLS will be a major subsystem of the Tribal Class Destroyer surface and air weapons system (SAWS). The VLS integrates directly with the MK 14V Weapon Direction System (WDS) which in turn receives targeting information from the Fire Control Radar System (FCRS) and the Continuous Wave Illuminator (CWI). The WDS interfaces directly with the VLS to integrate the VLS launcher capabilities into the SAWS (Figure 15).

4.5.1.1 Launch Control System (LCS). - The Launch Control System (LCS) manages VLS operations including ordering the VLS to select, prepare, support and launch missiles. The VLS LCS consists of:

- a. 2 Launch Control Units (LCUs) comprised of:
 - i 1 Data Processing Set (DPS) (AN/UYK 505)
 - ii 1 signal data recorder/reproducer set [AN/USH-26(V)]
- b. Data Terminal Group (DTG) (shared with the WDS) comprised of:
 - i 1 data terminal set [AN/USQ-69(V)]
 - ii 1 high speed printer (HSP 3609-212A)
 - iii 1 multiplexer (TD 1332/UYK)
- c. 1 1024 Hz clock
- d. 1 status panel
- e. 1 remote launch enable panel
- h. 1 Launch Sequencer (LSEQ) per module
- j. 1 motor control panel per module
- k. 2 power supplies per module
- l. 1 power distribution system.

The LCUs provide the interface between the VLS and the FCS via the WDS. The LCU interfaces with the Launch Sequencer (LSEQ) to provide mode control and launch sequence for the missile while receiving VLS equipment and missile status reports from the LSEQ. Each LCU has the capability of interfacing with up to 16 LSEQs, another LCU and the WDS. The LCU is basically a slaved unit operating totally in response to digitally coded command signals. Once the unit is powered-up and

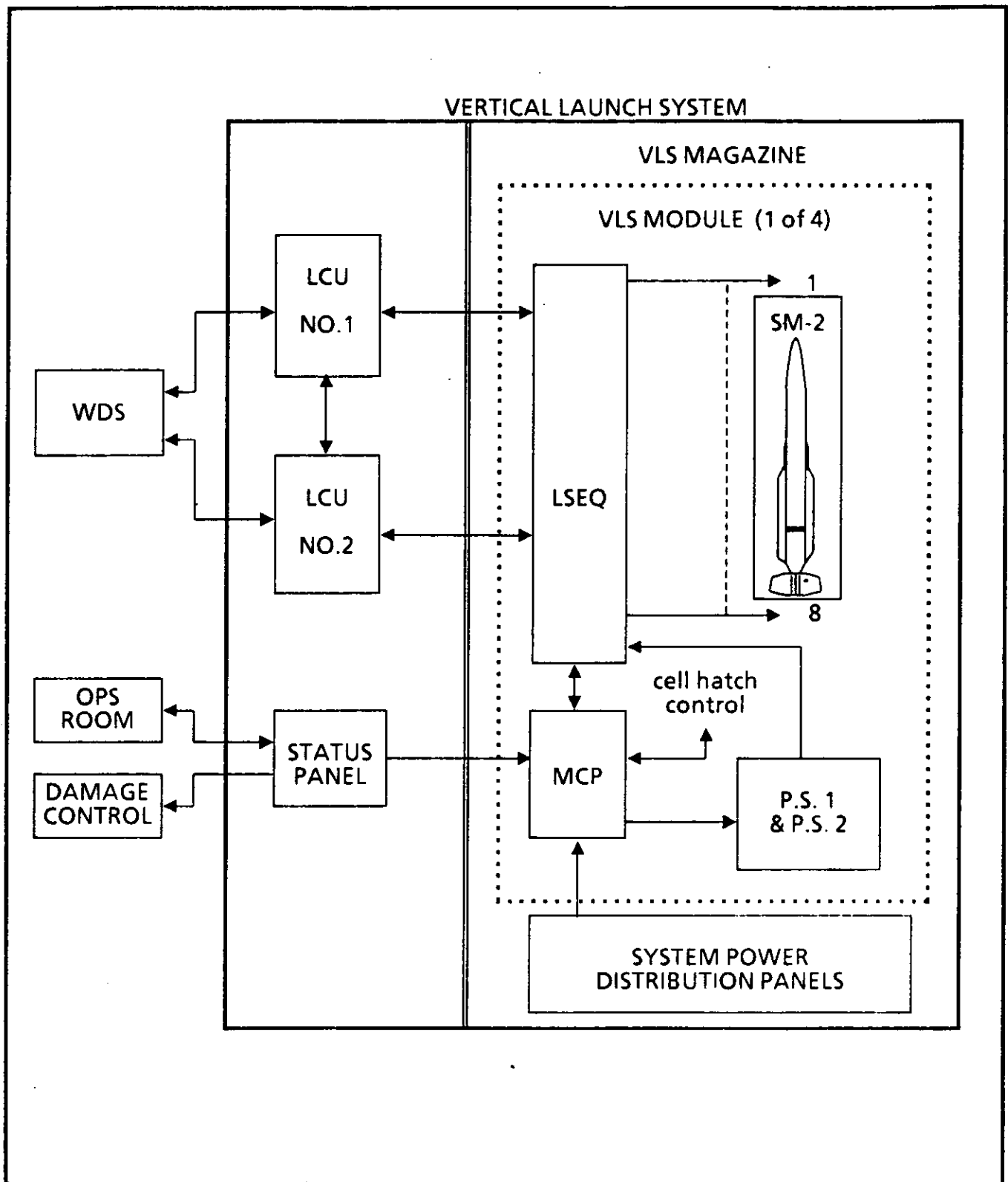


Figure 15 VLS Block Diagram

initialized with all of its required program data, the unit functions totally without operator interaction. Under normal operating conditions using the dual LCU configuration, only one LCU has primary responsibility for receiving messages from or transmitting messages to the WDS.

4.5.1.2 Status Panel. - The Status Panel (SP) provides continuous display of the module status and launcher hazards on front panel indicators. The SP also reports launcher hazards to the Damage Control Centre. Within the SP are circuit cards, relay assemblies and power supply assemblies. These assemblies provide the logic circuitry necessary for detecting the status of the damage control sensors and provide a visual indication when any of the sensors are activated. The indicators associated with the hazard sensors and malfunction detectors are grouped together on the front panel and are labelled Magazine Hazard and Module Status. The interface signals between the SP and the Command and Control System (CCS) are the status of launch enable, magazine power and local/remote. The signals from CCS to the SP include remote launch enable and remote magazine launch power. The SP responds to input signals from the CCS only when the Local/Remote key-switch is in the Remote position.

4.5.1.3 System Module. - The 8 Cell System Module (Figure 16 and 16A) is composed of the following:

- a. interim structure comprised of:
 - i deck structure
 - ii intermediate structure
 - iii base structure
- b. 1 60 Hz power distribution panel (PDP, A13)
- c. 1 400 Hz power distribution panel (PDP, A14)
- d. 1 launch sequencer (LSEQ, A10)
- e. 1 motor control panel (MCP, A11)
- f. 2 power supplies (PS1 (A27) and PS2 (A28))
- g. 1 anti-icing panel (AIP, A12)
- h. 1 system transformer platform (STP, A26)
- j. 1 module transformer platform (MTP, A16)
- k. 1 system lighting junction box (SLJB, A18)

- m. 1 module lighting junction box assembly (MLJB, A17)
- n. 1 damage control junction box assembly (DCJB, A15).

The System Module contains the equipment required to monitor and sequence the launch of up to eight missiles. The LSEQ maintains an NTDS slow serial data link with the LCU and performs command decoding and data processing functions through a series of microprocessors. The LSEQ provides decoded commands to the MCP and formatted data to the missiles. Responses are received from the MCP and missiles, formatted and sent to the LCU. The MCP controls power distribution within the module, the hatch motors, and plenum drain motors. The anti-icing system prevents the cell and uptake hatches from icing. The plenum drain assembly contains two switches (high water and excessive water) and a plenum drain valve. The module power supplies receive input power from the MCP and provide the required DC voltages for the missile via the LSEQ. The hatch motors are controlled by the LSEQ via the MCP and provide the electro/mechanical means of opening/closing cell and uptake hatches. The DCJB is the interface between the SP, launcher hazard sensors and the MCP. The 60 Hz and 400 Hz PDP's supply the required VLS voltages. The system transformer changes 440V 60 Hz input to 115V 60 Hz for normal transformed power to the 60 Hz PDP. The module transformer platform changes 440Vac input power to 115Vac and 290Vac power. The SLJB and MLJB provide the necessary electrical power and telephone communications required to perform maintenance on the module.

4.5.1.4 Standard Module. - The 8 cell standard module (A6 and A8) (Figure 16) is composed of the following:

- a. interim structure
- b. 1 launch sequencer (LSEQ, A10)
- c. 1 motor control panel (MCP, A11)
- d. 2 power supplies (PS1 (A27) and PS2 (A28))
- e. 1 anti-icing panel (AIP, A12)
- f. 1 module transformer platform (MTP, A16)
- g. 1 module lighting junction box assembly (MLJB, A17).

The Standard Module units function as described in paragraph 4.5.1.3.

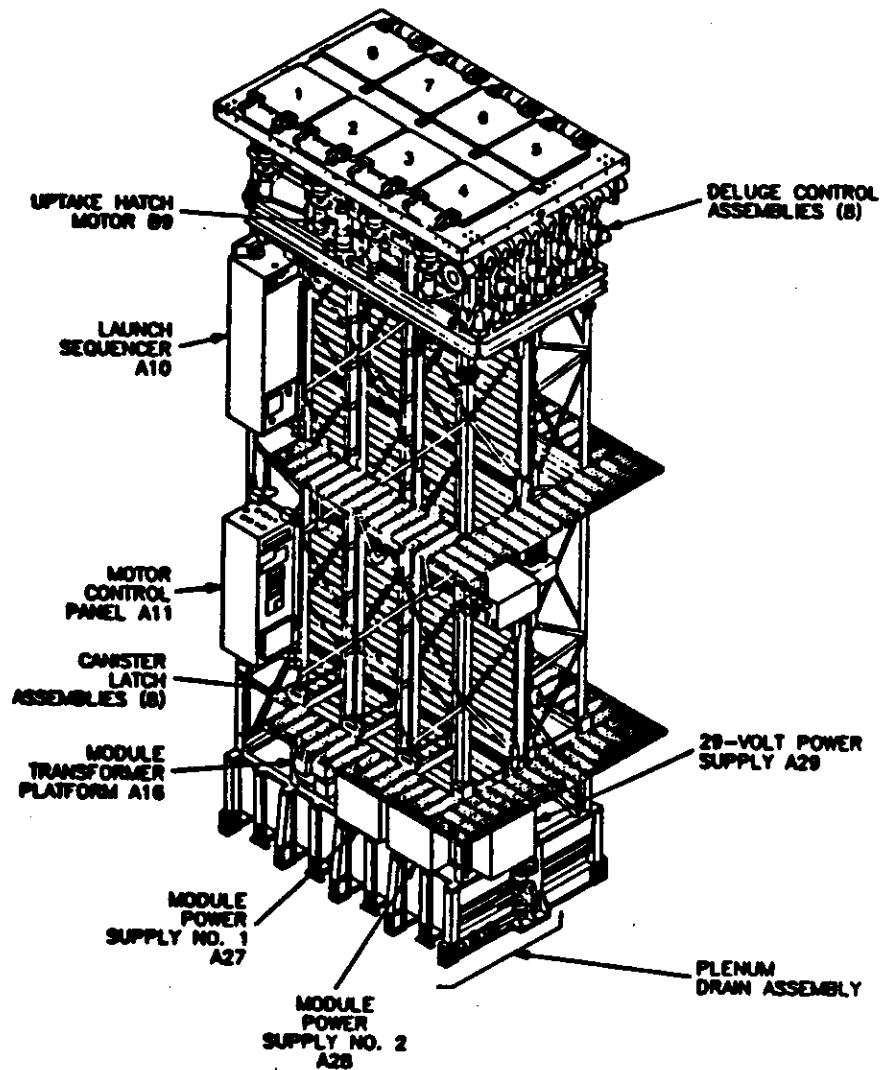


Figure 16 VLS 8-Cell System/Standard Module

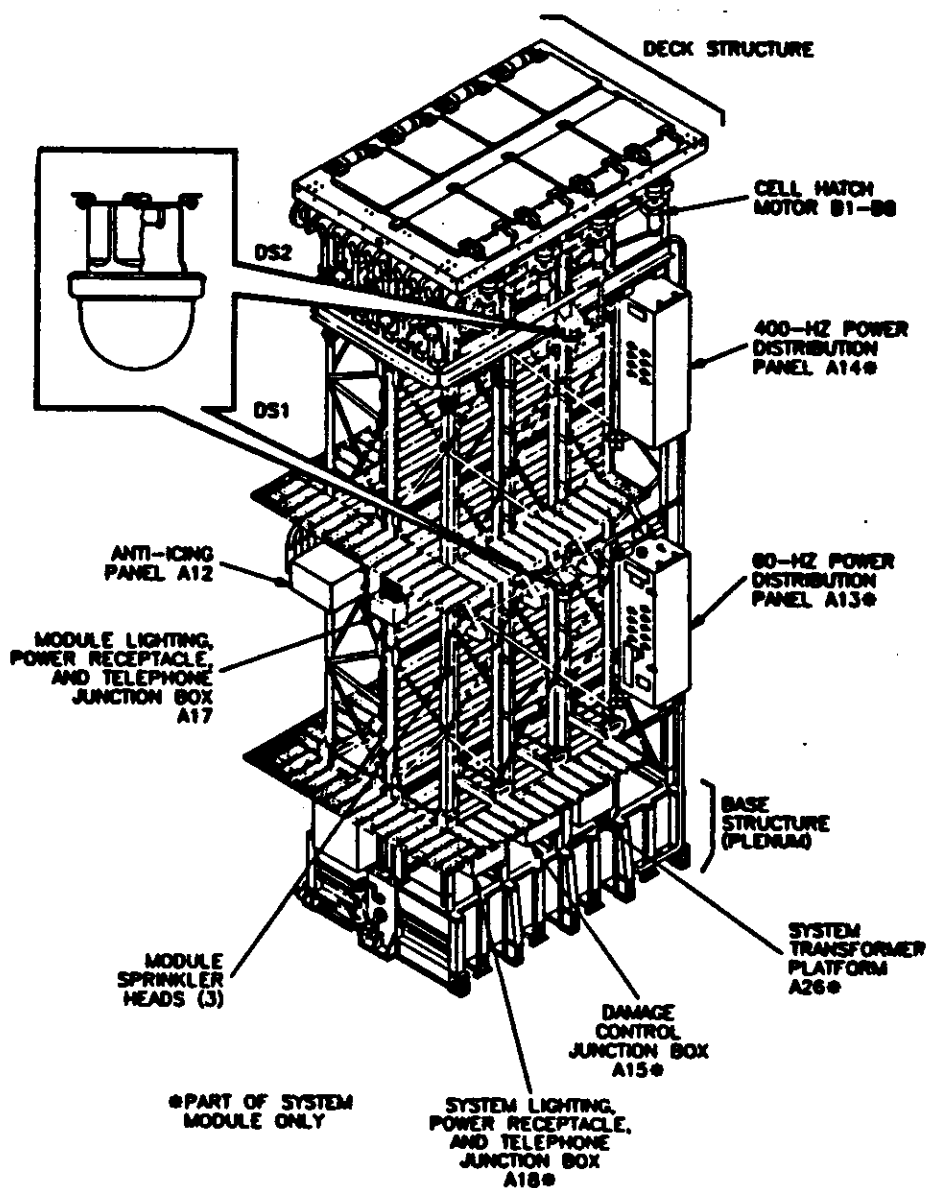


Figure 16A VLS 8-Cell System/Standard Module

4.5.1.5 Strikedown Module. - The 5 cell strikedown module (A5) (Figure 17 and 17A) is composed of the following:

- a. 5 cell interim structure
- b. 1 launch sequencer (LSEQ, A10)
- c. 1 motor control panel (MCP, A11)
- d. 2 power supplies (PS1 (A27) and PS2 (A28))
- e. 1 anti-icing panel (AIP, A12)
- f. 1 module transformer platform (MTP, A16)
- g. 1 module lighting junction box assembly (MLJB, A17)
- h. 1 strikedown VLS elevator
- j. 1 strikedown VLS crane
- k. 1 power distribution panel
- l. 1 elevator control panel.

Only five missile cells are provided. The space used in the 8 cell System and Standard Modules for an additional three missile cells is occupied by the strikedown crane, elevator and related equipment. Functioning of the units in the 5 cell module is as described for the 8 cell system and standard modules in paragraphs 4.5.1.3 and 4.5.1.4.

The strikedown crane's primary functions are to remove and install canisters. When not in an operating mode, the strikedown crane is knuckled and stored below deck. The crane is hydraulically powered from a hydraulic power supply located on the strikedown elevator assembly and controlled by 5 directional control levers. The levers are used to train (rotate) the crane mast, raise and lower the inner boom, raise and lower the outer boom, extend and retract the boom extensions and raise and lower the whip hook. The elevator assembly interfaces directly with the 5 cell module which provides the structural strength for the overall strikedown assembly. The base of the crane interfaces with the elevator platform through a slew drive mechanism which is powered from a common hydraulic power supply.

4.5.2 Standard Missile 2 Block II(SM2 Block II).-

4.5.2.1 General.- The SM2 Block II missile (Figure 18) is a medium range, solid-propellant, tail controlled surface-to-air missile (SAM) or surface-to-

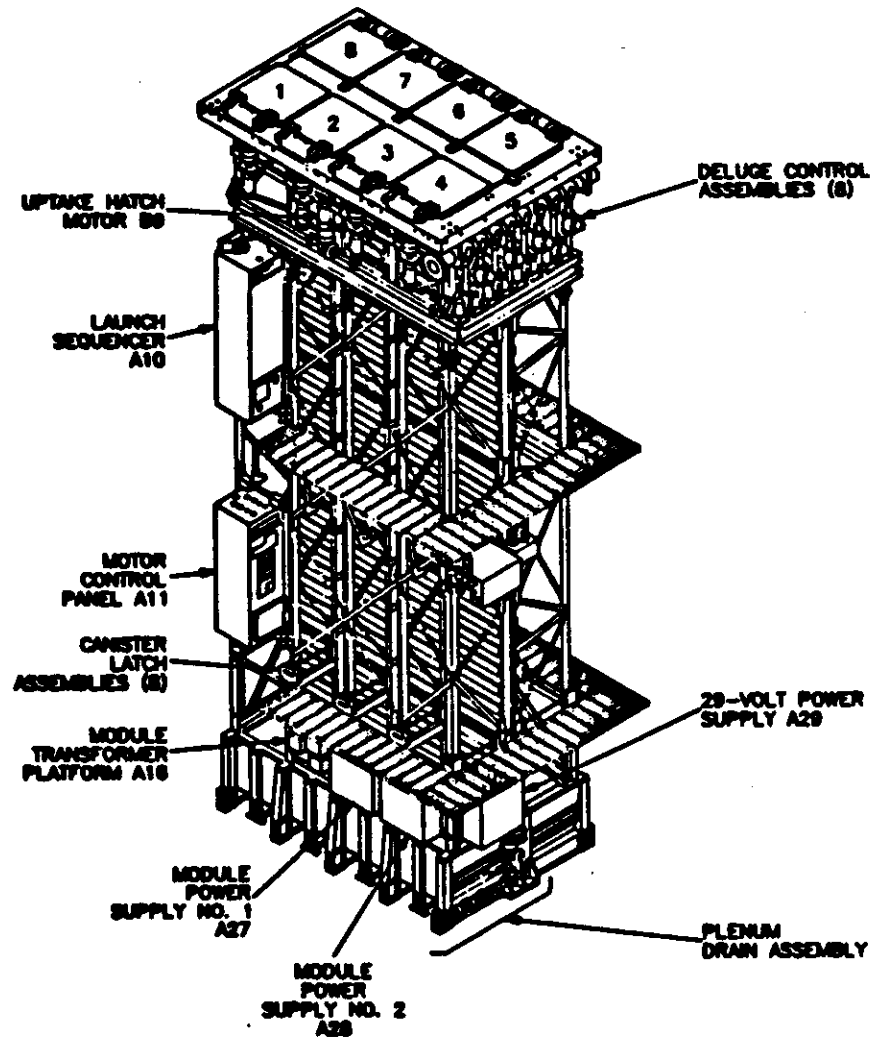


Figure 17 VLS Strikedown Module

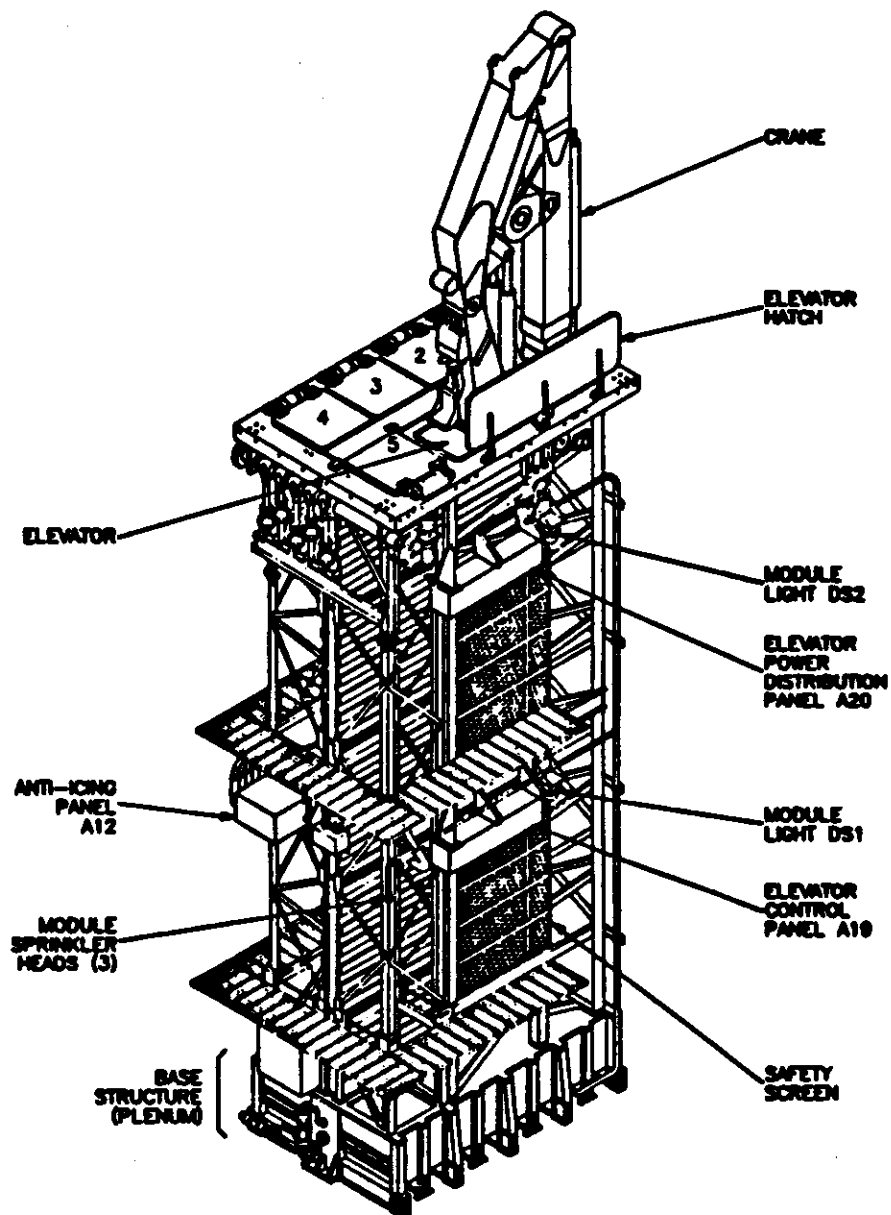


Figure 17A VLS Strikedown Module

surface missile (SSM), comprising the following major components: guidance section, ordnance section, autopilot/battery section, propulsion section and steering control section. The trajectory of the missile from the ship to the target can be described as a culmination of five phases, those being the Initialization, Boost, Midcourse, Homing and Endgame Phases.

4.5.2.2 Initialization.— During Initialization, the missile is fed target information (e.g., position and speed) from the ship via the VLS. AAW missile parameters which need to be preset before missile launch are set during this phase.

4.5.2.3 Boost Phase.— In the Boost Phase the missile is launched into unguided flight and reaches supersonic speed. By virtue of the VLS, the missile is launched at a relatively steep angle and climbs above the target early in flight so as to better maintain available kinematic energy.

4.5.2.4 Mid-course Phase.— Following the Boost Phase comes the Midcourse Phase. In the Midcourse Phase, the missile guides itself towards a point or a succession of points in inertial space using target data derived from the Radar System. New guidance points, along with target position and velocity data, are communicated via an uplink. The missile's knowledge of its own position and speed is provided by the inertial reference unit. The inertial reference unit consists of an instrument package coupled with a special-purpose computer. The instruments include three accelerometers, two rate-integrating gyros for measuring angular motion perpendicular to the missile body, and a space-stable, single axis platform for monitoring missile roll. The computer solves the equations of motion to keep track of missile position, velocity and attitude in the inertial coordinate frame established prior to launch.

4.5.2.5 Homing Phase.—

4.5.2.5.1 In the Homing or Terminal Guidance Phase the missile uses semi-active guidance (transmitter and receiver linked but not collocated) to 'home' in on the target. This phase is necessary because midcourse guidance is not sufficiently accurate, even at short range, to consistently achieve miss distances less than the lethal radius of the warhead. The source of illumination is the

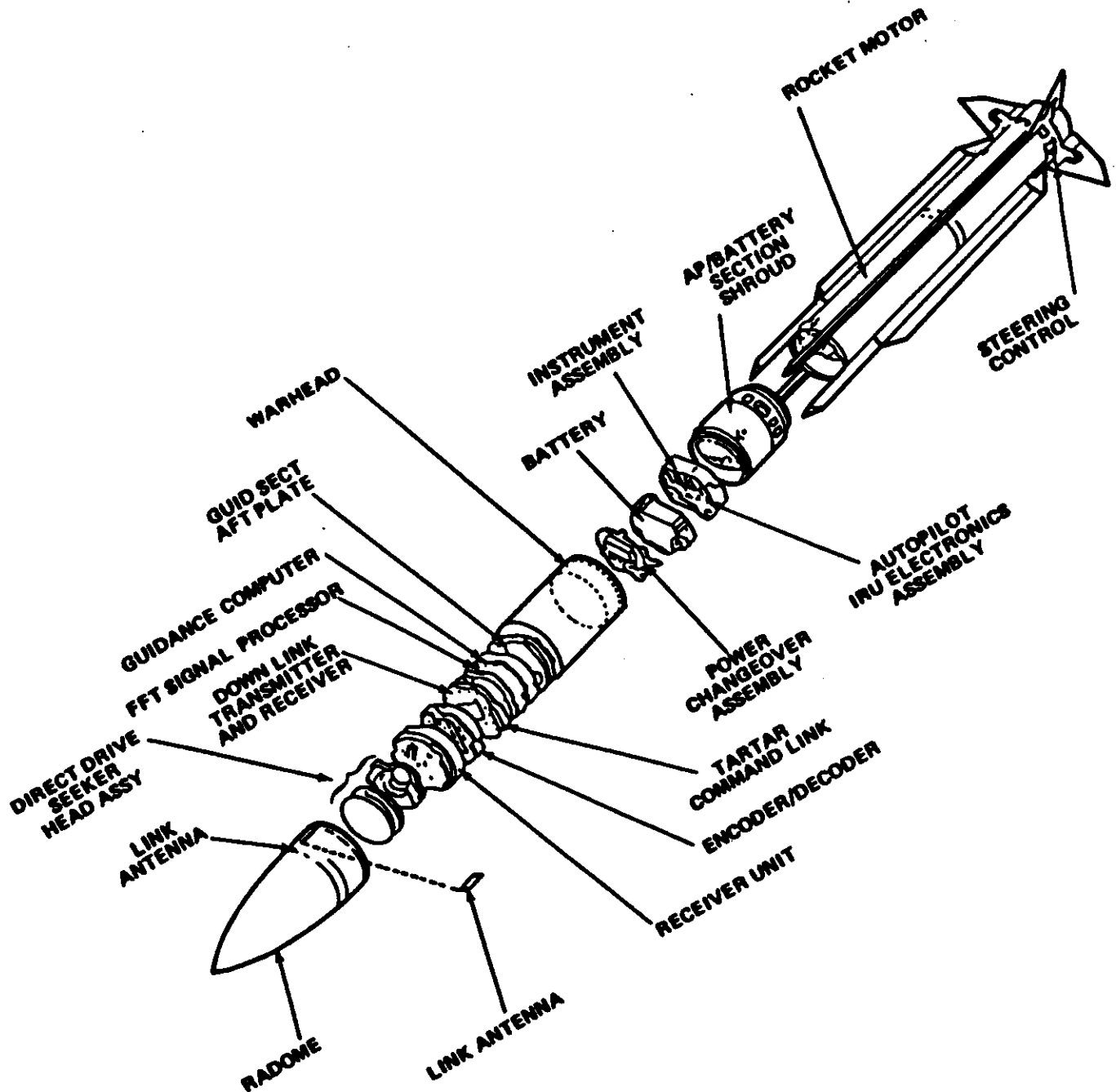


Figure 18 SM-2 Configuration Layout

Continuous Wave Illuminator radar via the STIR 1.8 director. A portion of the illuminator signal is received directly by the missile for use as a Doppler frequency reference. To accomplish this, the illuminator antenna combines a narrow beam directed toward the target with a broad reference beam that encompasses the missile throughout flight.

4.5.2.5.2 The missile is also able to home passively on electronic countermeasures signals radiated by the target. Home-on-Jam processing is automatically selected when the target skin return cannot be identified and when incoherent energy is present whose frequency and angle of arrival are approximately correct.

4.5.2.5.3 The seeker antenna receiving the signal is inertially stabilized to remove missile pitch and yaw motion. The missile receiver has two primary outputs, a line-of-sight angle measurement and a closing velocity (Doppler) measurement. The guidance computer uses these measurements to generate steering commands in accordance with a proportional navigation guidance law. This involves guiding the missile on an intercept course with the target as opposed to a pursuit course. Finally, the autopilot converts the guidance computer's electronic commands to missile tail deflections so as to alter the missile's trajectory.

The use of midcourse guidance followed by a relatively short period of terminal homing provides a significant improvement in firepower and missile intercept coverage over a Home-all-the-way method because the shipboard illuminators can be used more efficiently to engage a larger number of targets. Furthermore, the missile has a better chance of "seeing" the target in the presence of standoff jamming following a period of midcourse guidance than it would immediately after launch.

4.5.2.6 Endgame.— The Endgame is the final phase of the missile's flight and is characterized by a high-speed encounter with the target. Accurate timing of the warhead detonation is essential in this phase. When the missile and the target are close, a small radar aboard the missile (proximity fuse) senses the target's presence. A calculation is then performed to determine the optimum time to trigger

warhead detonation. If the missile collides with the target before that time, a contact fuze detonates the warhead on impact.

4.6 Gun Weapon System (GWS).- The Gun Weapon system (GWS) consists of a single OTO Melara 76/62 Super Rapid Gun Mounting (SRGM) and two Oto Melara 76 mm Lower Ammunition Hoists. The primary role of the GWS is to provide a point defense capability in the anti-air (AA) and anti-surface (SU) modes. Secondary roles include naval gunfire support (NGS) and sovereignty assertion. During normal operation, the 76/62 SRGM will be remotely controlled by the Fire Control System, with the WIC providing the functional interface. However, the mount also includes a Captain of Turret console for maintenance and stand-alone operation.

4.6.1 OTO Melara 76/62 Super Rapid Gun Mounting (SRGM).- The Oto Melara 76mm Super Rapid Gun System (76mm SRGS) (Figures 19 and 20) is a light, rapid-fire, naval, single-mount gun with dual feeding capabilities for anti-aircraft (AA) and surface (SU) roles. The gun incorporates a carriage on which the automatic feeding, loading and spent case ejection systems are arranged, together with a revolving feed magazine. The component sections constitute a single assembly and train on a single training bearing. A local stabilization unit on the gun counterbalances ship torsions. The screw feeder and associated revolving feed magazine extend below the weather deck while the carriage above is protected by a monoblock fiberglass shield. The rate of fire can be regulated and the gun barrel is provided with an automatic water cooling system to permit periods of sustained firing. When the magazine and feeding systems are completely loaded, 80 AA/AM rounds may be fired at rates up to 120 rounds per minute without intervention by the gun crew. Operation in the surface mode is semiautomatic, requiring manual loading through the feeding system. Transition from the surface mode to the automatic AA mode can be achieved in 5 seconds. The primary mode of control is remote. The train and elevation servo-systems are electrical with electronic amplifiers and controlled rectifiers. The feeding and loading systems are dynamically operated by a hydraulic power unit fitted on the carriage. The logic system on the mount (control interlocks, sensors and indicator devices) are performed by the gun computer.

4.6.1.1 SRG Main components. - The main components of the gun include:

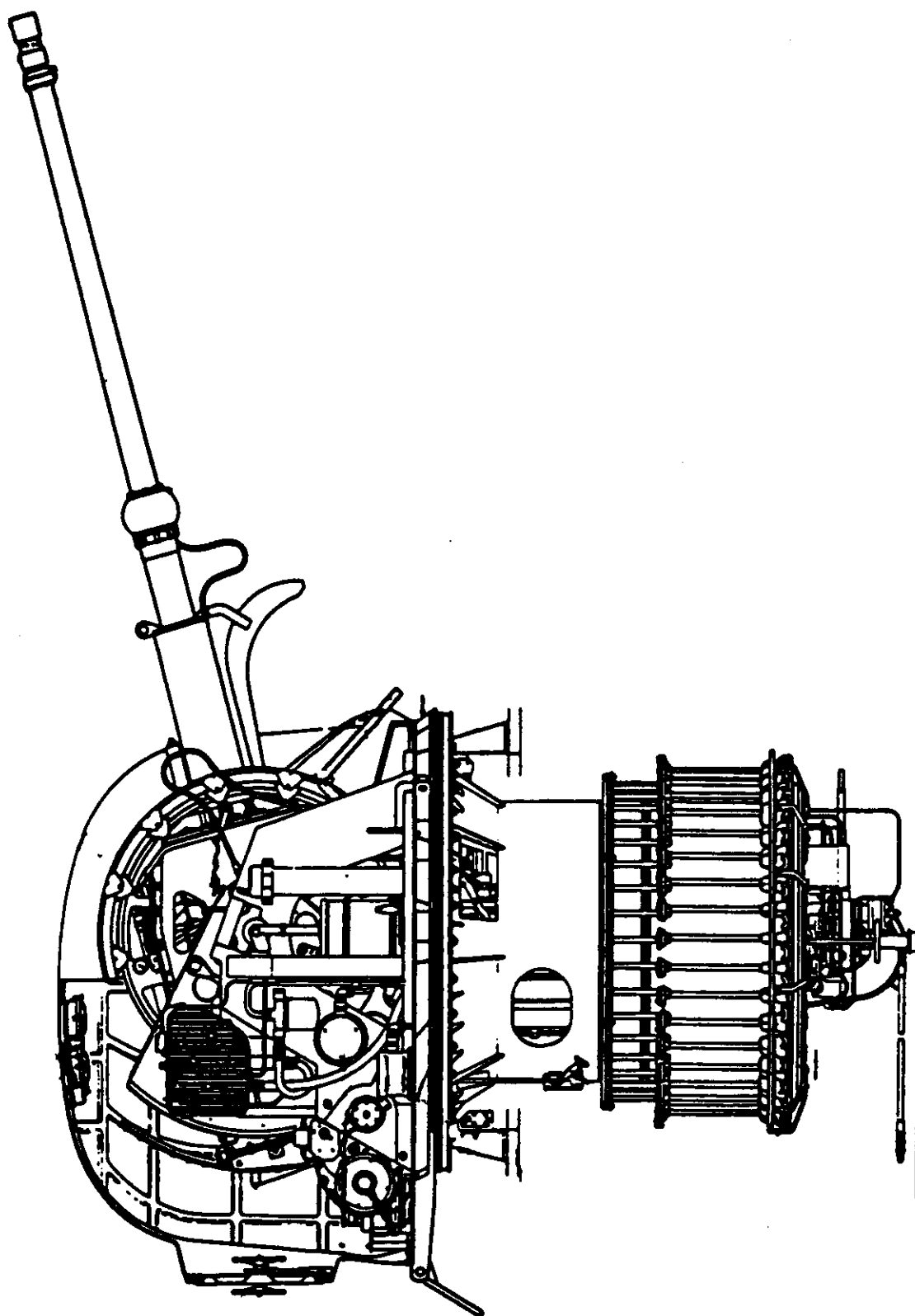


Figure 19 76/62mm Super Rapid Gun Right Side View

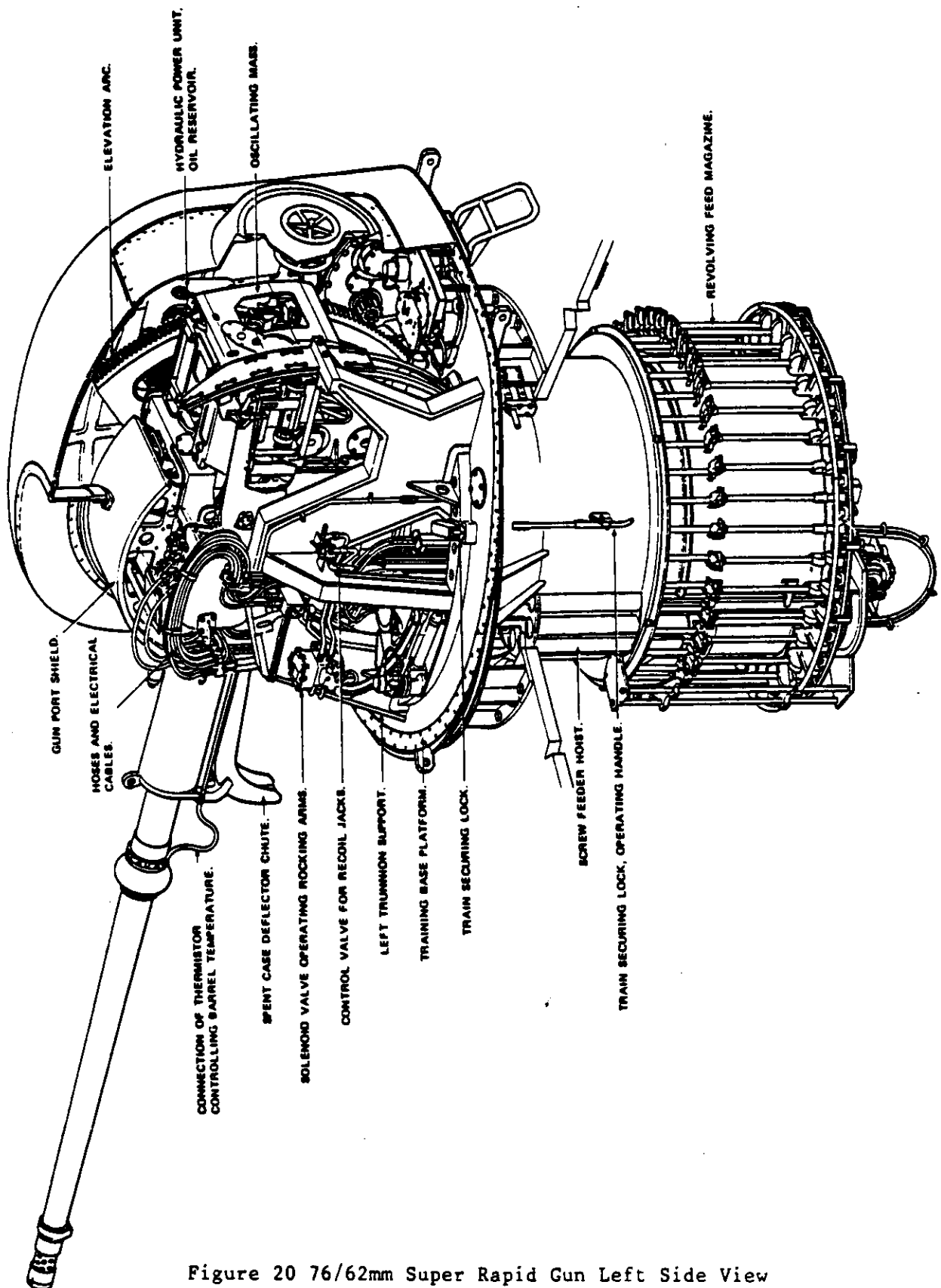


Figure 20 76/62mm Super Rapid Gun Left Side View

- a. gun barrel with muzzle brake, bore evacuation and water cooling jacket
- b. hydraulic circuit automatically controlling the loading system
- c. rocking arms and loader drums transferring the rounds from the screw feeder hoist to the elevating mass
- d. screw feeder hoist, supplying the rounds to the rocking arms
- e. revolving feed magazine, manually loaded and supplying the screw feeder hoist with AA ammunition
- f. train and elevation power drives, electronically controlled through an SCR circuit
- g. control lever assembly to preset screw feeder hoist and revolving feed magazine for manual loading of surface ammunition.

4.6.2 Ammunition.-

4.6.2.1 Ammunition to be available for the 76/62 SRGM is as follows:

- a. Multi-role OTO Munition (MOM),
- b. Semi-armour piercing surface rounds (SAPOM),
- c. Extended range semi-armour piercing surface rounds (SAPOMER),
- d. Proximity fuze (VT) High Explosive (HE) rounds,
- e. Point detonating (PD) HE rounds,
- f. Practice rounds,
- g. SMART shell for the 76/62 SRGM.

4.6.2.2 The MOM is a prefragmented shell fitted with a proximity fuze. However, when the proximity fuze is paralyzed (in the gun, prior to firing) it assumes a delayed action point detonating role, thus making the round particularly well suited for the anti-surface role. Note that when the mount is filled with MOM ammunition, it can fire at its maximum rate (120 rounds per minute) regardless of whether or not the proximity fuze has been paralyzed.

4.6.3 Ammunition Lower Hoists.- The 76 mm Ammunition Lower Hoists will be used to transfer single 76 mm cartridges between the lower deck ammunition magazines and from the magazines to the gun loading area. Since there are to be two lower deck magazines on two adjacent decks, one hoist will be used to transfer ammunition

cartridges between the upper and lower magazines. A second hoist will be needed to transfer the cartridges from the upper magazine to the gun loading area.

4.7 Close-In Weapon System (CIWS).- The CIWS to be used for TRUMP is the General Dynamics Phalanx International Block 1 Close-In Weapon System. The Phalanx CIWS is a radar directed, computer controlled, 20 mm gun system designed to engage anti-ship missiles and aircraft. The CIWS automatically carries out the functions of search, detection, target declaration, tracking, evaluation, declaration of engageability, firing, and kill assessment, while providing for manual override. During firing, the track radar tracks the incoming target as well as the outgoing shells. Thus, a closed loop fire control solution is obtained. In its primary role, the CIWS, without assistance from other ship systems, will automatically engage anti-ship attackers that penetrate the ship's primary defense systems. In its secondary role, it will accept target designations from the CCS and engage attacking targets in a manner identical to the autonomous mode.

4.7.1 Operational Concepts.-

4.7.1.1 The CIWS search radar automatically searches and detects targets in the space around the horizon of the ship and retains in fire control computer memory (maximum 8) those targets whose trajectories could impact the ship. These targets are then handed over autonomously to the track radar when it reaches the engagement range.

4.7.1.2 The track radar tracks the target and the fire control computer calculates gun orders to maximize target hit probability. When the target reaches the open fire range, the fire control computer commands the gun to open fire.

4.7.1.3 During firing, the track radar tracks the incoming target and 'spots' the outgoing shells. The fire control computer computes the open loop fire control solution and applies continuous vernier angular projectile spotting corrections. Resultant closed loop gun orders are then applied to hold the centroid of the projectile stream on target.

4.7.1.4 The fire control computer assesses target kill when target trajectory parameters indicate the target is no longer capable of executing a manoeuvre which permits impact with the ship. After target kill is assessed, surveillance is reinitiated by the search radar.

4.7.2 CIWS System Description. - The CIWS consists of the following major assemblies:

- a. Weapon Group
- b. Local Control Panel (LCP)
- c. Remote Control Panel (RCP)

4.7.2.1 Weapon Group. - The Weapon Group consists of a Gun Fire Control System (GFCS), a six-barrel 20 mm M61A1 Gatling gun, a mount and train drive assembly, environmental control, built-in test equipment (BITE) and a power supply and control group.

4.7.2.1.1 The GFCS includes a search and track radar which performs the functions of target search, detection, acquisition, tracking and projectile spotting. In addition, the GFCS produces a fire control solution and interfaces with the LCP/RCP displays.

4.7.2.1.2 The six-barrel 20 mm Gatling gun has a firing rate of 3000 rounds per minute. A self-contained Phalanx magazine stores 1550 rounds which can be reloaded in less than 10 minutes with an experienced crew.

4.7.2.1.3 The mount and train drive assembly provides structural support to the CIWS, as well as housing the servo-drive components.

4.7.2.1.4 Environmental control units consist of a closed-loop air conditioning system which maintains the necessary environmental control for the various Phalanx equipment subsystems.

4.7.2.1.5 BITE provides on-line monitoring of critical functions, a centralized system for remote test point selection and access, and external test points for connection of common or peculiar support equipment.

4.7.2.1.6 Finally, the power supply and control group controls the distribution of ship's power within the Phalanx.

4.7.2.2 Local Control Panel (LCP).-

4.7.2.2.1 The LCP will be located below decks from the CIWS. It consists of a control panel, a tape control, and a power supply unit housed in a cabinet.

4.7.2.2.2 A Test Point Selector Unit (TPSU) is mounted atop the cabinet. The LCP will be used to input threat criteria and engagement data to the CIWS computer. It can also be used as the primary control panel for the Phalanx if the RCP is inoperable. Finally, the LCP allows the operator to perform operability tests, fault isolation and maintenance operations.

4.7.2.3 Remote Control Panel (RCP).- The RCP will be located in the Operations Room and duplicates most CIWS operational command and control functions of the LCP. The RCP also contains circuitry to automatically accept target designations from other ships' systems.

4.8 Electronic Warfare (EW) System.- The function of the EW System is to provide Electronic Support Measures (ESM) on-board the ship and Electronic Countermeasures (ECM) support both off-board and on-board. The EW system comprises the following subsystems:

- a. Existing LF/MF/HF/ ESM RDF System AN/SRD-501
- b. Radar ESM System, CANEWS
- c. SHIELD-2 Chaff and Infrared Decoy System.

4.8.1 LF/MF/HF ESM System.- The existing AN/SRD-501 consists of a twin loop antenna set and a dual channel superheterodyne receiver operating over the frequency range of 60 KHz and 30 MHz in six bands. Bandwidth is selectable at 1, 3 or 6 KHz. The

receiver can detect AM, SSB, CW, PM and FSK signals and has a range of 95 to 130 km. Two types of relative bearing indication are provided; a visual display presented on a CRT screen and an audio indication received via headphones.

4.8.2 Radar ESM System.— The CANEWS is a new radar ESM system to be fitted during TRUMP. It is a computer controlled long range radar sensor which will provide signal analysis, threat detection, classification and identification of radar emissions over 360 degrees. CANEWS utilizes wide open frequency and bearing receivers with an over-the-horizon detection capability. Fully automatic processing is the normal processing operational mode, but manual override also permits intervention by an operator. CANEWS will interface with the CCS and comprises the following components:

- a. Masthead DF and Frequency Antenna.— Covers the bands 1 to 18 GHz with separate frequency receivers provided for each frequency band;
- b. Processor.— Provides an extensive radar mode library, in excess of 100 lock-on warner channels and fully automatic signal analysis;
- c. Display Console.— High resolution colour display which allows the operator to provide clear colour distinction between known friendly and hostile threat signals.

4.8.3 On-board ECM System.— The existing AN/ULQ-6C is a radar deception jammer and decoy system. It has a frequency range of 7 to 11 GHz and has a minimum saturated peak power output of 750 watts. The AN/ULQ-6C has been designed to counter pulse modulation systems [such as Conical Scan (CORSO) and Lobe on Receive Only (LORO)] by receiving, amplifying and introducing false scan modulation to the interrogating signals, then transmitting the distorted signals back to their source. The DDH-280s have two AN/ULQ-6C systems fitted (Port and Starboard). Each system is completely independent of the other, with its own control panel, receiver, transmitter, antenna and logic circuitry.

4.8.4 SHIELD-2.—The Shield II Off-Board ECM System (Figure 21) provides the TRUMP 280 class ship protection from anti-ship missile attacks by means of tactically deployed decoys via four fixed azimuth launchers, each with six parallel barrels deploying chaff and/or IR rounds by means of a Shield Control System. Adjacent to

the launchers are munitions stowage lockers and loaders units, which are used to isolate firing circuits primarily during reloading. Each pair of port and starboard launchers are controlled and powered by a Launcher Control Module (LCM). Each LCM receives ships power through Emergency Power Modules (EPM) which alternatively serve the port and starboard sub-systems by means of batteries in the event of normal power supply failure. Each port or starboard subsystem can be monitored from the Bridge Module (BM) which can be used to manually deploy decoys. The control system units are linked to a Command Module (CM) which is interfaced to the ships data bus. The CM is the principle control and display unit and contains tactics modules to provide optimized decoy deployments for the selected control modes and imposed attack scenarios.

4.8.4.1 List of major units. - The Shield Off-Board ECM System consists of the following units:

- a. 1 Command Module,
- b. 2 Bridge Modules,
- c. 2 Emergency Power Modules,
- d. 2 Launcher Control Modules,
- e. 4 Launchers- 6 Parallel barrels with anti-icing heaters,
- f. 2 Loaders Units,
- g. 8 Floodable munitions lockers (12 rounds each),
- h. 4 12V batteries,
- j. 2 Alarm Klaxons,
- k. 1 Test probe and damper test lever,
- m. 1 Drill Round,
- n. 1 Set of free end connectors.

4.9 Sonobuoy Processing System (SPS).- The Sonobuoy Processing System (SPS) will provide the operator with visual and aural data from deployed sonobuoys. Data from up to eight sonobuoys is simultaneously received for processing, recording or both. The operator can select any one of the eight channels for display while listening to another.

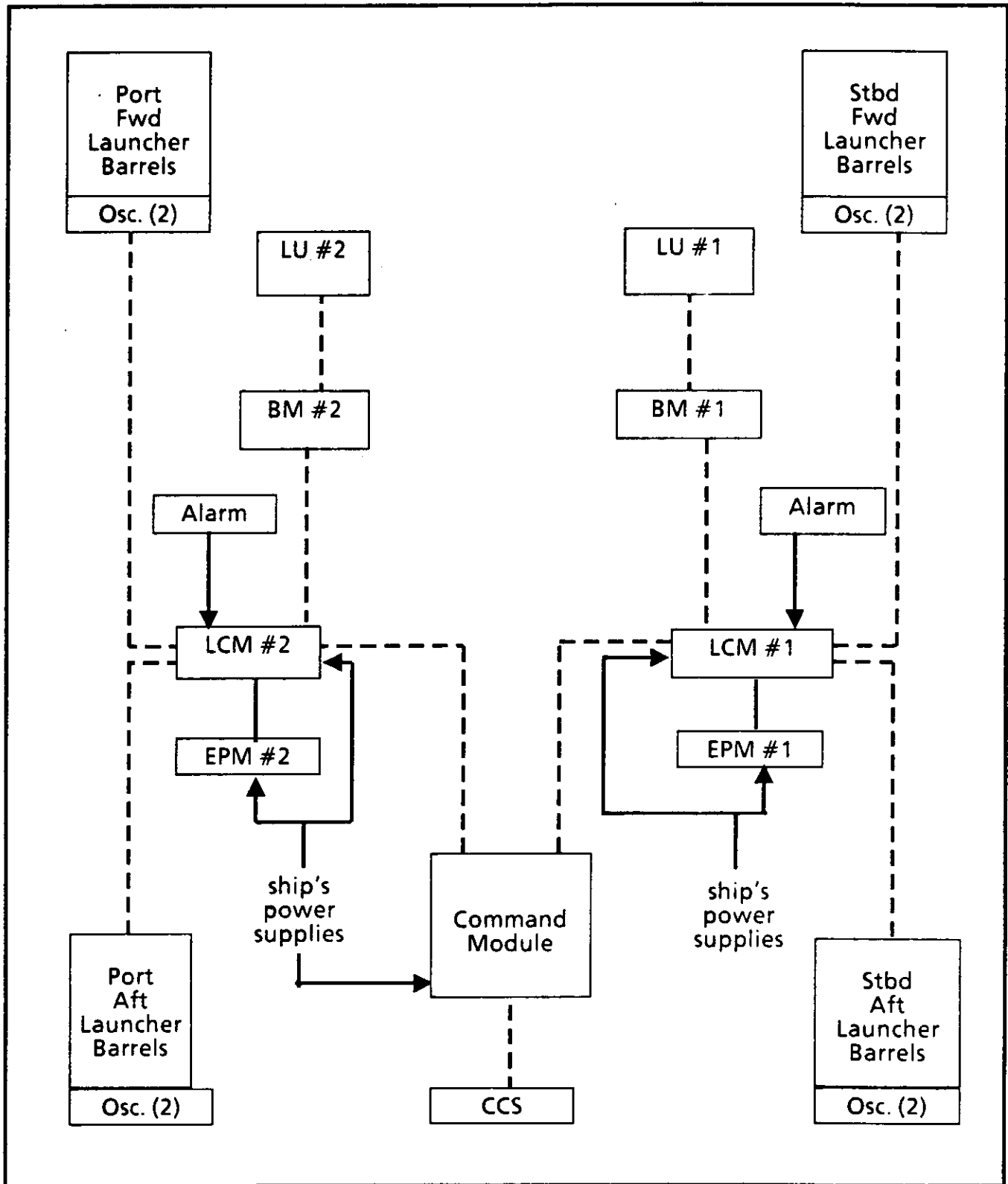


Figure 21 SHIELD-2 Off-Board ECM System Block Diagram

The SPS (Figure 22) for the 280 class ship is comprised of the following major elements:

- a. AN/ARR-75 Sonobuoy Receiver Set
- b. AN/UYS-503 Sonobuoy Processor & Keyboard (SBPS)
- c. FWSI Model 15-SPS Recorder/Reproducer Set (R/R)
- d. FWSI Model 15-SPS Time Code/Remote Unit (TCG)
- e. Cathode Ray Tube Monitor (CRTM)
- f. Audio Control Box (ACB)

4.9.1 AN/ARR-75 Sonobuoy Receiver Set. - The Sonobuoy receiver set consists of two units, the OR-69/ARR-75 receiver group and the C-8658/ARR-75 radio set control. The receiving group, OR-69/ARR-75, receives, demodulates and amplifies FM Sonobuoy transmissions. Each set is capable of receiving 4 channels simultaneously and providing demodulated outputs for analysis and display. The radio set control, C-8658/ARR-75, provides the independent selection of any one of 31 RF channels for each of the four receiver modules. It is also provided with a switch for initiation of the built-in-test (BIT) function. Two Sonobuoy receiving sets will be used in the TRUMP SPS.

4.9.2 AN/UYS-503 Sonobuoy Processor and Keyboard. - The SBPS is a Sonobuoy demultiplexer, signal analyzer and display generator that interfaces between Sonobuoy receivers and display systems. Input is from 8 standard Sonobuoy receiver outputs grouped in pairs. Each pair is connected to a processing channel that can process the signal from 2 Omni or Bathythermal buoys, 1 DIFAR, 1 DICASS or 1 Ranger buoy. Processed data history storage is provided within the unit. The SBPS also generates an RS-343 815 line video output to drive a display of processed data as well as to provide tableaux for controlling, processing, and viewing the results of processing. There is 1 pair of audio outputs for listening and a command transmitter control interface.

The keyboard, for data entry and function control, will comprise a keyboard and a Force Stick in or on a shelf attached to the front of the SPS equipment rack.

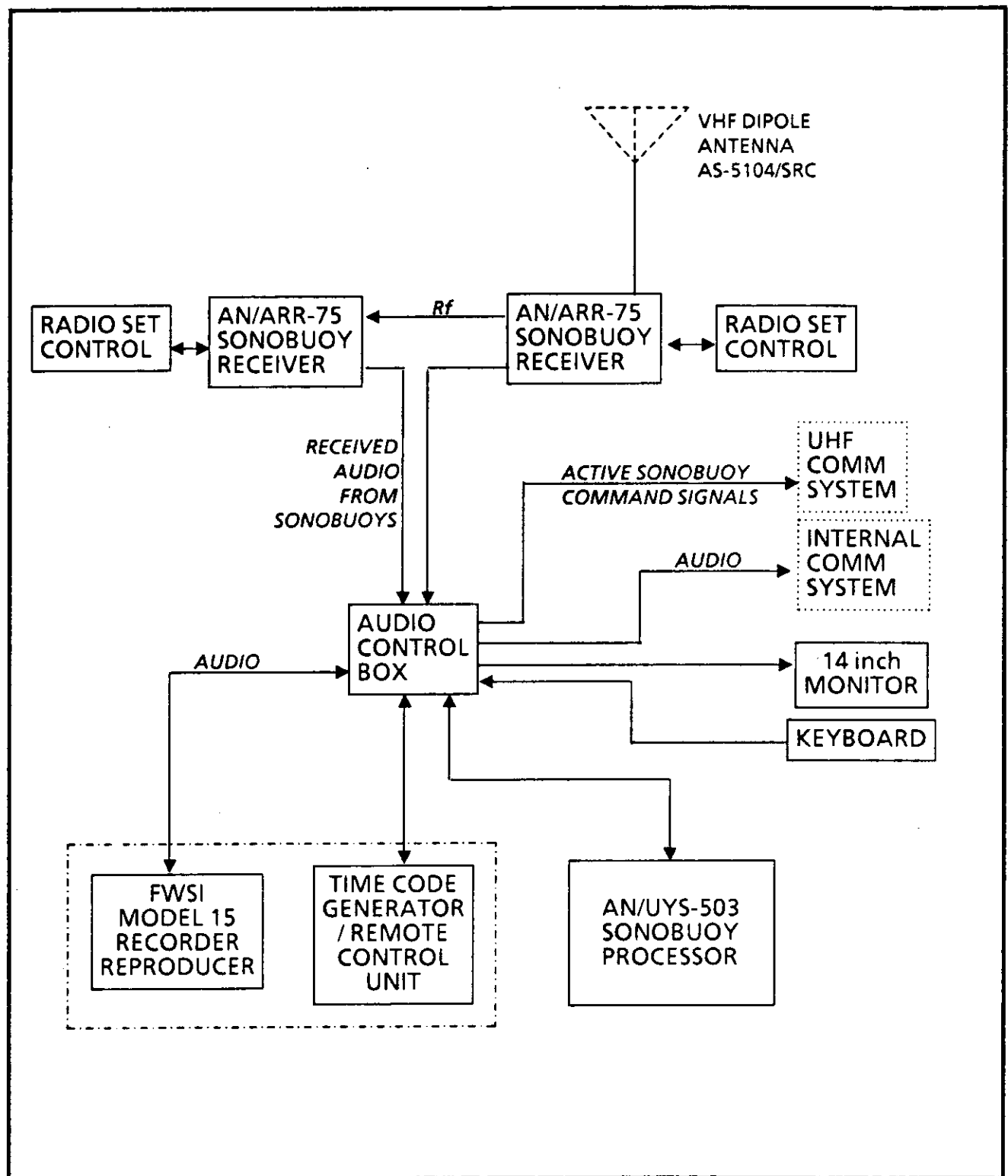


Figure 22 Sonobouy Processing System

4.9.3 FWSI Model 15-SPS Recorder/Reproducer Set. - The R/R will provide shipboard magnetic recording/reproducing for anti-submarine warfare (ASW) data recording, storage and reproduction. The set uses direct recording, wideband frequency modulation (FM) recording techniques and has BIT functions. The recorder is an eight channel reel to reel which will record eight acoustic channels for future processing and shall be independent of the real time processing of the SBPS.

4.9.4 FWSI Model 15-SPS Time Code/Remote Unit. - Control of the R/R will be via the time code/remote unit (TCG) and will be mounted in the SPS equipment rack.

4.9.5 CRT Monitor. -The monochrome monitor, mounted in the SPS equipment rack above the keyboard, will display the processed output from the SBPS.

4.9.6 Audio Control Box. - The ACB will act as a junction box, signal level converter, interface buffer and data source selector. It will provide a changeover switch function to select either live data or recorded data for the sonobuoy processor.

4.10 Torpedo Handling and Stowage System (THSS). - The Torpedo Handling and Stowage System (THSS), (Figure 23), consists of five assembly groups: overhead rail, bridgecrane, stowage chocks, loader/dolly and deck track. The purpose of the THSS is to stow up to 18 Mk 46 torpedoes in a two high configuration, transfer torpedoes to and from stowage positions, and move the torpedoes to the port and starboard load positions. In addition, the loader/dolly will be used to replenish the Ready Service Locker by transferring torpedoes into position where they can be hoisted to the helicopter deck by a "cherry picker" crane.

The two overhead rail assemblies consist of steel I-beams mounted to the overhead structure. A roller chain is mounted to the bottom side of each rail and meshes with the carriage drive sprockets of the bridgecrane assembly (Figure 24). The rail assemblies function is to support and guide the carriage assembly, with the carriage wheels riding on the inside flange of the rails.

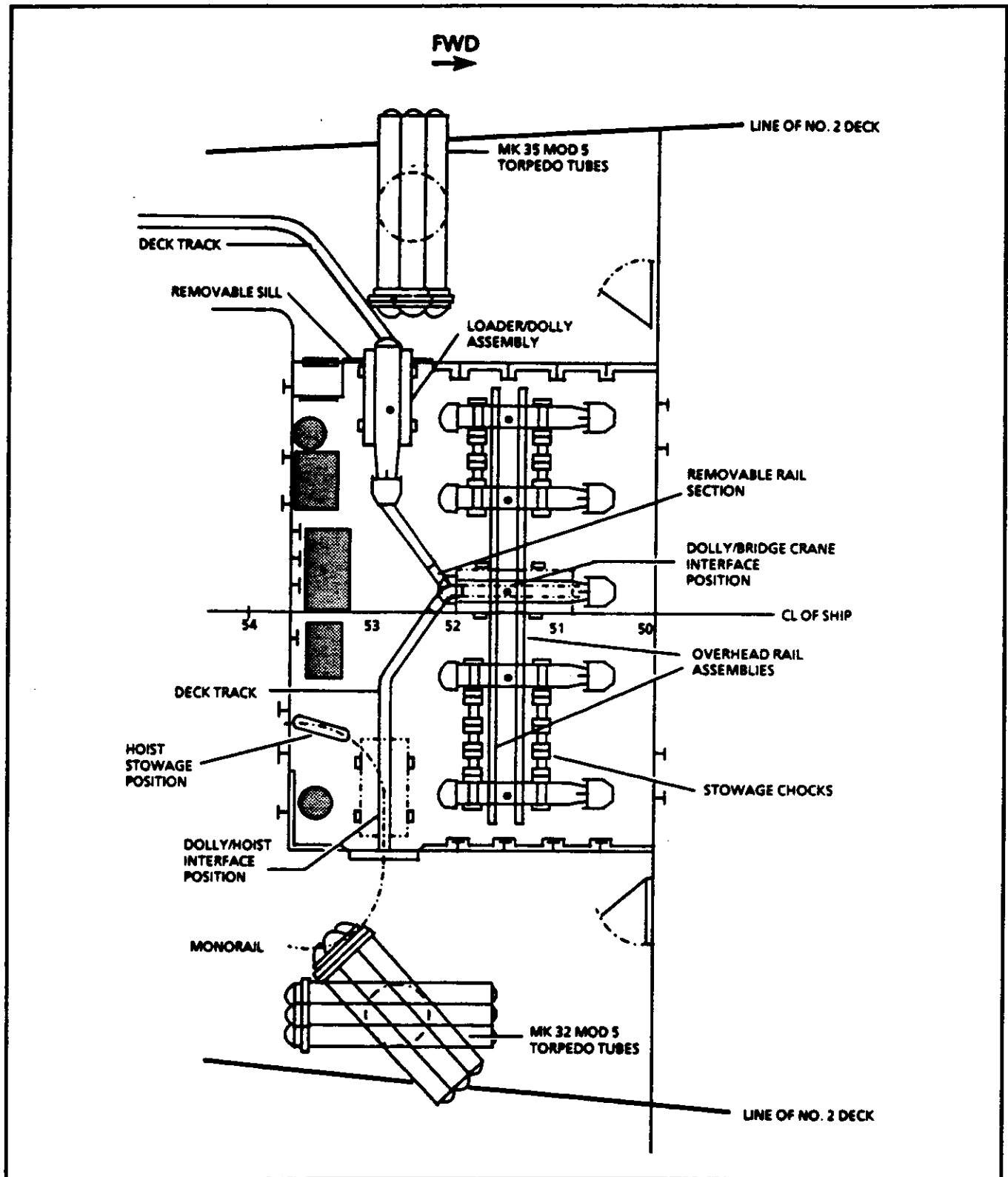


Figure 23 New Torpedo Magazine Layout

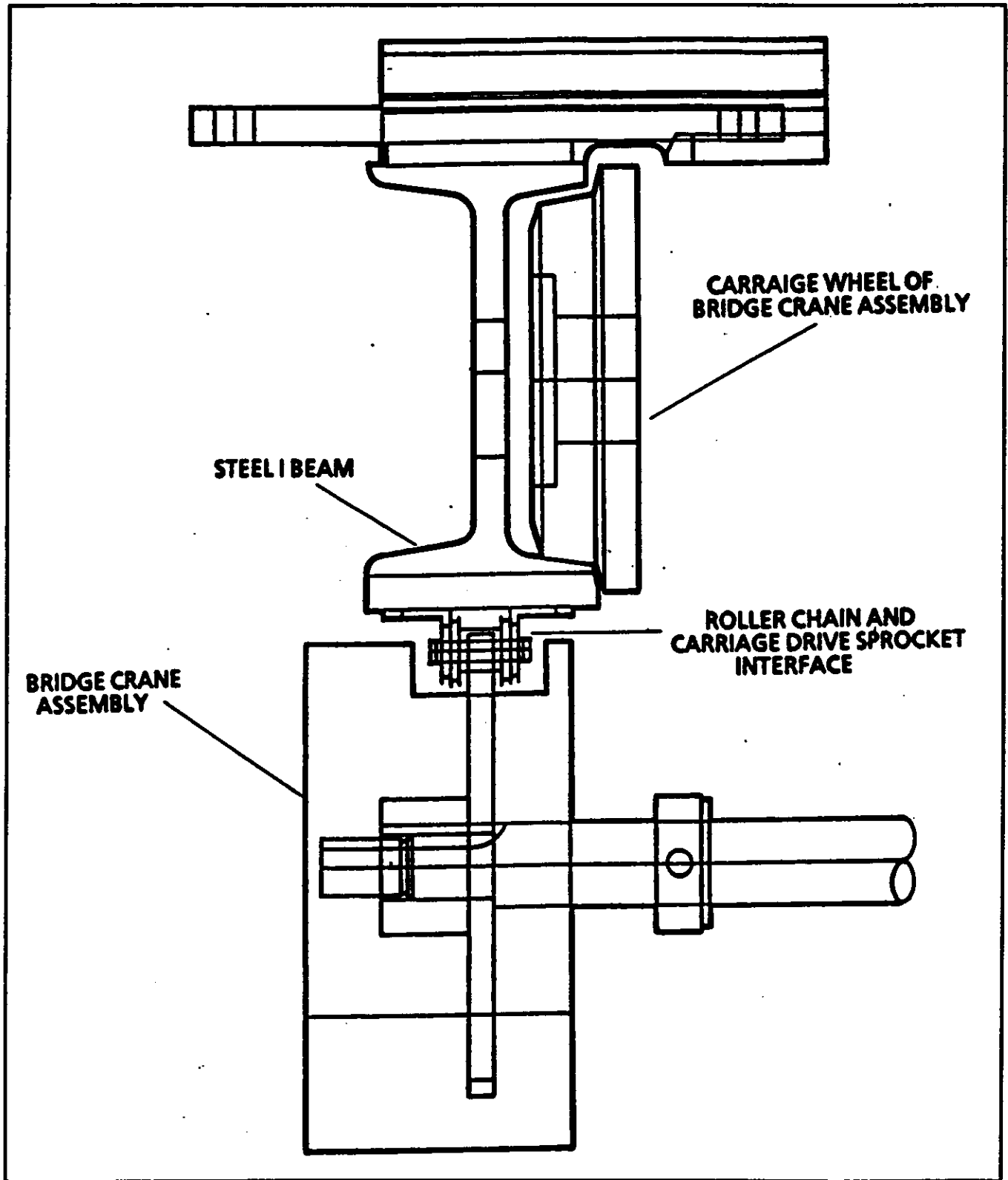


Figure 24 Overhead Rail Assembly Cross Section

The bridgecrane assembly (Figure 25) is pneumatically powered and can be manually operated in the event of loss of air pressure. It consists of the following major subassemblies:

- a. main carriage - forms the basic structure with carriage wheels and air motors (hoist and traverse) attached to the main frame
- b. intermediate and inner carriage - move vertically inside the main carriage and are powered by the hoist air motor
- c. torpedo clamp - bolted to the bottom of the inner carriage assembly and serves to secure the torpedo by means of two cam shaft assemblies and two nylon straps.

The stowage chocks (Figure 26) are constructed of high tensile aluminum forgings and provide stowage for up to 18 Mk 46 torpedoes. Rubber pads are bonded to the chocks to protect the torpedoes from shock and vibration. Each chock section contains locking devices that are used to secure the chock sections together.

The loader/dolly (Figure 27) is used to transfer torpedoes from the open deck during replenishment, to the magazine for transfer to stowage positions, and to transfer torpedoes from the magazine to a load position for the torpedo tubes. The loader/dolly is guided by a T-slot guide that fits into a track welded to the deck.

The deck rails are deck-mounted and provide a positive means of controlling the loader/dolly under adverse sea state conditions. The track follower of the loader/dolly fits into the T-slot which provides positive guidance during all movements of the loader/dolly.

4.11 Interior Communications System (ICS).- The ICS will consist of an AN/SCC-502(V) Shipboard Integrated Interior Communications System (SHINCOM), it replaces the existing AN/SIC-503(V) Interior Communications Set. SHINCOM will interface to existing radio and crypto-radio in order to provide all operational interior and exterior communications.

4.11.1 System Description.- The Shipboard Integrated Communication (SHINCOM) System is a secure, versatile, and fully integrated Internal Communication System

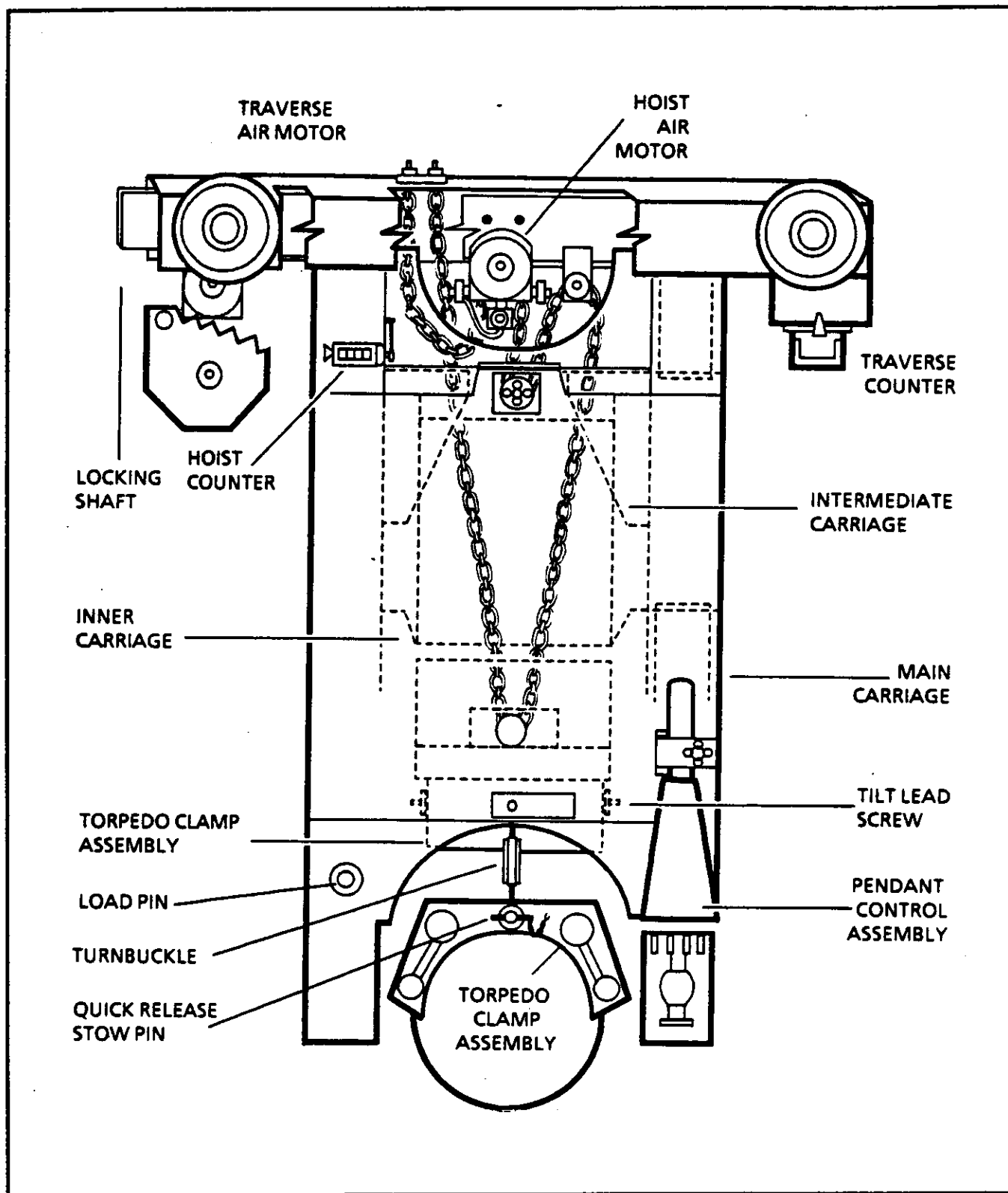


Figure 25 Bridgecrane Assembly

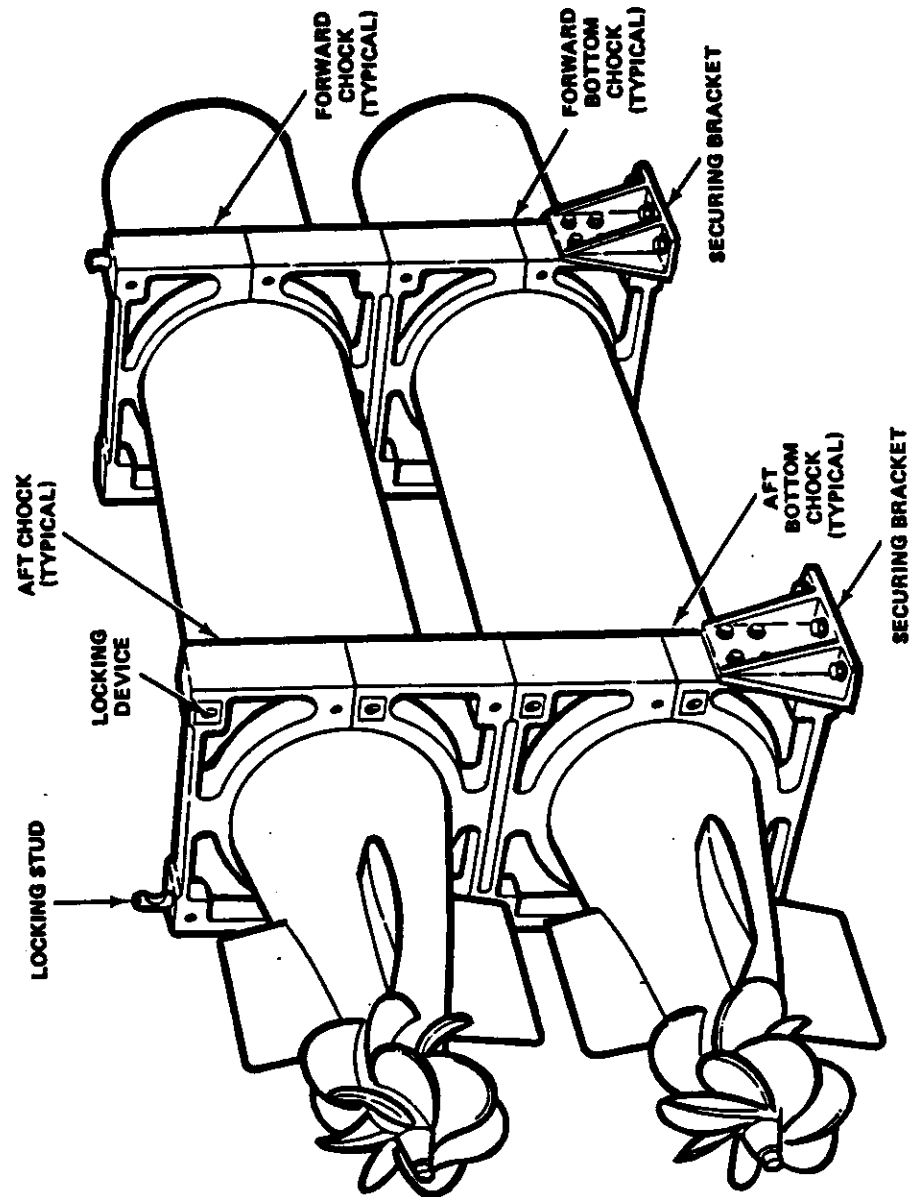


Figure 26 Stowage Chocks

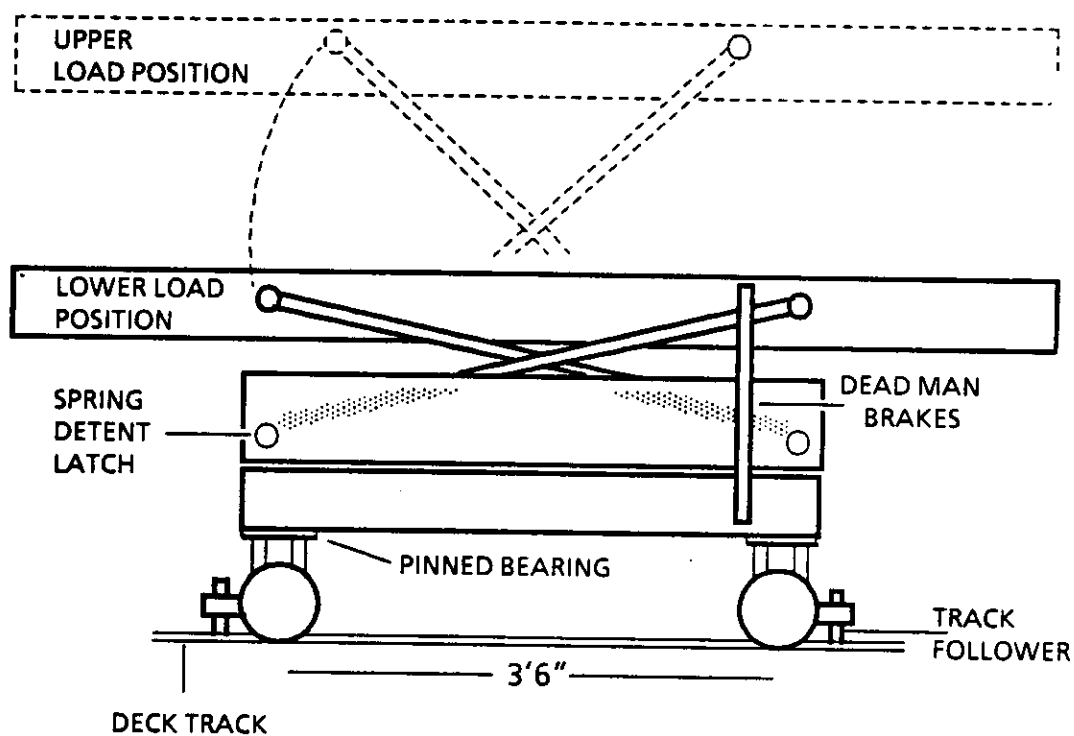


Figure 27 Combination Loader Tray/Torpedo Dolly

which is capable of providing redundant/survivable operational and routine communications within the TRUMP ship. SHINCOM is configured into a 'redundant network' or 'dual star' configuration to prevent the loss of vital communications in the event of unit, subunit, cable or component failures (Figure 28). This is achieved by providing two Central Switches, (Primary and Secondary), each separately located, to which all vital terminals and interfaces are linked. The processors of the two Central Switches are interconnected to allow the secondary switch to immediately assume the control functions in the event of a primary processor failure. Each central switch is capable of being battery supported for a period of not less than one hour during a loss of ship's power. A cartridge magnetic tape-recorder unit (CMTU) permits loading of diagnostic and operational software, and a Data Terminal Set (DTS) permits reallocation of terminal capabilities and directory numbers and diagnostic monitoring. The system consists of seven principal functional groups as illustrated in Figure 29. These groups are:

- a. Control Group
- b. Network Group
- c. Primary Power Group
- d. Maintenance/Administration Group
- e. Main Distribution Frame Group
- f. Terminal Group with Ancillary Equipment
- g. Interface Group.

4.11.1.1 Control processor group. - The Control Processor Group consists of an AN-UYK-502(V) computer and a Cartridge Magnetic Tape Unit (CMTU) [AN/USH-26(V)] together with computer interfaces as specified herein. The Control Group provides the facilities necessary to detect a communication requirement, assemble the switching resources necessary to satisfy the requirement, and re-allocate the switching resources as appropriate when the requirement is complete. Additional functions of the Control Processor Group include:

- a. A maintenance/administration group interface: to provide a hardware and software interface necessary for the Maintenance/Administration Group Display and Cartridge Magnetic Tape units.

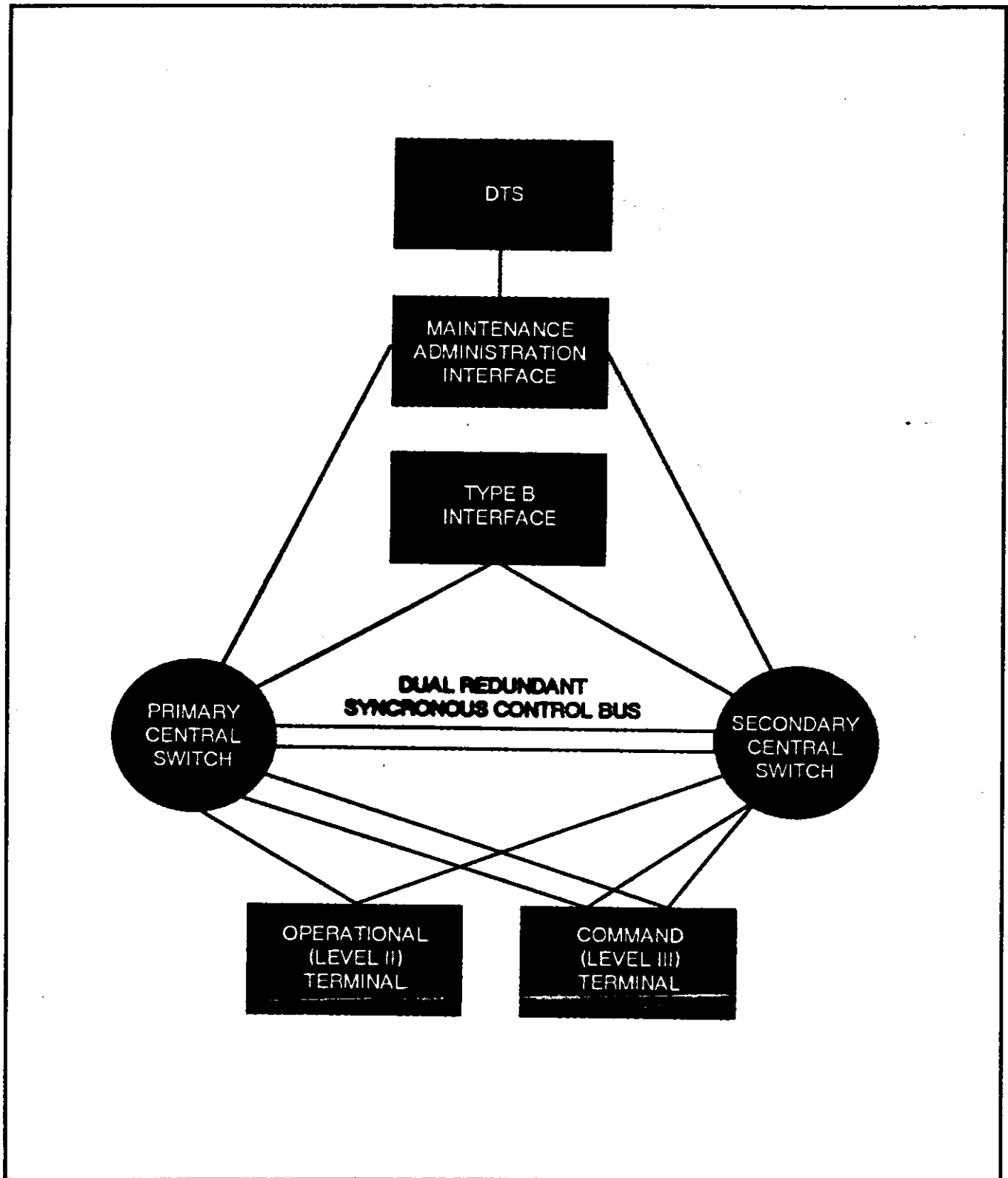


Figure 28 SHINCOM "Dual Star" Configuration

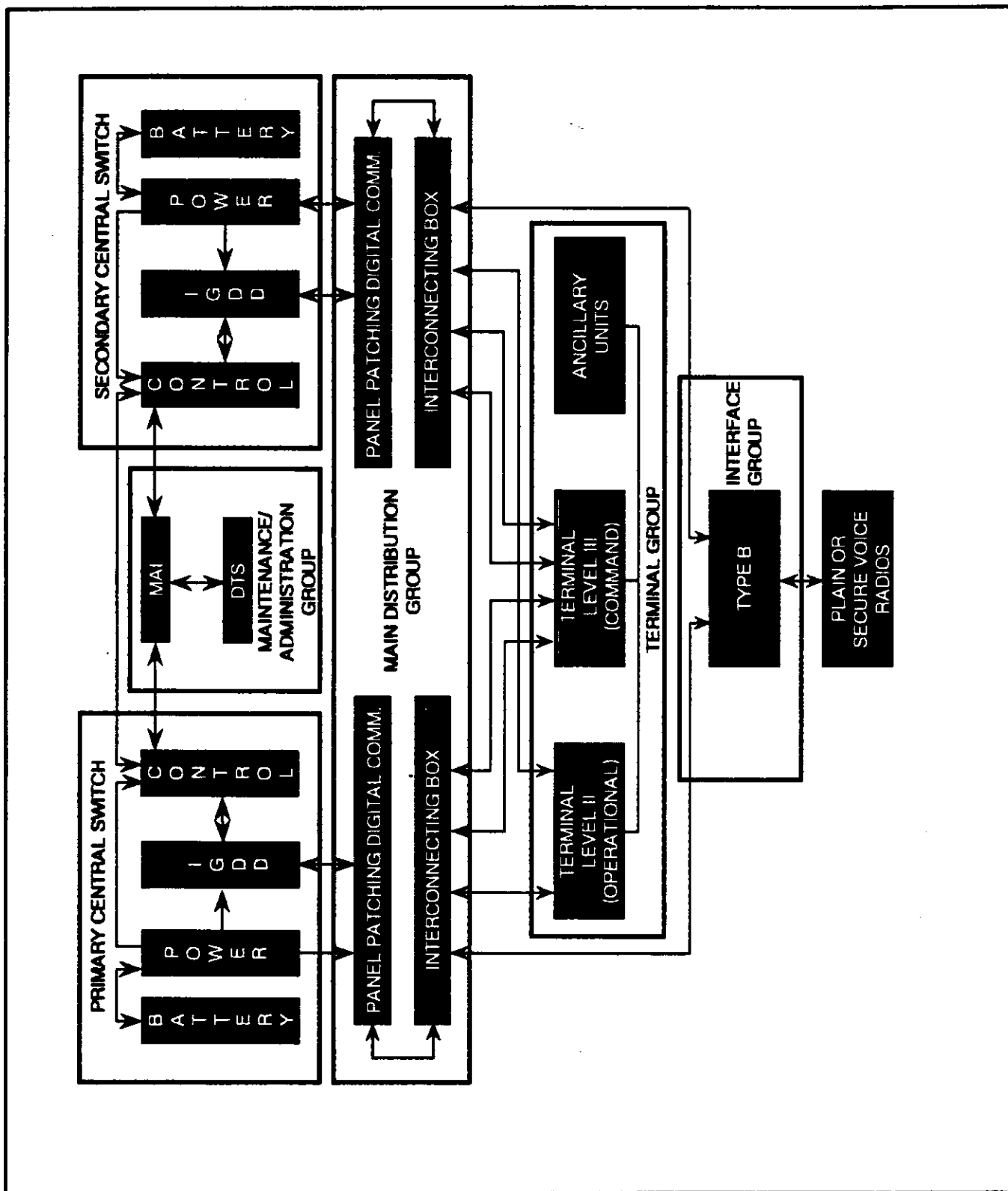


Figure 29 SHINCOM Functional Group Block Diagram

NON CLASSIFIED

- b. A network group interface: to provide the hardware necessary to extend the control signals from the Control Group to the Network Group.
- c. An alarm interface: To provide visual and audible alarm indications for major fault situations.

4.11.1.2 Network group. - Each Network Group provides the hardware which, under Control Group processing control, detects a communication requirement, and provides the hardware switching resources necessary to satisfy that requirement.

4.11.1.3 Power group. - The Primary and Secondary Power Groups interface to ship's power supplies having characteristics in accordance with C-26-003-001/MS-001 from an external source, and supply the Network Group, Terminal Group, and Interface Group with 28 volts DC nominal and the control group with 115V AC, 60 Hz single phase. Each Power Group provides a capability for uninterrupted power via emergency battery backup. This is implemented such that when the external AC line voltage drops below an acceptable level, a Central Switch provided with a battery is automatically powered directly from the battery without the necessity for physical switchover. External AC power is automatically applied when again available. The automatic power switchover function also sends indications to the Network Group that the switchover has occurred in both cases. Neither the calls in progress nor the call processing capability of the Central Switch is affected by the loss of AC power if battery is provided and it is in a fully charged condition.

4.11.1.4 Maintenance/administration group. - The Maintenance/Administration Group consists of one Data Terminal Set (DTS) [AN/USQ-69 (V)] and a switch box, designated the Maintenance/Administration Interface (MAI). The AN/USQ-69 (V) DTS is used for the following:

- a. To monitor routine system diagnostic routines.
- b. To monitor maintenance routines.
- c. To re-configure terminal features by modification of the Control Group processing software.

4.11.1.5 Main distribution frame group. - The Main Distribution Frame (MDF) Group facilitates interconnection of the Network Group to the individual terminals and external equipment interfaces. The functional areas of the MDF Group are:

- a. Main distribution frame unit. - The Main Distribution Frame facilitates a flexible distribution of terminals and interfaces within the Network Group.
- b. Junction boxes. - Each Junction Box routes subgroups of terminals and interfaces within the Network Group. Each Junction Box has a fan out capacity of 16 lines.
- c. Cabling. - Each terminal and interface is connected via Junction Boxes and MDF to the Specified Central Switch with two twisted-pair cables. These cables are appropriately grouped into subgroup multi core cables.

4.11.1.6 Terminal group. - The SHINCOM system for the TRUMP ship provides two levels and types of terminal service:

- a. Level II vital operational terminals. - Level II terminals are dual homed/single channel. Each has one line connected to the Primary Switch and one line connected to the Secondary Switch. The Level II terminal front panel is fitted with a standard fixed function keypad, a transducer to generate the ringing tone, a volume control, a four-digit numeric display and a dimmer control. A press to talk (PTT) indicator and an Emergency indicator are also provided. A separate bank consisting of 16 keys are also included. The functions associated with these keys are programmable via the Maintenance/Administration group, and are selectable from the following list subject to the number of keys available:
 - i) Prearranged Conference nets (16)
 - ii) Plain and Cypher (2)
 - iii) Abbreviated Dialing (16)
- b. Level III Vital Command Terminals. - Level III terminals are dual homed/dual channel. Each Level III terminal has two independently routed

lines connected to the Primary Switch and one line connected to the Secondary Switch.

The Level III terminal unit provides the same services as the Level II terminal unit, except that two independent communication channels, each with its own directory number, are provided simultaneously. The dual homed terminal can switch one of the two paths, from the Primary or Secondary Switch to the handset, under control of the central switch. Both Terminal types receive and transmit digital signaling information from and to the Network Groups of the Primary Switch and Secondary Switch (if connected). They also transmit and receive digitized audio data to/from the respective receiving and transmitting device.

4.11.1.7 Terminal ancillary equipments. - Terminal Ancillary equipments include the following:

- a. Microphone. - The hand held microphone consists of a dynamic noise-cancelling microphone element, a microphone case, a "PRESS-TO-TALK" switch.
- b. Handset. - The handset consists of a dynamic noise-cancelling microphone element, an earphone receiver, a handset shell, and a retractable non-kinking cord.
- c. Headset. - The headset consists of two earphone receivers, a dynamic noise-cancelling microphone element, a headband, a microphone and a combination microphone-receiver cord assembly.
- d. Switch Cord Assemblies. - There are three types of switch cord assemblies.
 - i) The single footswitch cord and connector assembly permits the use of one foot-operated PTT switch while using the headset or Talk back Unit with a Level II terminal or an Extension Unit.

- ii) The dual footswitch cord and connector assembly permits the use of two foot-operated PTT switches while using the headset with a Level III terminal.
- iii) The handswitch cord assembly consists of left and right "PRESS-TO-TALK" switches for use with Level II or III terminals or the Extension Unit.

4.11.1.8 Interface group. - Consists of a Type B interface unit and Personality Modules. It performs D/A and A/D conversions for radio transmission, and provides radio status. Access via terminals equipped with radio keys. The Interface Group interfaces the TRUMP ICS with ECS.

4.12 Integrated Navigation System (INS).- The Combat System requirements for ship's attitude data (roll, pitch, heading) and the navigation requirements of position data (latitude, longitude) shall be provided by two AN/WSN-5(MOD) stabilized gyrocompass/inertial navigation systems in a primary/secondary relationship. The primary AN/WSN-5(MOD) equipment shall receive automatic position fixes from the existing ships MX 1105 SATNAV receiver. The primary AN/WSN-5(MOD) shall input fixes to the secondary AN/WSN-5(MOD). The output from the SATNAV receiver shall be switchable to the secondary AN/WSN-5(MOD). The AN/WSN-5(MOD) equipments shall interface directly to the CCS data processor group and SM2 Block II Weapon Direction System. Ship's attitude shall be distributed to analogue users via an Integrated Navigation Data Bus (INDB). The INS comprises the following equipment groups:

- a. Satellite/Omega Navigator
- b. Inertial Navigation Set
- c. Integrated Navigation Data Bus

4.12.1 Satellite/Omega Navigator.- The MX 1105 Satellite/Omega Navigator will receive satellite information and relay this information, via digital switch, to either of the two inertial navigation sets for reset and time mark purposes.

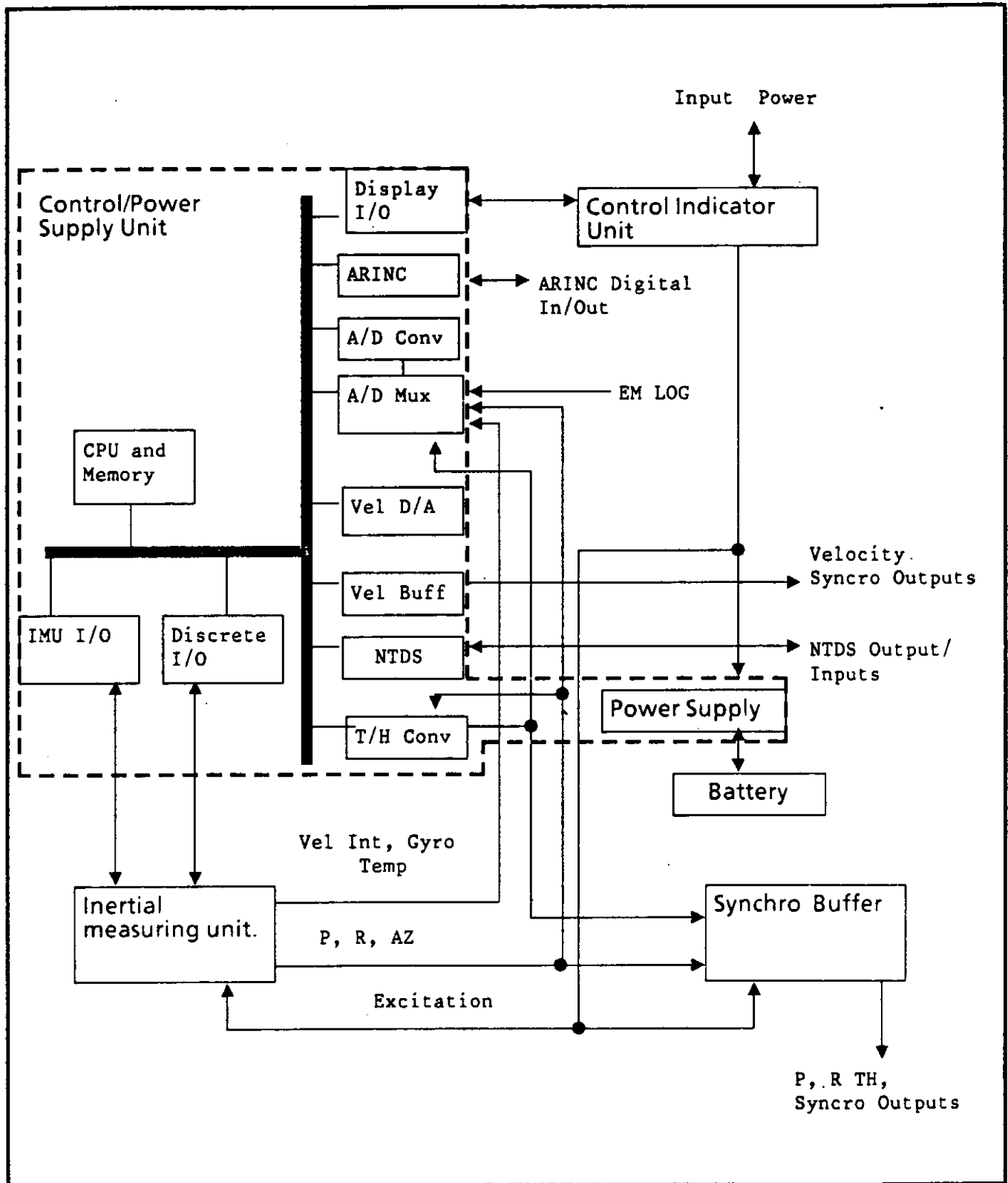


Figure 30 AN/WSN-5(Mod) Inertial Navigation Set Block Diagram

4.12.2 Inertial Navigation Set.- The AN/WSN-5 (Mod) Inertial Navigation Set is a self-contained stabilized gyro system providing full inertial navigation capability. Derived from the U.S. Navy's AN/WSN-2 Stabilized Gyrocompass, the system operates at all latitudes and provides continuous display and data outputs of ship's position, heading, north/south and east/west velocity, roll and pitch attitude. Incorporating the latest inertial instrument technology and digital computation techniques, the system provides the precision navigation and attitude reference data required for sophisticated modern weapon systems. Accurate present-position data (latitude/longitude) derived from NAVSAT, OMEGA, Loran C, radar fixes or other position fixing sources may be entered manually via the navigator control/display keyboard, or automatically via optionally available digital communications lines. The system automatically performs the reset computation from the entered data using modern digital optimal processing techniques. The navigation computations are performed in real-time by the inertial navigation set computer and are synchronized with Greenwich Mean Time by an internal GMT clock.

4.12.2.1 AN/WSN-5(Mod) functional description. - The entire AN/WSN-5 (Mod) (Figure 30) is contained within a single enclosure and makes use of the integrated single-box concept, thereby providing for simple installation and maintenance features. The system consists of an inertial measurement unit mounted within a shock isolation system, computer, power supply, synchro buffer amplifier unit, and control/display panel. The inertial measurement unit (IMU) contains the stable platform and platform electronics consisting of velocity quantizers, gyro torquing circuits, gimbal servos and temperature control circuits. Platform angles are measured by resolvers for heading, pitch and roll. These resolver angles are buffered, amplified, and converted to synchro information within the synchro signal amplifier unit prior to transmission to the user equipment. A digital computer is used as the control element for the platform electronics and to process information from both external (position fixes and EM log) and internal sources (accelerometer and attitude data). It also is used to perform mode control, reset mechanization and optimization, built-in-test, display, and I/O processing. The power supply provides all necessary voltages required to operate the inertial navigation set including optional features. A battery provides power to the system in event of failure of the ship's primary power source. During battery operation, vital heading is provided and navigation parameters are displayed.

4.12.2.2 INDB general. - The INDB (Figure 31) comprises a distributed system based upon a dual redundant data bus. Data is transferred via the selected Bus Processor unit (BP) to four remote terminal units (RT) over a dual redundant MIL-STD-1553B multiplex data bus. Either BP can be selected by the Bus Controller. The selection process being automatic should a fault occur within the selected BP or alternatively by demand from the command and control system. The unselected BP will act as a remote terminal enabling access to its data sources. All data input to the INDB is interfaced by the two BP's. The BP's and RT are connected to the main bus cable run as transformer coupled stubs from appropriately positioned bus coupler modules.

4.12.3 INDB functional description. - All inputs to the INDB network are converted into parallel digital data form suitable for operation upon by the Central Processor Unit (CPU). This data is accessed by the CPU via a time division multiplexed parallel data bus. Suitably converted/manipulated data is then presented to the output PEC's which convert the parallel data into a form suitable for the attached user. The internal multiplexed highway (D3 bus), consists of control data and address lines which are derived from the CPU buses. The D3 bus is driven by a Watchdog Interface (WI) PEC, this unit buffers the CPU buses and monitors the PEC's attached to the D3 bus. It is also used to check the operation of the CPU and looks for faults on the D3 bus itself. All cards interfacing the D3 bus do so through a common interface arrangement. This interface buffers data between the D3 bus and the PEC and incorporates a status register which is accessed when the PEC is addressed. This register is used to indicate any faults which occur upon the PEC and the information is then used to bring on the appropriate alarm. A great deal of built in test equipment (BITE) is incorporated into both systems and individual PEC's.

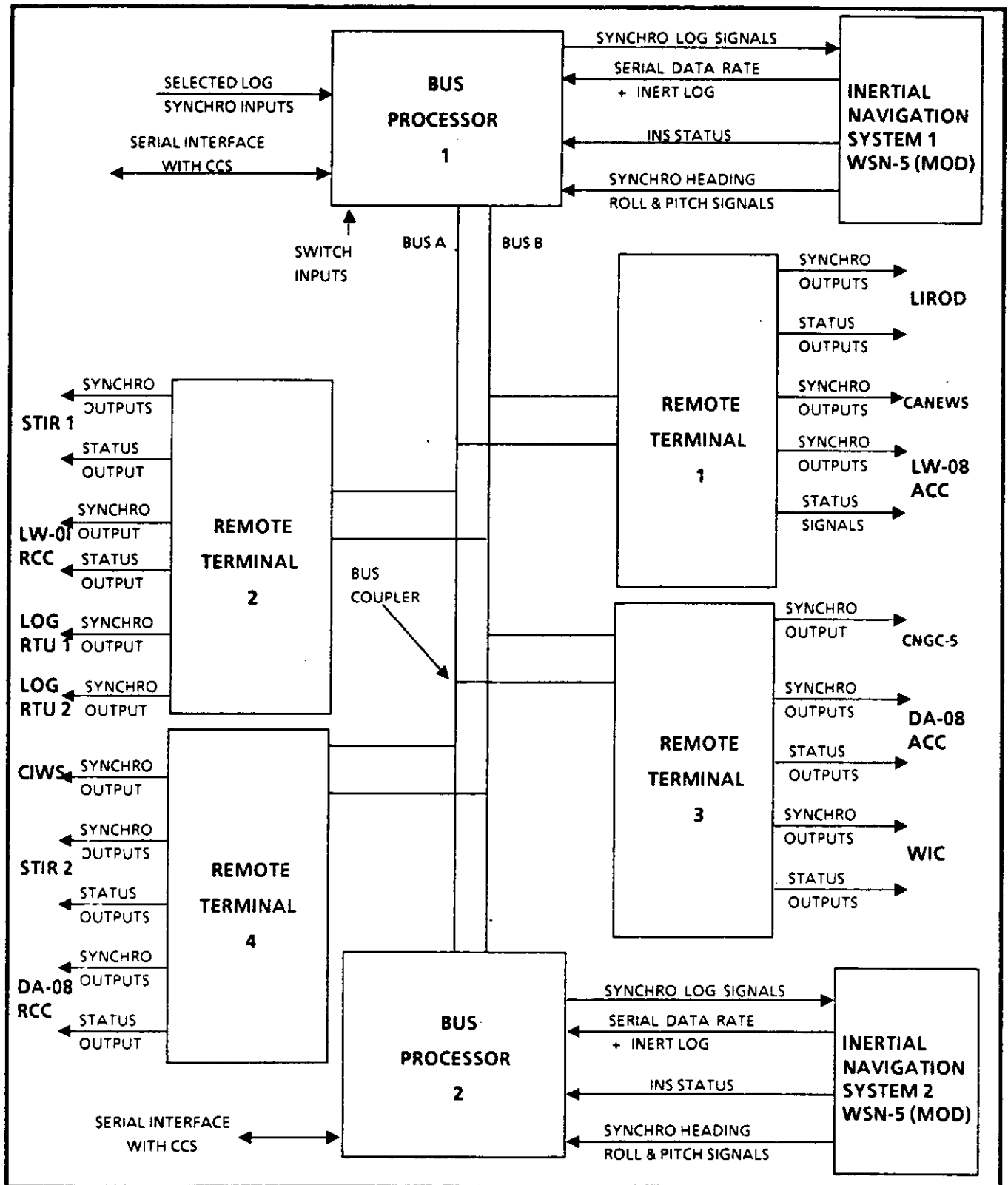


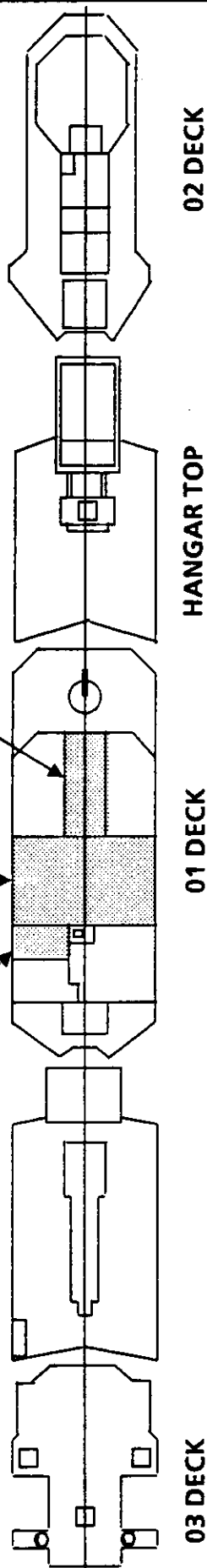
Figure 31 Integrated Navigation Data Bus (INDB) Block Diagram

ATTACHMENT 1
COMMAND AND CONTROL SYSTEM

OPERATIONS ROOM

CCER NO.1

STAFF OFFICE

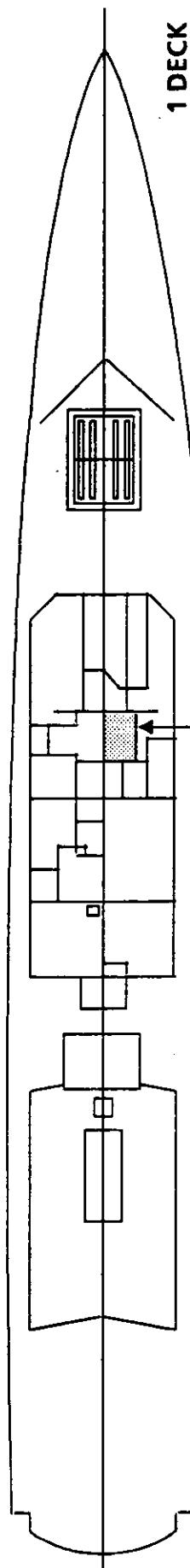


02 DECK

HANGAR TOP

01 DECK

03 DECK

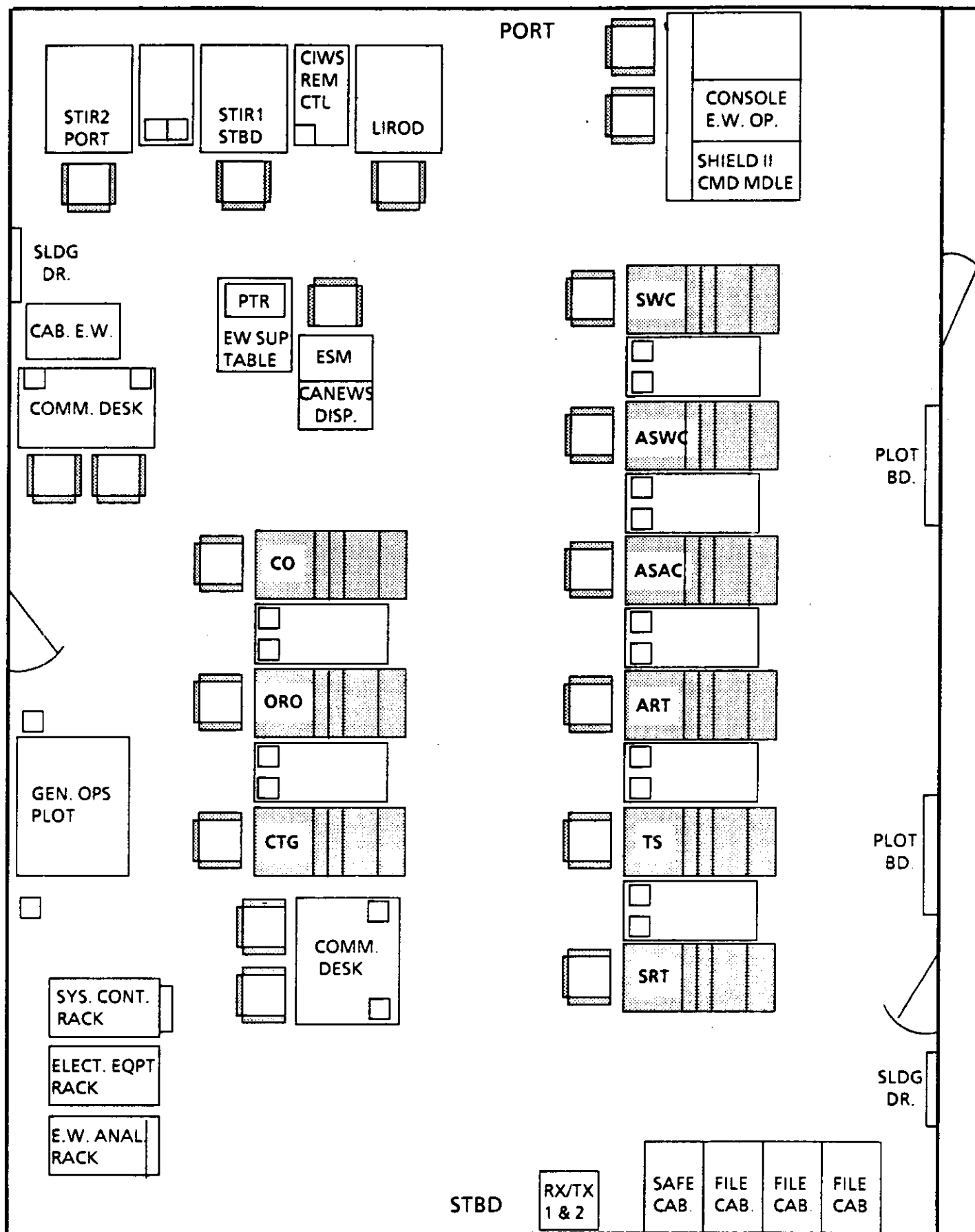


1 DECK

CCER NO.2

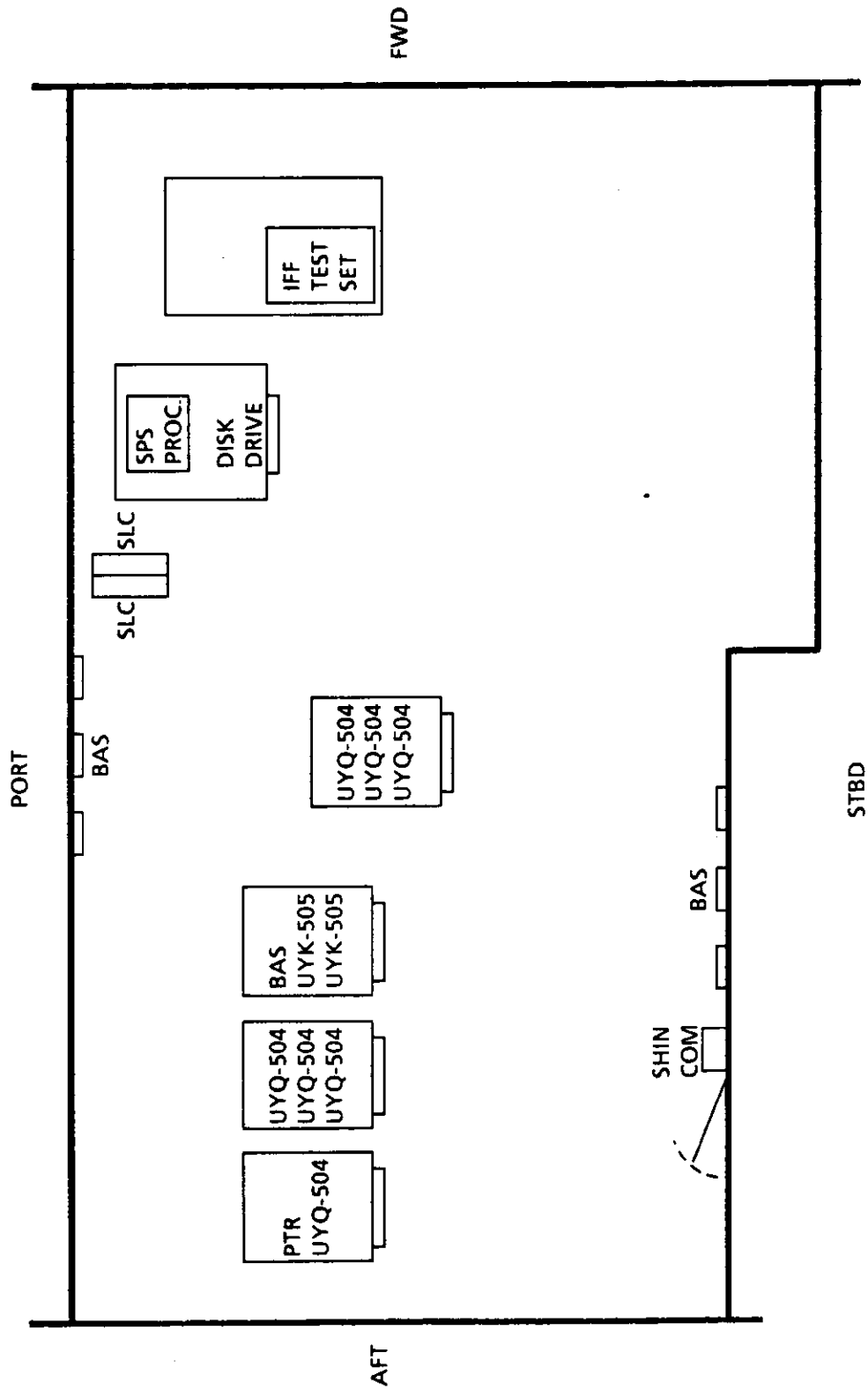
SHIP PLANVIEW - CCS

CBS-T0508



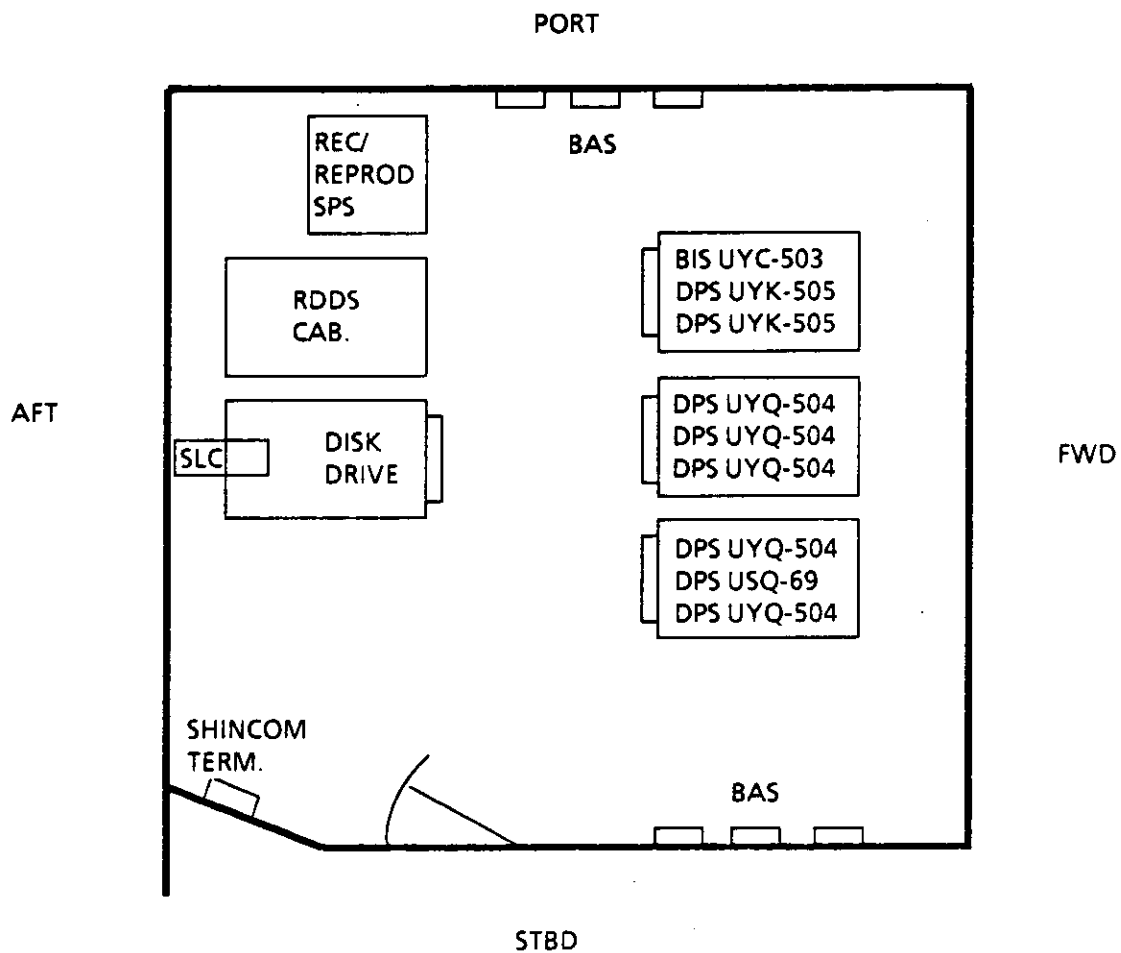
OPERATIONS ROOM

CBS-T0510



COMMAND AND CONTROL EQUIPMENT ROOM #1

CBS-T0511

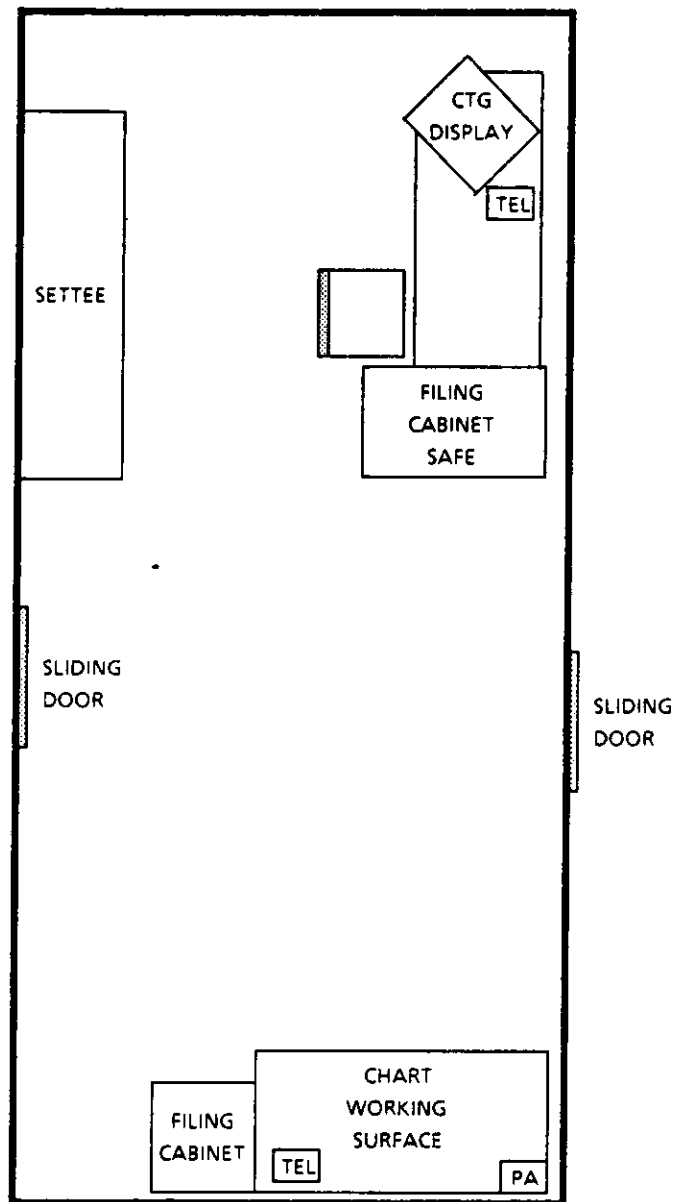


COMMAND AND CONTROL EQUIPMENT ROOM #2

CBS-T0512

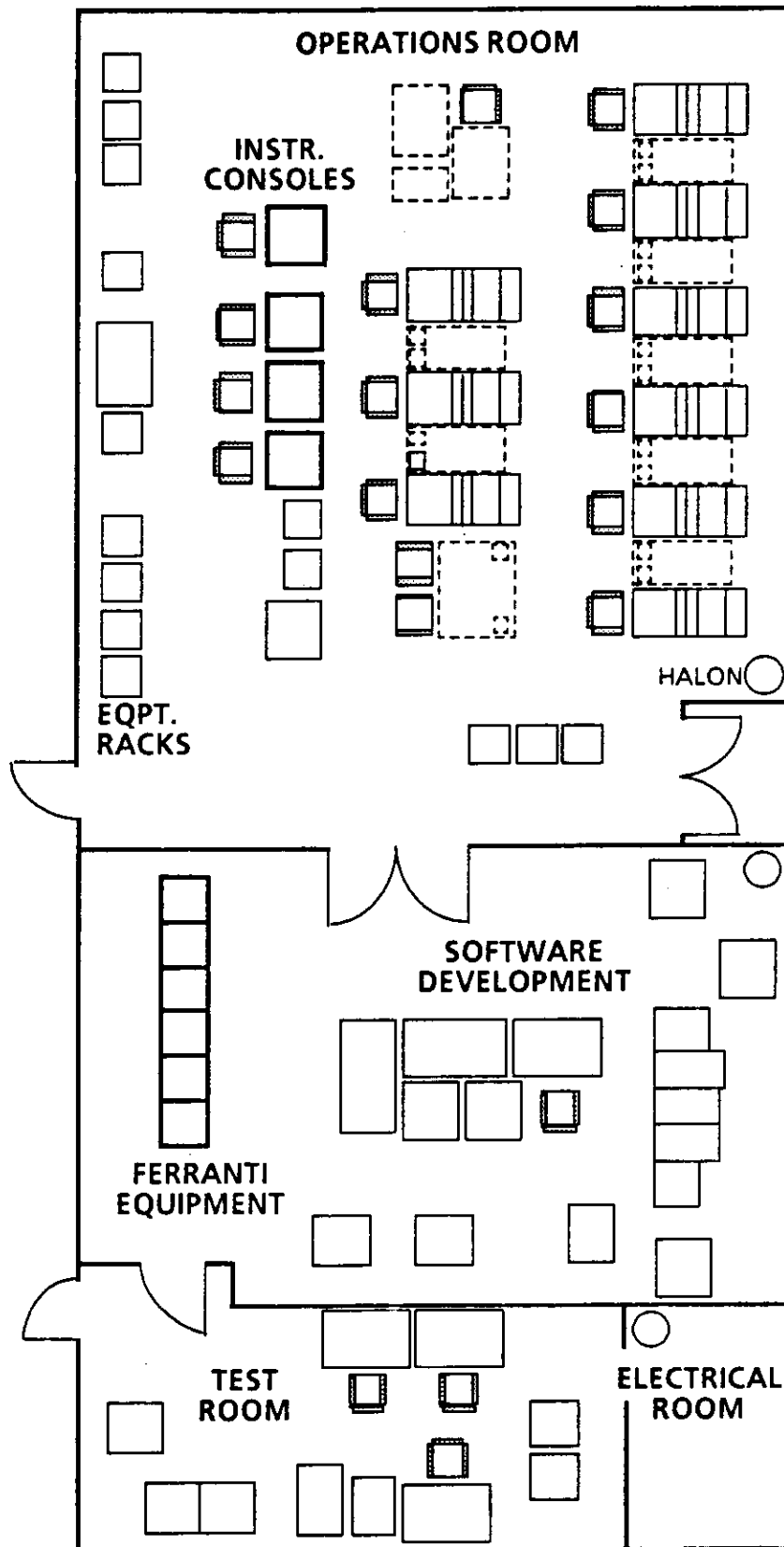
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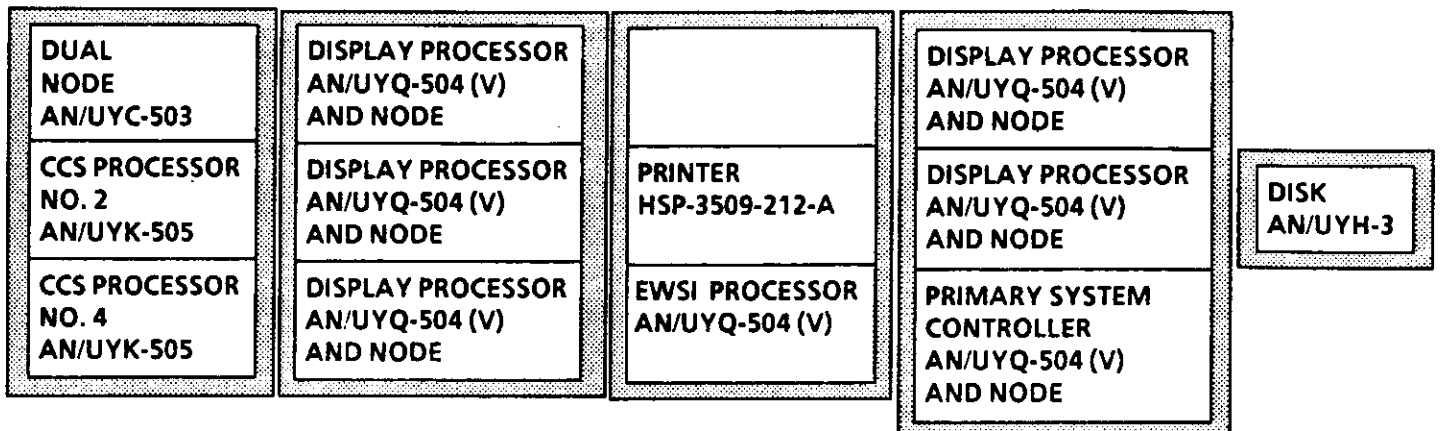
FWD



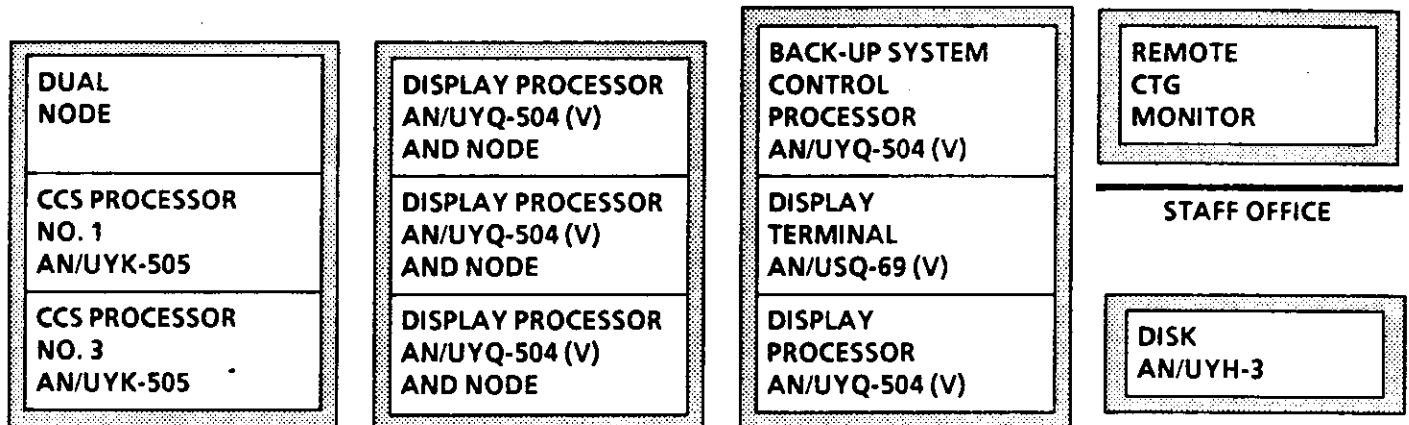
STAFF OFFICE

CBS-T0513

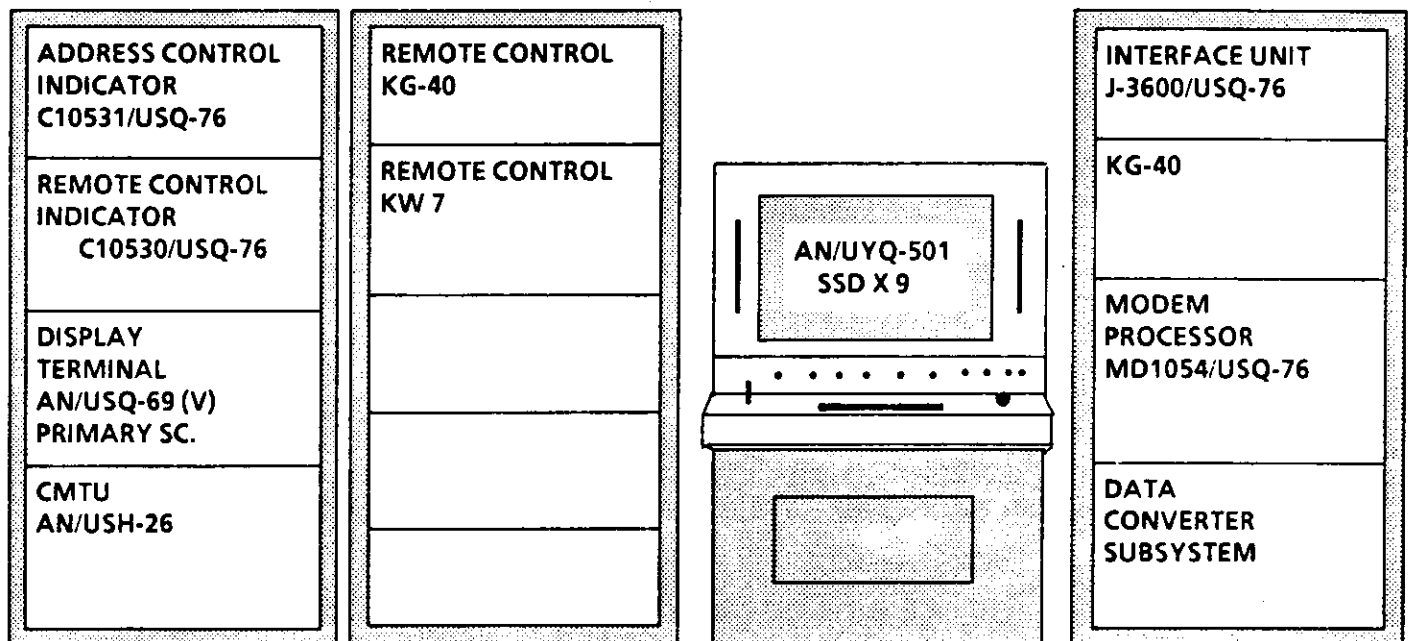




EQUIPMENT ROOM NO.1



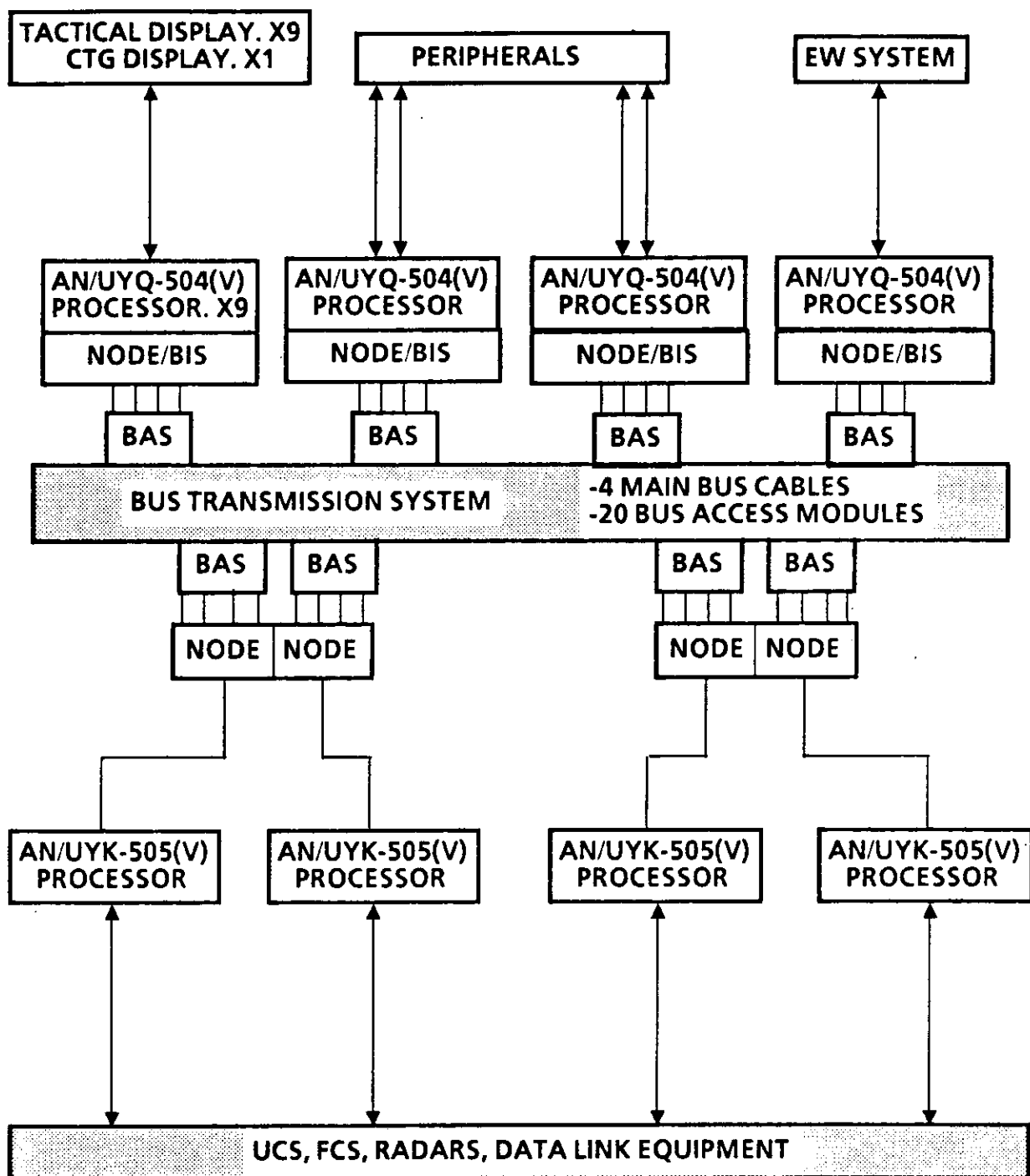
EQUIPMENT ROOM NO.2



OPERATIONS ROOM

EQUIPMENT RACKING AND LOCATION

CBS-T0509



SERIAL DATA BUS

CBS-T0561

FUNCTION AVAILABILITY

	SSD	DTS
POWER UP AND INITIALIZATION		✓
RECONFIGURATION	✓	✓
DIAGNOSTIC S/W	✓	✓
DEBUG	✓	✓
SOFTWARE UPDATE		✓

SYSTEM CONTROLLER DISPLAY

AN/USQ-69

- Two displays, AN/USQ-69(V) Data Terminal Set
- Configuration
 - ASCII keyboard
 - MIL-STD-188C Serial interface
 - 3 memory pages
- Operator interface to System Controller Processor

ALERTS	ALARMS	ALARM IN QUEUE
24 ROWS X 80 COLUMNS		

SYSTEM CONTROLLER DATA TERMINAL SET SCREEN LAYOUT

MASTER CONTROL

A

INITIALIZATION

PROCESSOR
RELOAD

SUBSYSTEM
STATUS
SUMMARY

SUBSYSTEM
STATUS
DETAIL

SDB
COMPUTER
STATUS

SDB
STATUS

SOFTWARE
STATUS/
CONTROL

CANEWS
SUBSYSTEM
STATUS

STIR
SUBSYSTEM
STATUS

ATMS
SUBSYSTEM
STATUS

TRAINING
SUBSYSTEM
STATUS

SHIELD
SUBSYSTEM
STATUS

WDS
SUBSYSTEM
STATUS

LINK 11
SUBSYSTEM
STATUS

LINK 14
SUBSYSTEM
STATUS

SONAR
SUBSYSTEM
STATUS

RDDS
SUBSYSTEM
STATUS

TEWA
SUBSYSTEM
STATUS

SDC
SUBSYSTEM
STATUS

HISTORY
RECORDING
SUBSYSTEM
STATUS

NAVIGATION
SUBSYSTEM
STATUS

LIROD
SUBSYSTEM
STATUS

INDB
SUBSYSTEM
STATUS

DISPLAY
MANAGEMENT
SUBSYSTEM
STATUS

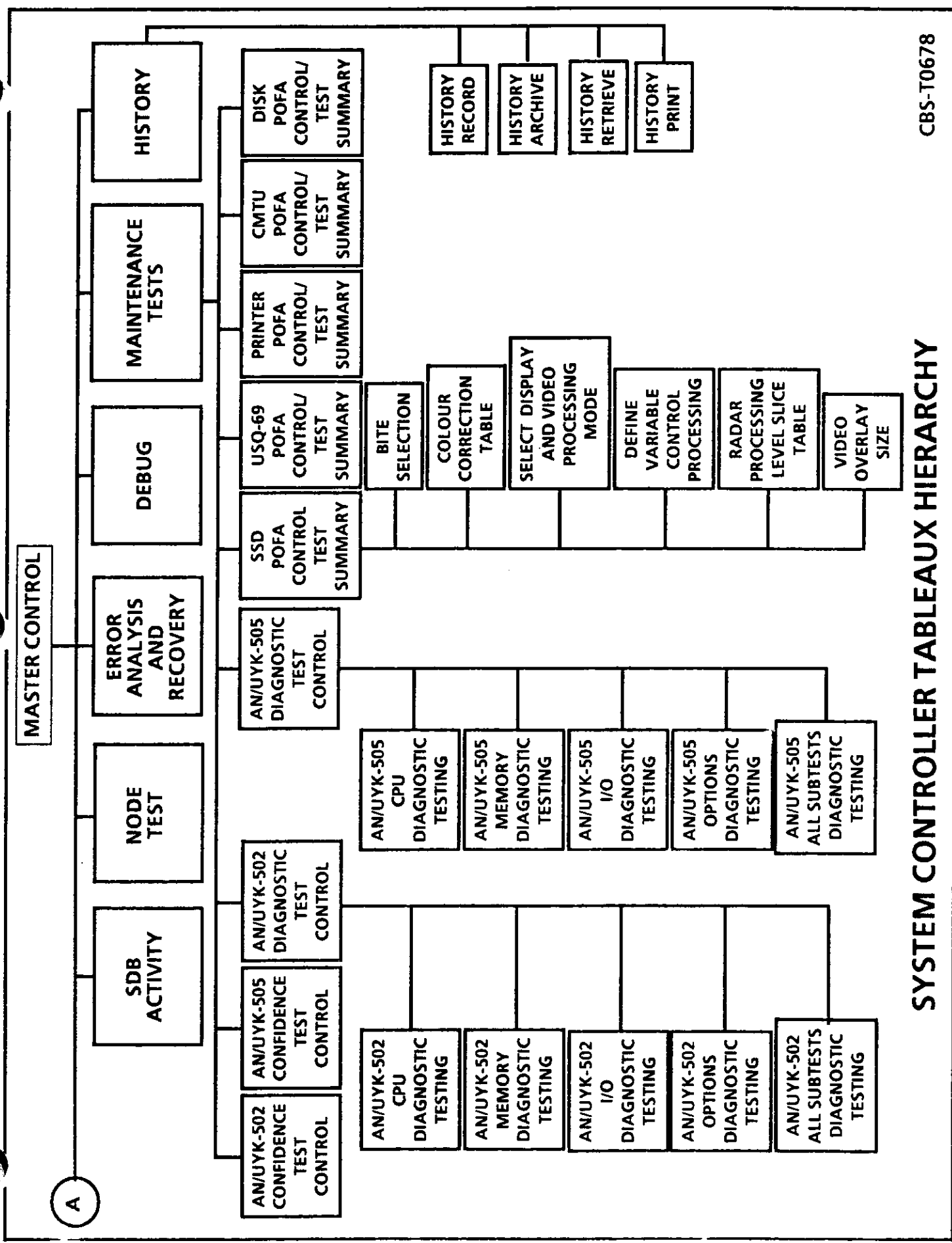
DATA
MANAGEMENT
SUBSYSTEM
STATUS

TRACK
MANAGEMENT
SUBSYSTEM
STATUS

CONTROL
MONITOR
SUBSYSTEM
STATUS

SYSTEM CONTROLLER TABLEAUX HIERARCHY

CBS-T0677



SYSTEM CONTROLLER TABLEAUX HIERARCHY

MASTER CONTROL

- < > INITIALIZATION
- < > PROCESSOR RELOAD
- < > SUBSYSTEM STATUS SUMMARY
- < > SUBSYSTEM STATUS DETAIL
- < > SDB COMPUTER STATUS
- < > SDB STATUS
- < > SOFTWARE STATUS / CONTROL
- < > SDB ACTIVITY
- < > NODE TEST
- < > ERROR ANALYSIS AND RECOVERY
- < > DEBUG
- < > MAINTENANCE TESTS
- < > HISTORY

INITIALIZATION

REQUEST COLD START : [n]

- | | | | |
|--------------|--------------|--------------|--------------|
| (1) CONFIG 1 | (2) CONFIG 2 | (3) CONFIG 3 | |
| (4) CONFIG 4 | (5) CONFIG 5 | (6) CONFIG 6 | (7) CONFIG 7 |

REQUEST DISPLAY MODE : [n]

- | | | |
|------------|------------|------------|
| (1) MODE 1 | (2) MODE 2 | (3) MODE 3 |
|------------|------------|------------|

PROCESSOR RELOAD

REQUEST RELOAD

< > SC1	< > DP6
< > SC2	< > DP7
< > EWSI	< > DP8
< > DP1	< > DP9
< > DP2	< > CCS 1
< > DP3	< > CCS 2
< > DP4	< > CCS 3
< > DP5	< > CCS 4

* - LOAD IN PROGRESS

SUBSYSTEM STATUS SUMMARY

DISPLAY MGMT	DP1	DP2	DP3	DP4	DP5	DP6	DP7	DP8	DP9	SC1	SC2
STATUS	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

CCS	1	DB	TM	NAV	LIROD	FCR-P	FCR-S	SONAR	SDC
ROLE		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
STATUS		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

CCS	2							ATMS	WDS	INDB
ROLE		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
STATUS		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

CCS	3			RDDS	H REC	TEWA	TEWA		
ROLE		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
STATUS		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

CCS	4					TRAIN	LNK11	LNK14	H PBK
ROLE		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
STATUS		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

EWSI

ROLE	XXXX	XXXX	XXXX	XXXX
STATUS	XXXX	XXXX	XXXX	XXXX

SC	CM	H FM
1 ROLE	XXXXXX	XXXXXX
STATUS	XXXXXX	XXXXXX
2 ROLE	XXXXXX	XXXXXX
STATUS	XXXXXX	XXXXXX

REQUEST SUBSYSTEM STATUS

CBS-T0574

SHIELD SUBSYSTEM STATUS - SUBSYSTEM

MODE	XXXXX			PATTERN	XXXXX
FIRE DELAY	XXX			REC HDG	ddd
CHKFIRE	XXXXXXXX			SP CHG	XXXXX
		PORT	STBD	PORT	STBD
LCHR	XXXXXX		XXXXXX		
IR LOADED				CHAFF LOADED	
FWD	XXX		XXX	FWD	XXX
AFT	XXX		XXX	AFT	XXX
IR FIRING		XXX		CHAFF FIRED	XXX
FWD	XXX		XXX	F/RNG	nnnnn
AFT	XXX		XXX	A/RNG	nnnnn
TM UPDTD		hhmm ss		TM FIRED	hhmm ss

XXXXXXXXXXXXXXXXX SUBSYSTEM STATUS - INTERFACE

PROCESSOR	CCSa	CCSb
ROLE	X	X
STATUS	XXXXXX	XXXXXX

VALID INTERFACE ROLES

- 1 - PRIMARY
- 2 - ALTERNATE
- 3 - DISABLED

[illegible]

< > ACTIVATE SELECTED CONFIGURATION

HISTORY ARCHIVE

TAPE LOADED IN DRIVE (Y/N) : n

CMTU DRIVE NO:

< > DRIVE ONE < > DRIVE TWO < > DRIVE THREE < > DRIVE FOUR

OVERWRITE DATA ON TAPE (Y/N) : x

ARCHIVE :

< > FIRST SEGMENT
< > SECOND SEGMENT
< > THIRD SEGMENT
< > CONTINUOUS

SEGMENT DATA

START TIME

yyyy ddd hhmm ss
yyyy ddd hhmm ss
yyyy ddd hhmm ss

STOP TIME

yyyy ddd hhmm ss
yyyy ddd hhmm ss
yyyy ddd hhmm ss

HISTORY RECORDING

RECORD

START TIME : yyyy ddd hhmm ss

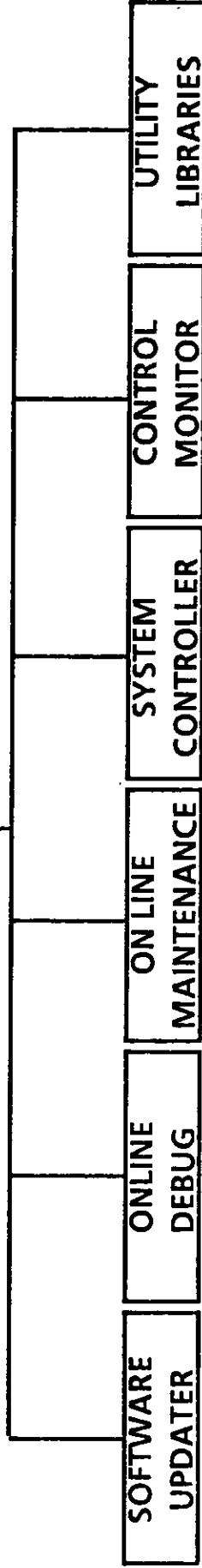
STOP TIME : yyyy ddd hhmm ss

RATE (1 - 5) : n

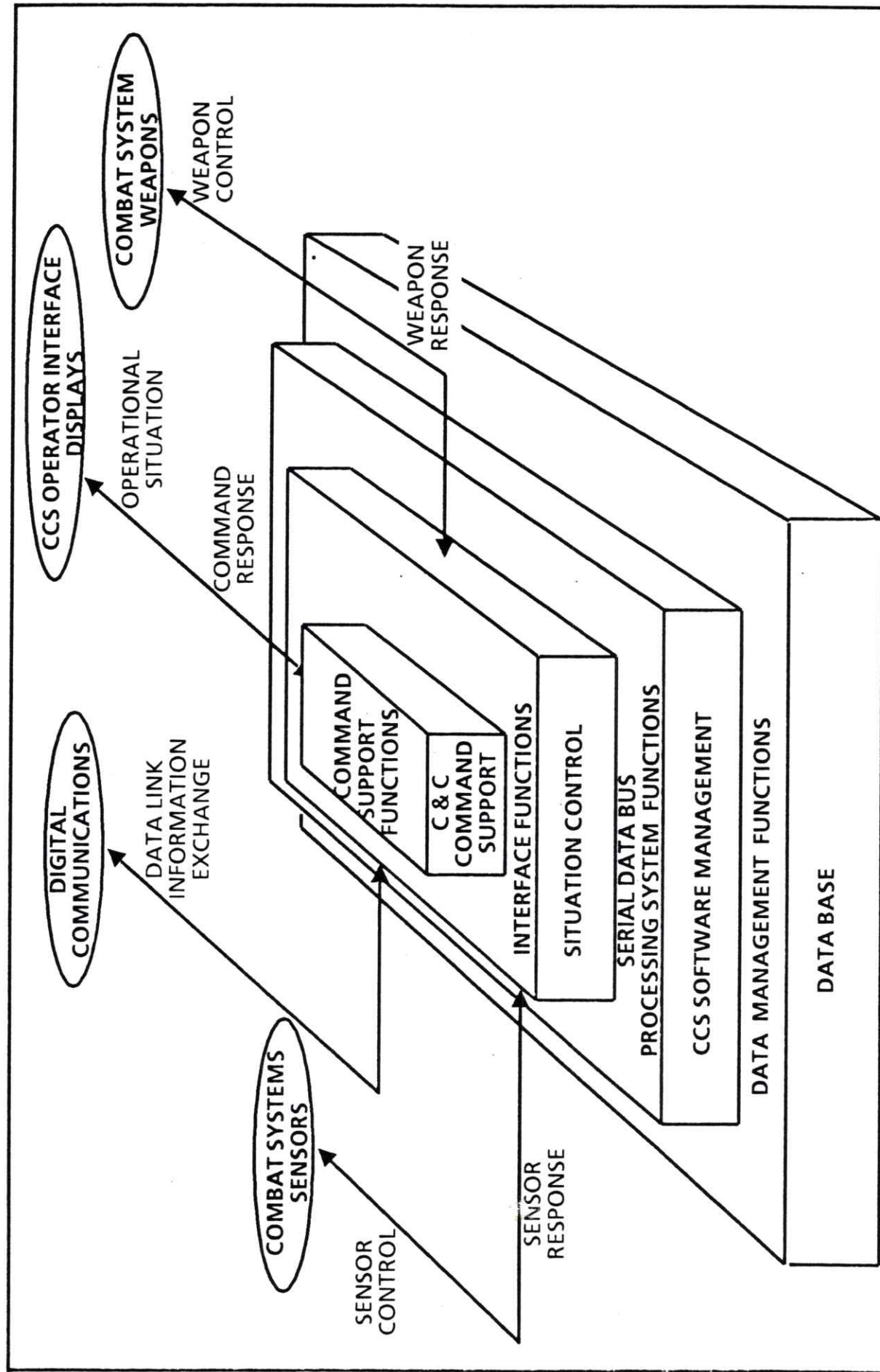
OVERWRITE RECORDED DATA (Y/N) : x

STOP RECORDING NOW < >

TRUMP OPERATING SYSTEM

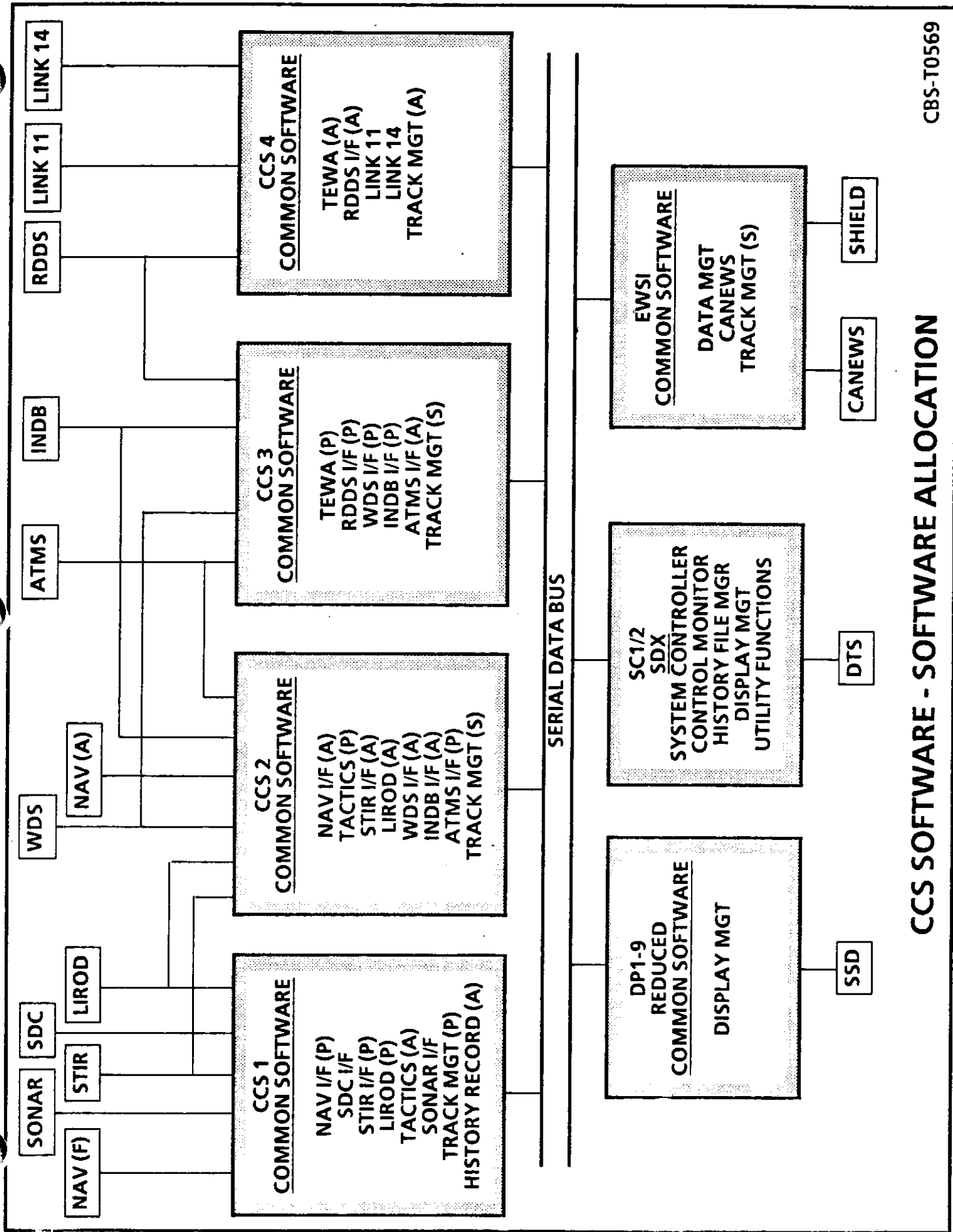


SOFTWARE ARCHITECTURE



TRUMP COMBAT SYSTEM CCS SOFTWARE RELATIONSHIP

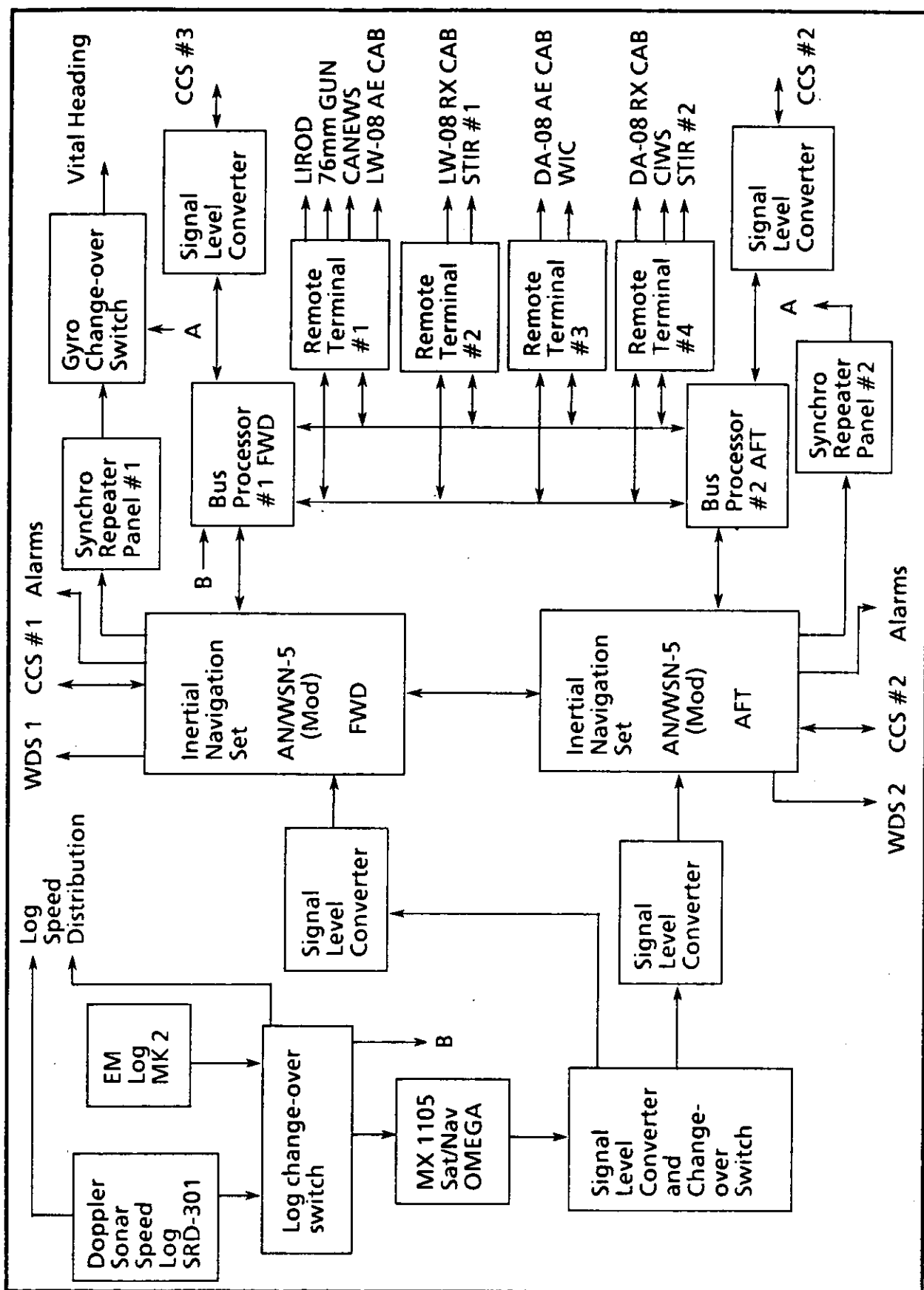
CBST0679



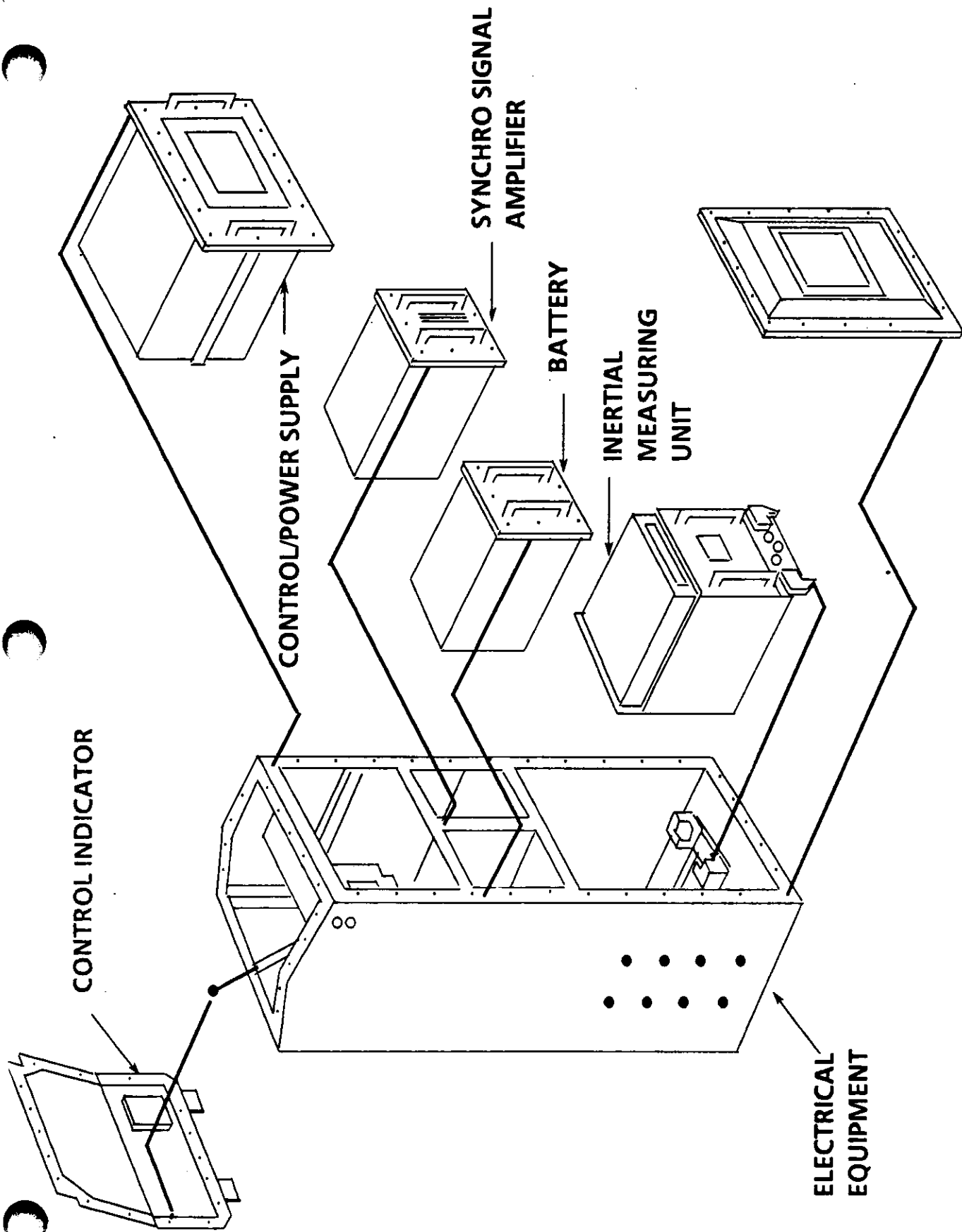
CCS SOFTWARE - SOFTWARE ALLOCATION

CBS-T0569

ATTACHMENT 2
INTEGRATED NAVIGATION SYSTEM



INTEGRATED NAVIGATION SYSTEM

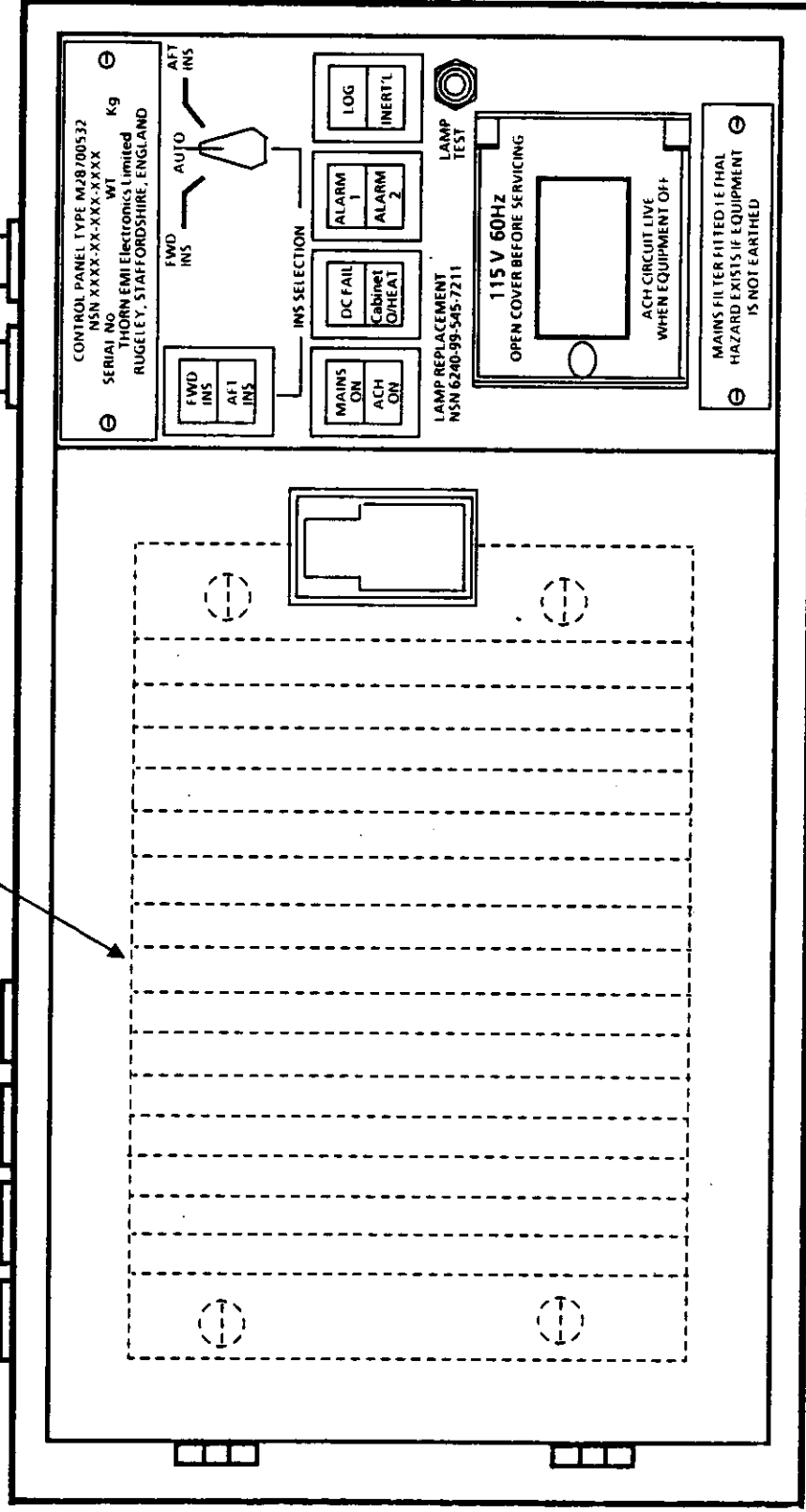


MODULAR DESIGN OF AN/WSN-5 (MOD) INS

I/O CONNECTORS

RACK ASSEMBLY
HOUSING D3 PECS

POWER / REFERENCE
CONNECTORS

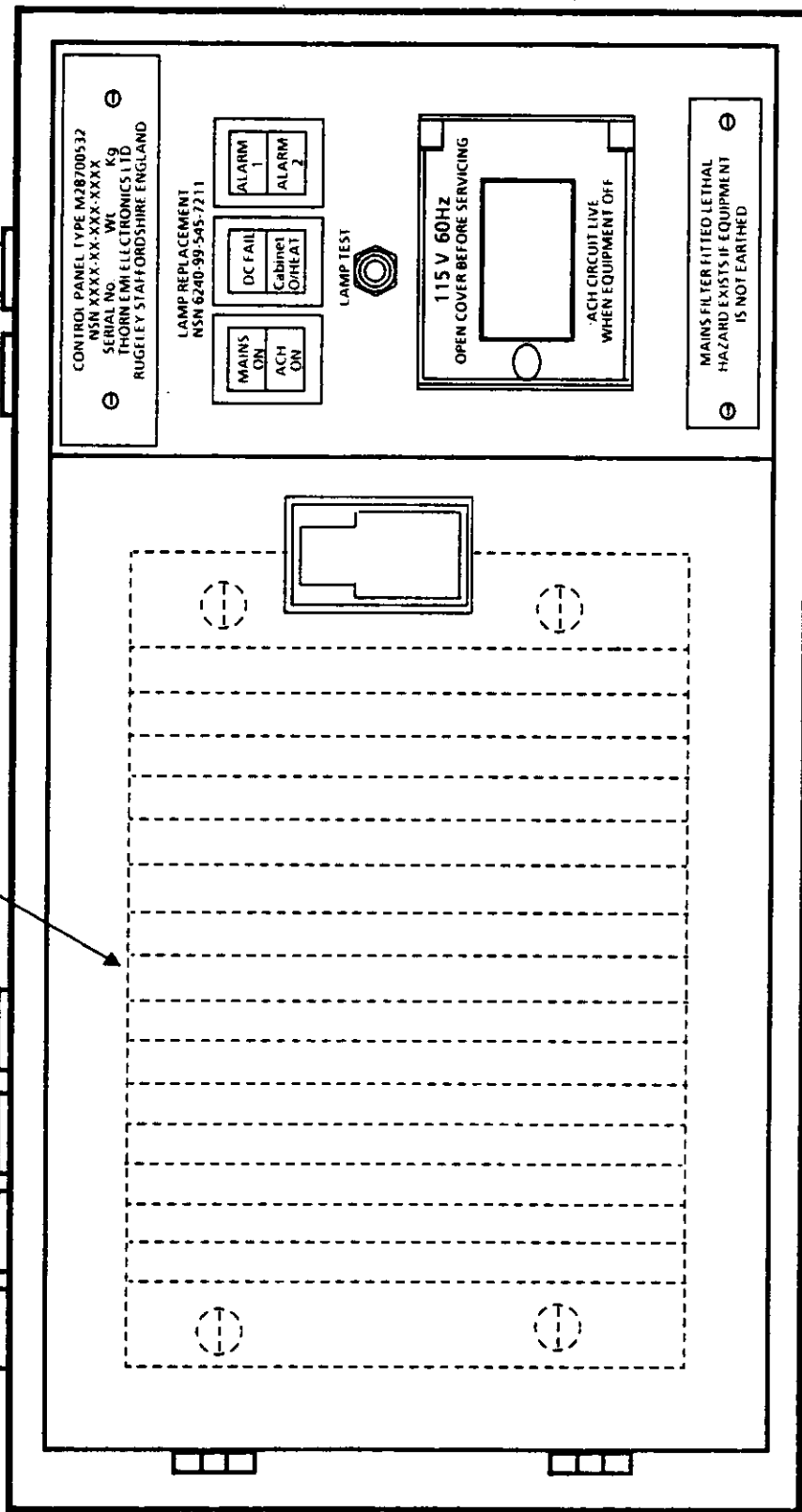


INDB UNIT

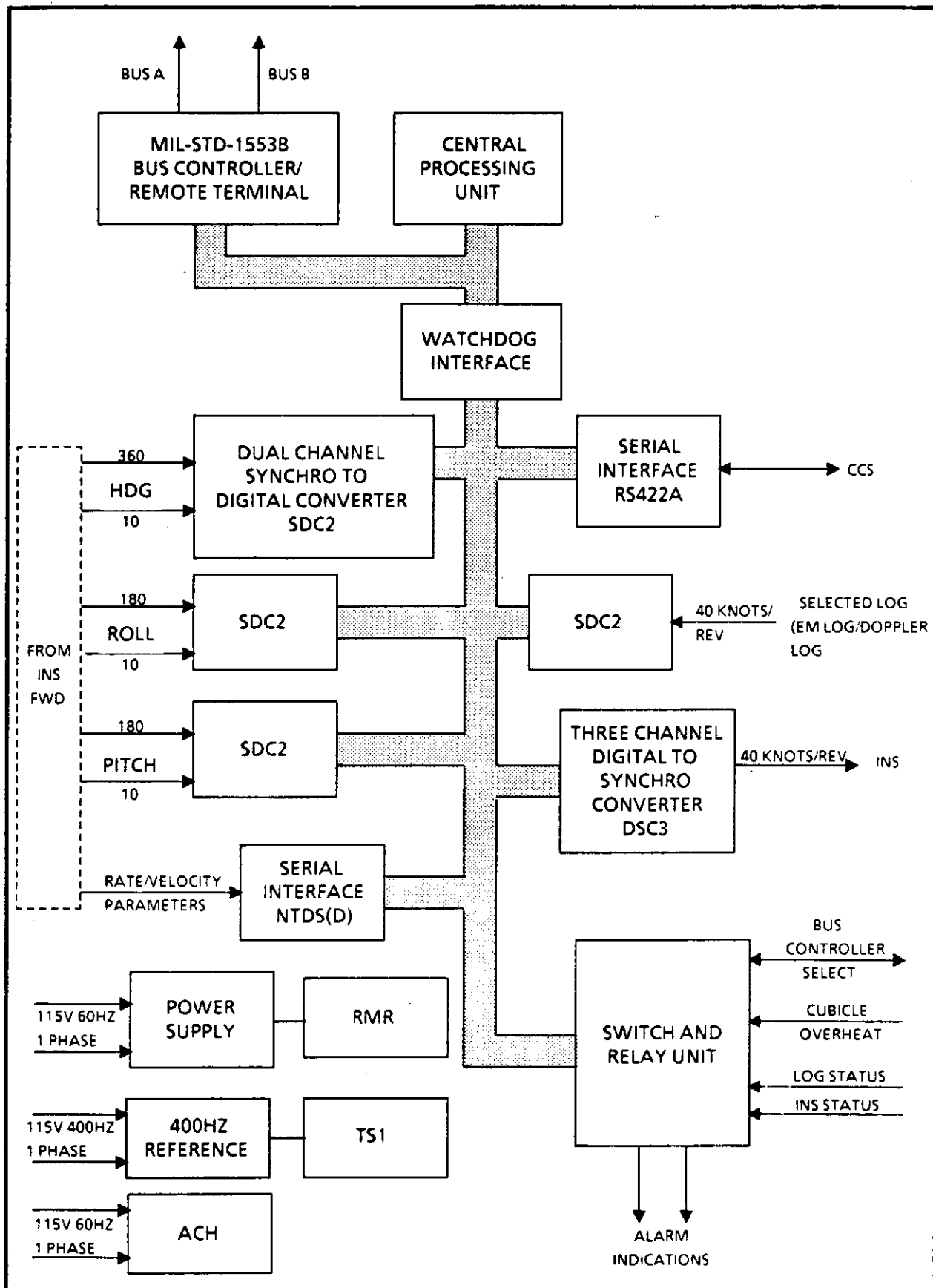
I/O CONNECTORS

RACK ASSEMBLY
HOUSING D3 PECS

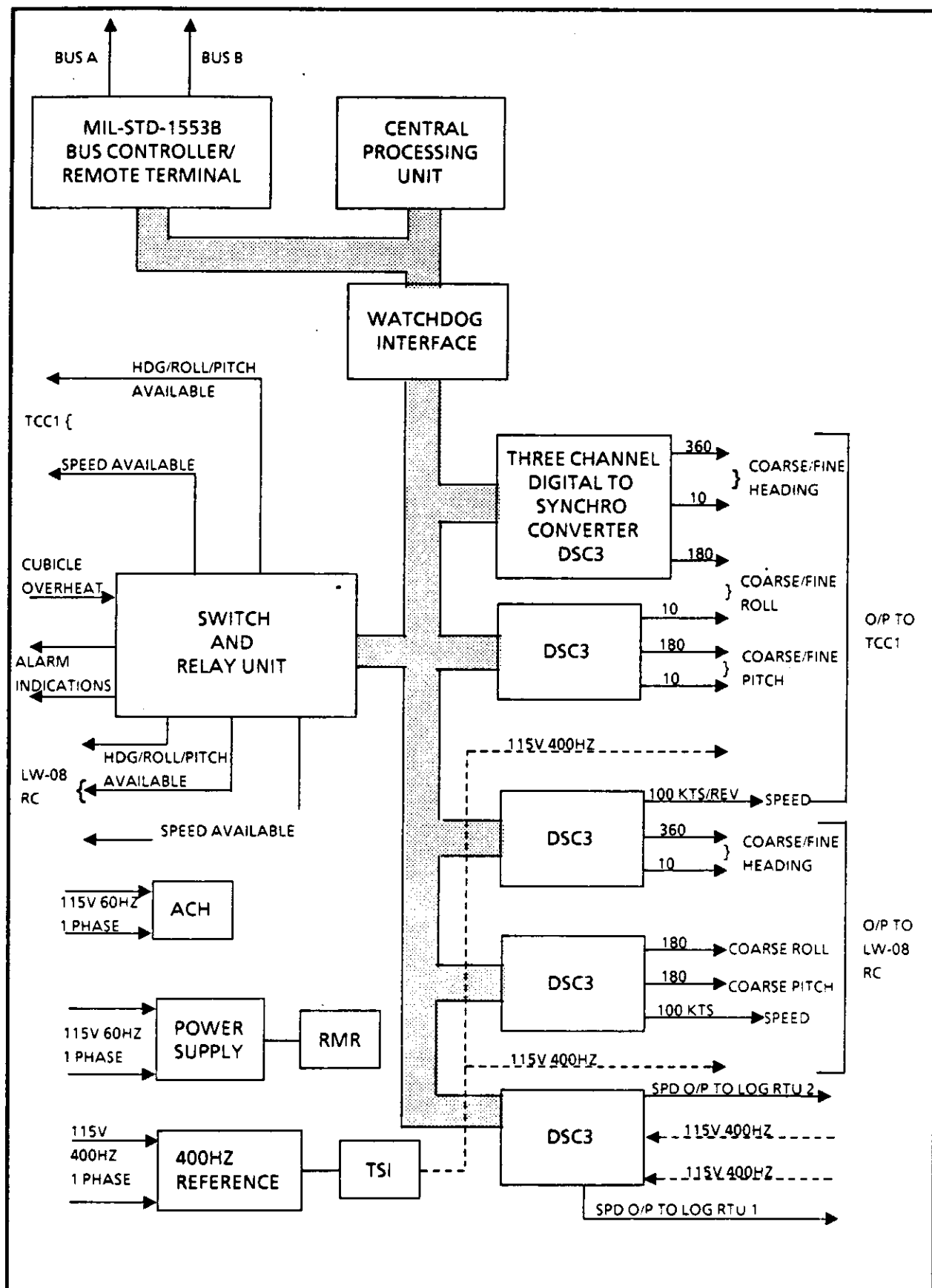
POWER / REFERENCE
CONNECTORS



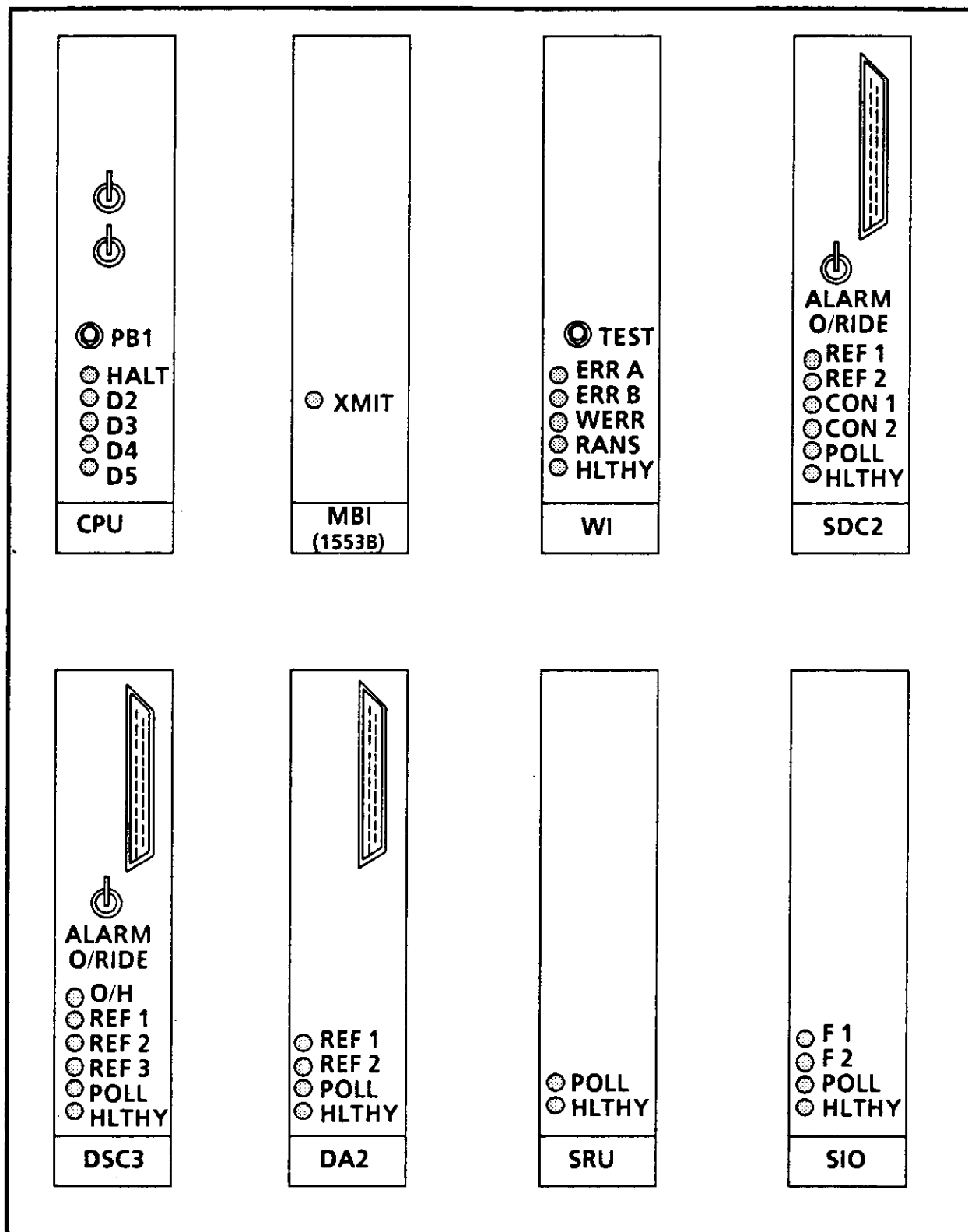
INDB REMOTE TERMINAL UNIT



INDB BUS PROCESSOR CONFIGURATION / LAYOUT

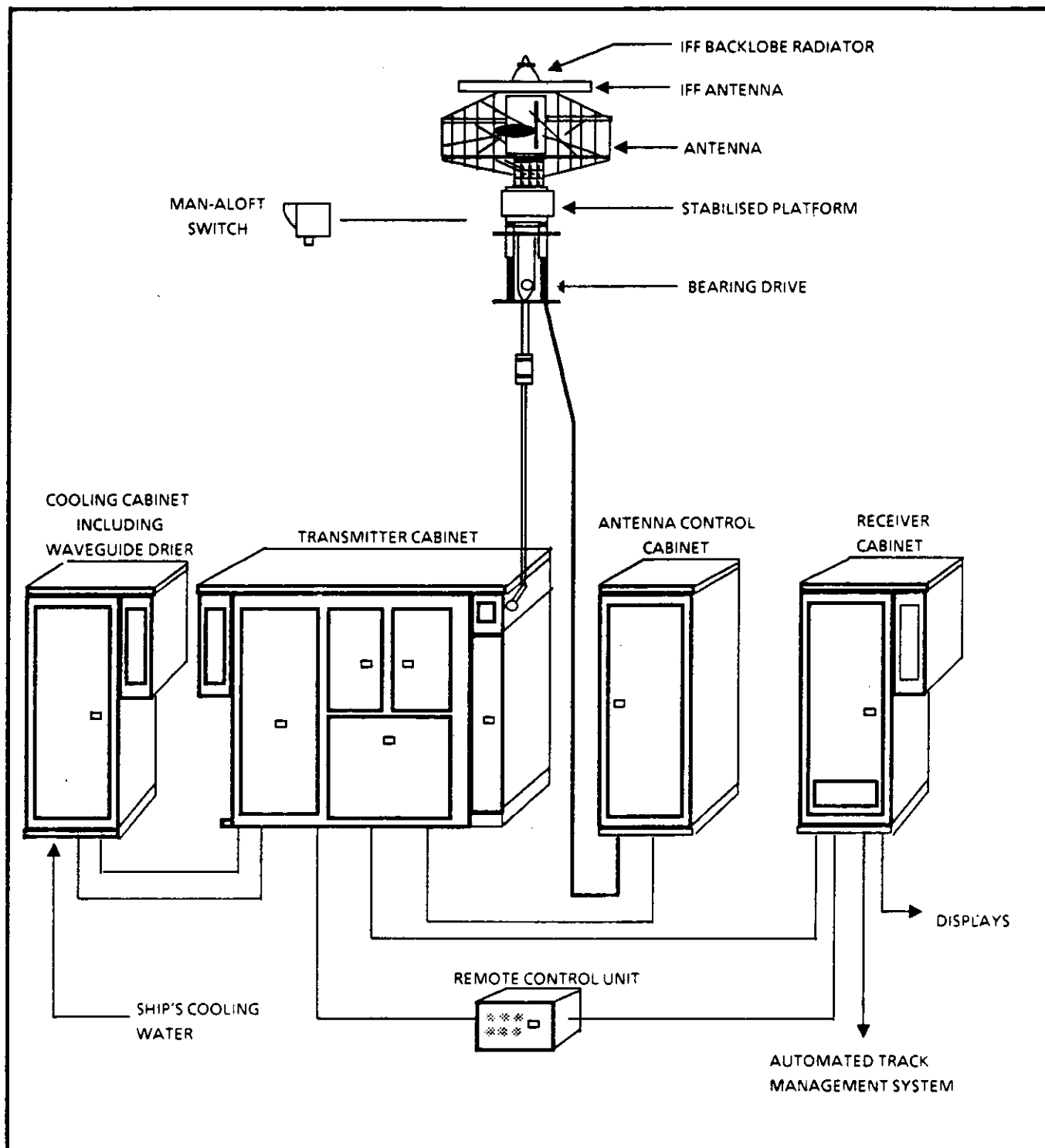


INDB CONFIGURATION / LAYOUT REMOTE TERMINAL



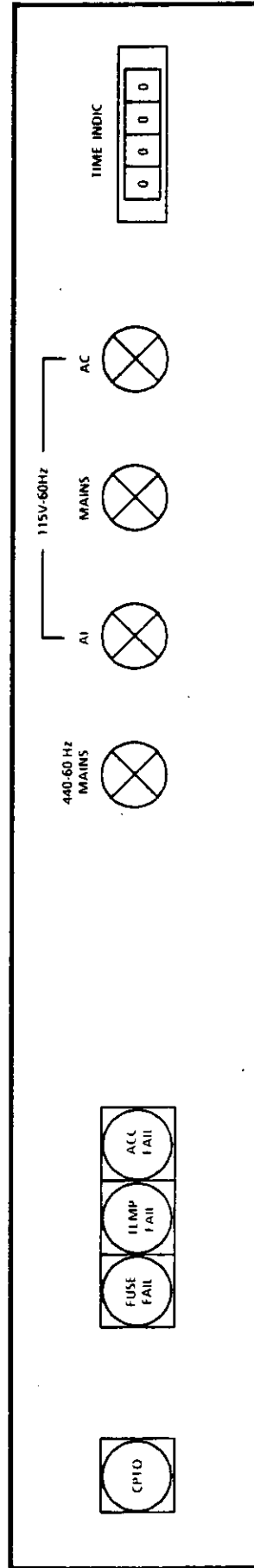
INDB CARD BIT INDICATORS

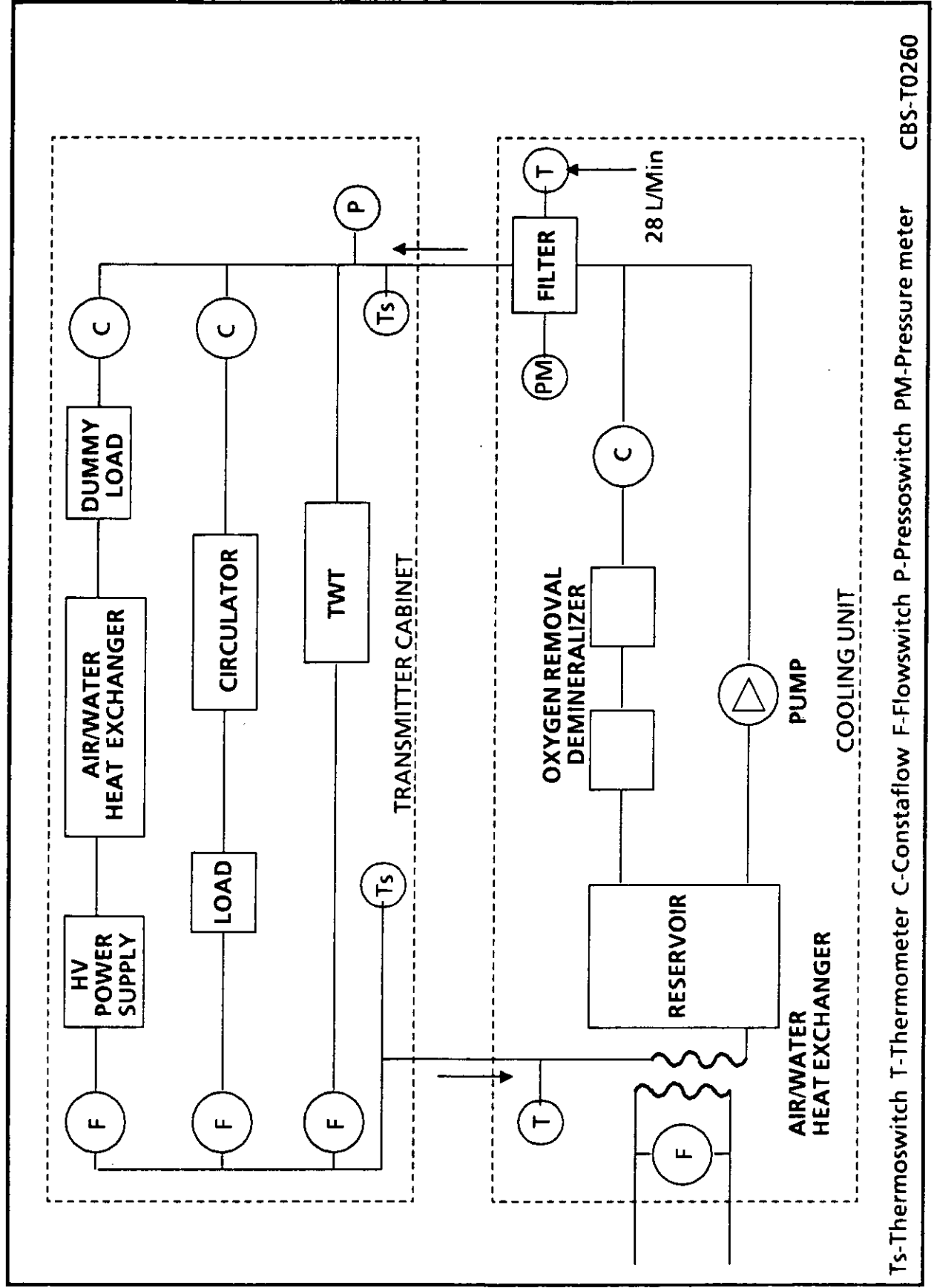
ATTACHMENT 3
RADAR SYSTEM



DA-08 Radar System

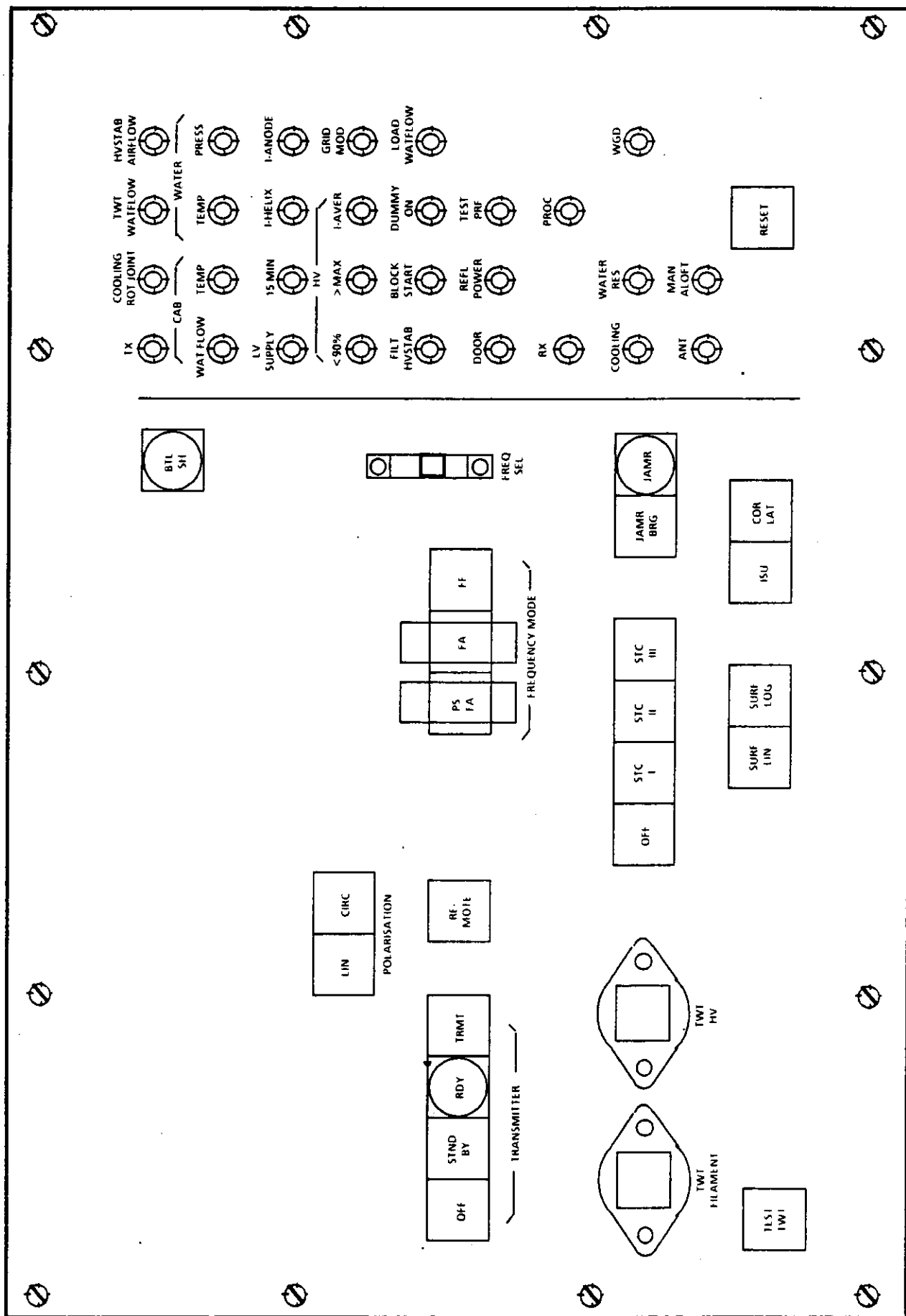
TOP PANEL - ANTENNA CONTROL CABINET

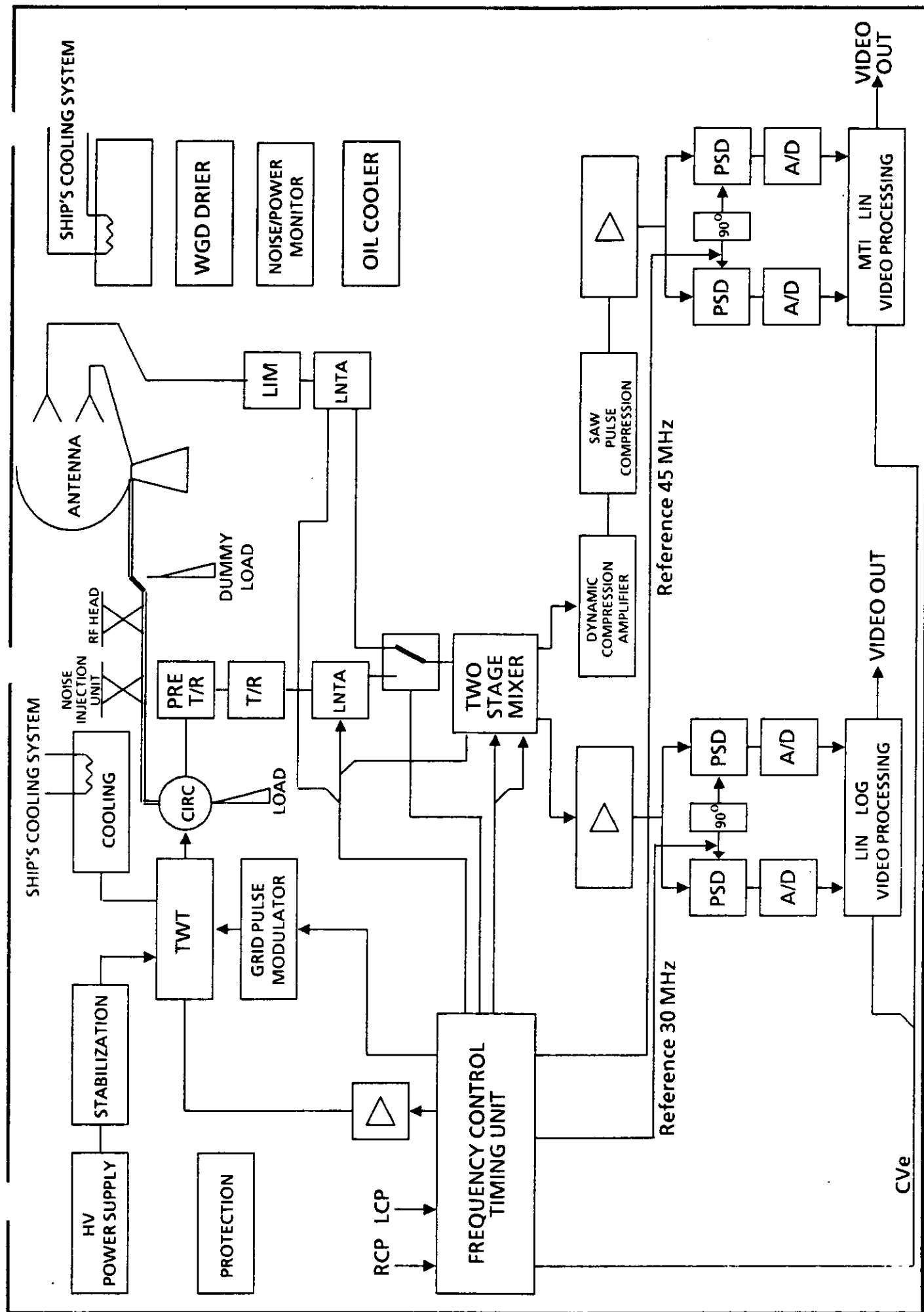




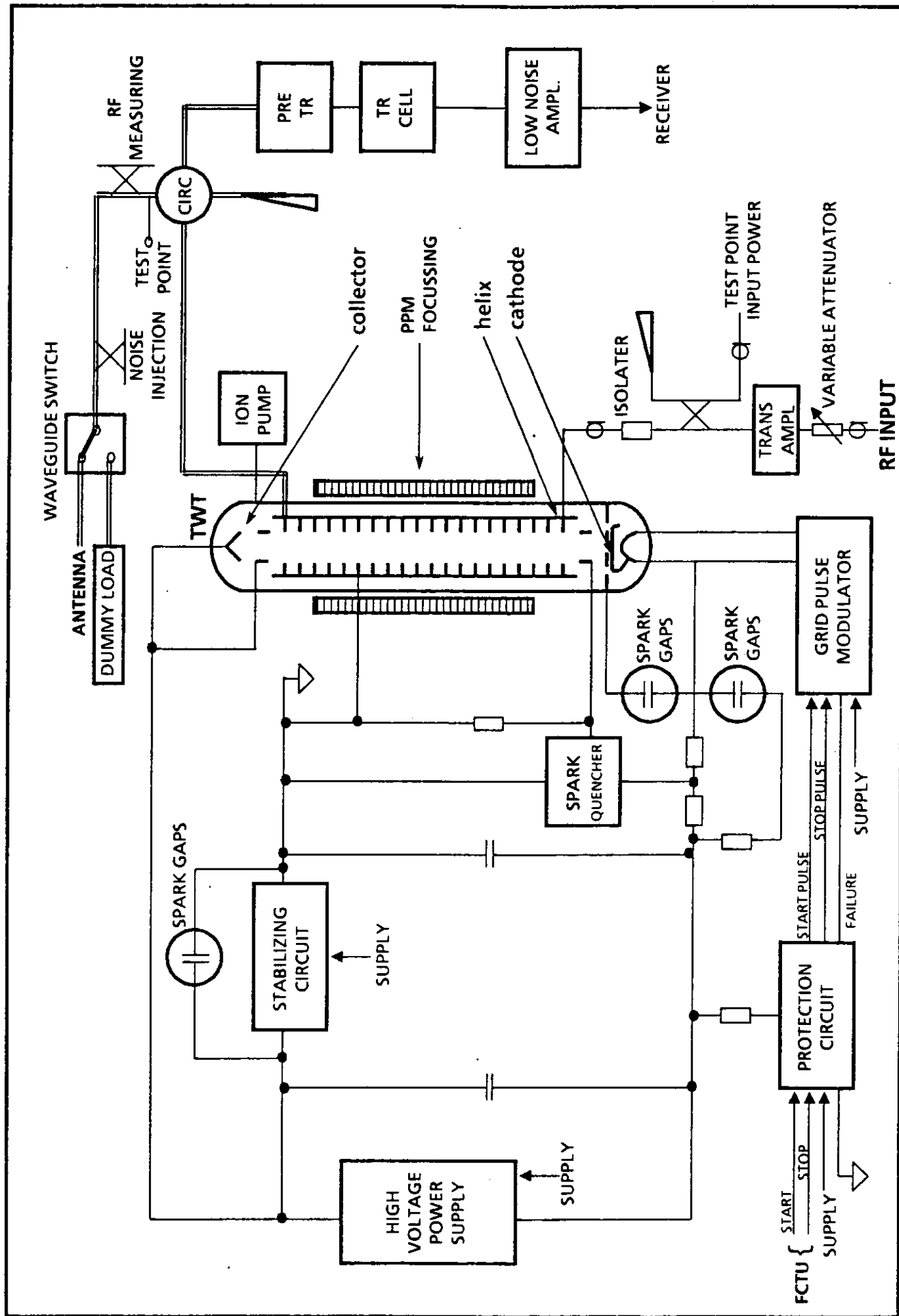
COOLING DIAGRAM

LOCAL CONTROL PANEL DA-08 TRANSMITTER CABINET

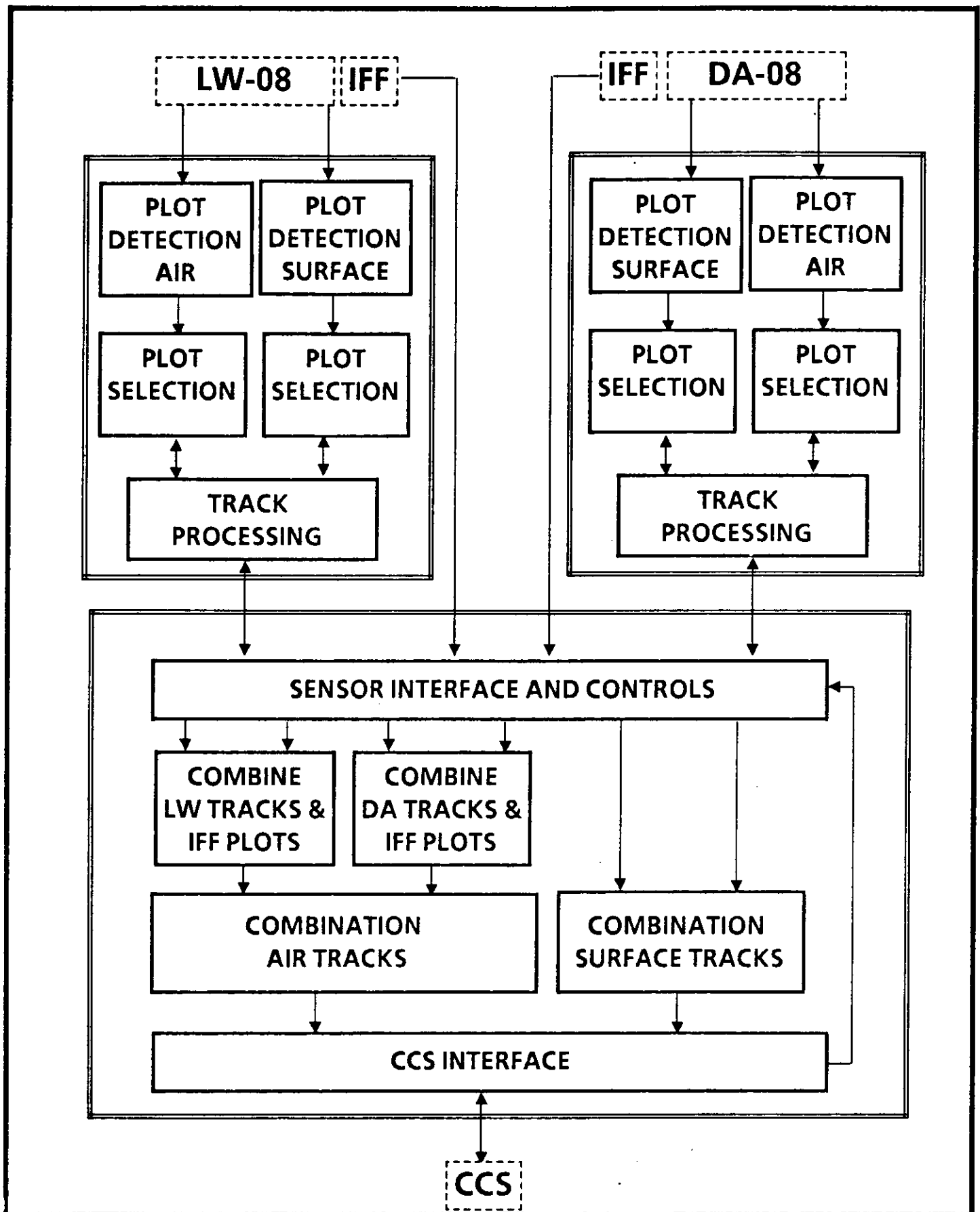




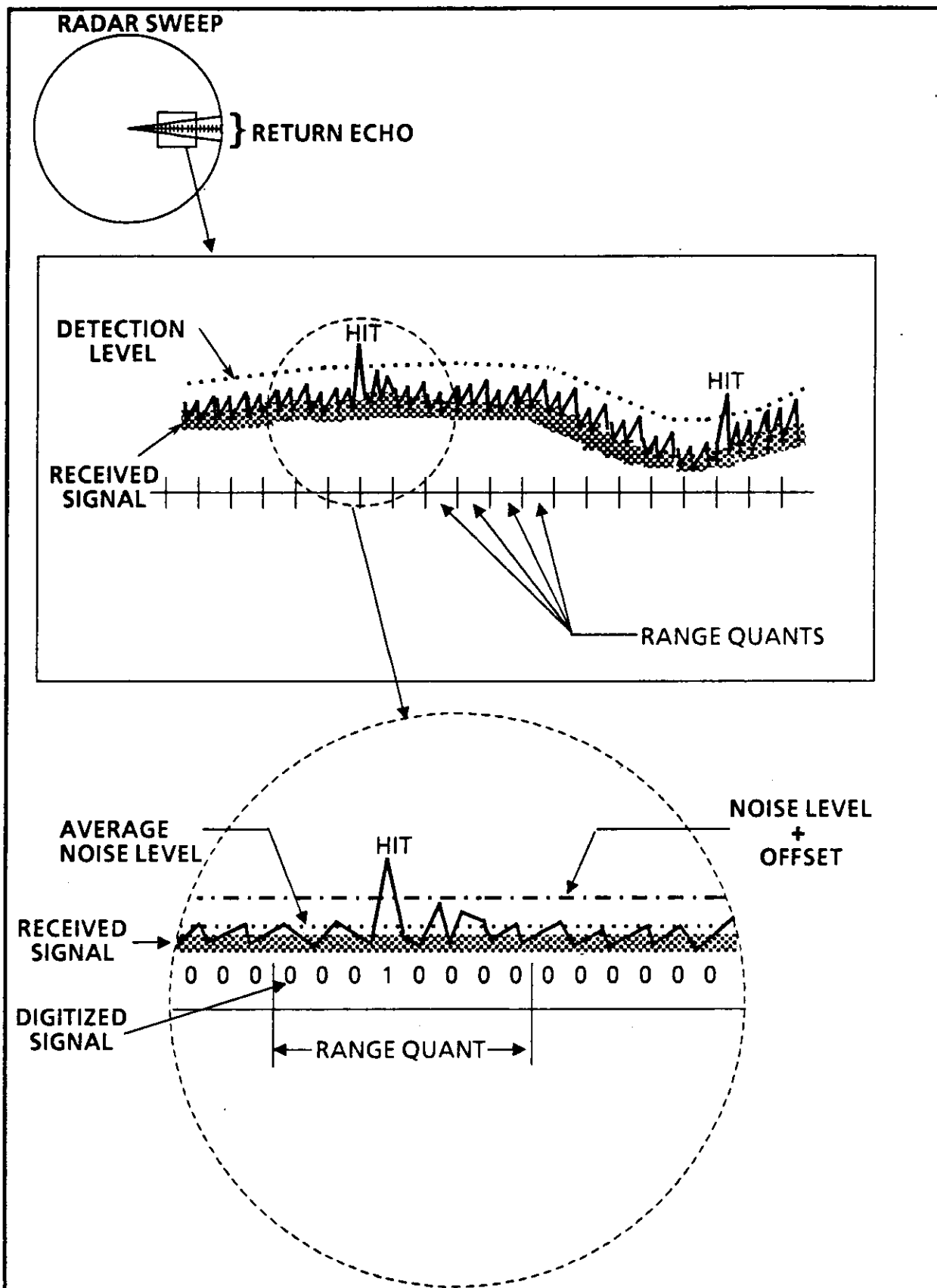
DA-08 Functional Block



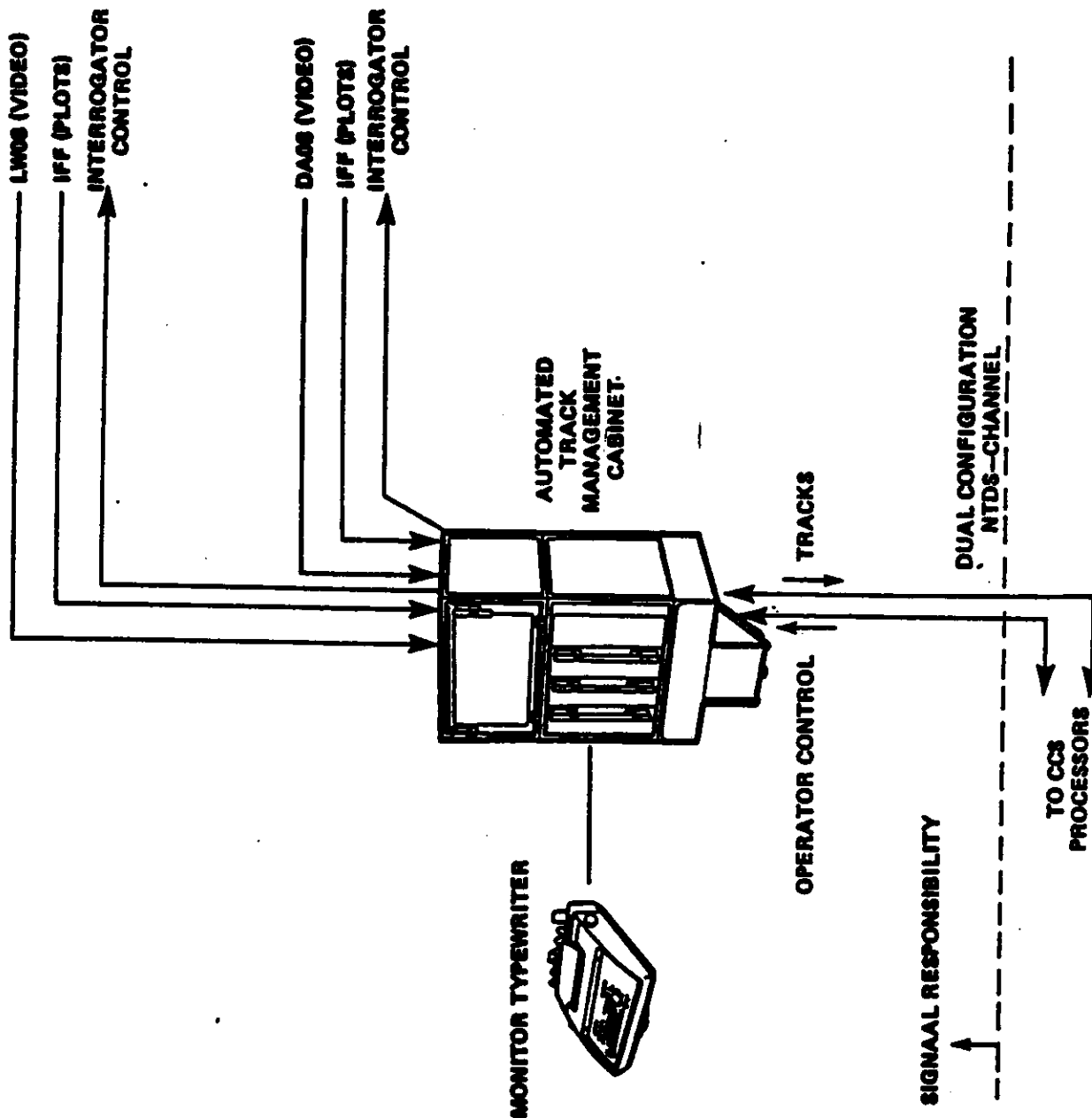
DA-08 TRANSMITTER BLOCK DIAGRAM



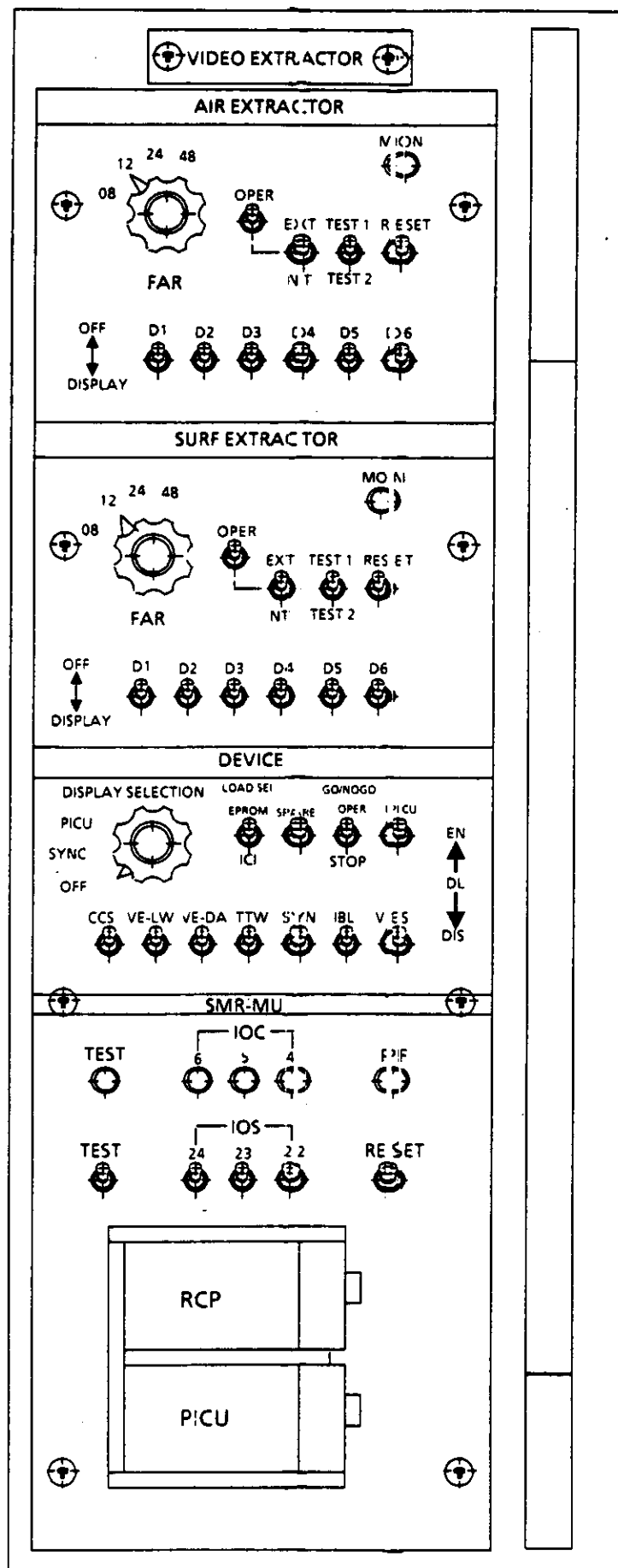
ATMS FUNCTIONAL BLOCK DIAGRAM



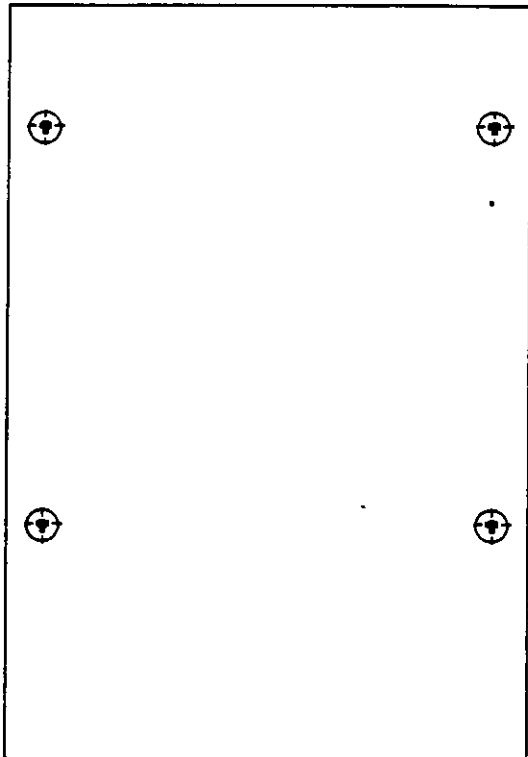
HIT DETECTION



ATMS Equipment Configuration



TRACK/PLOT COMBINER



DEVICE

DISPLAY SELECTION LOAD SET FORWARD

PICU EPROM SPARE OPER PICU

SYNC ICI STOP

OFF

CCS VE-LW VE-DA TTW SYN IBL VES

EN DL DIS

SMR-MU

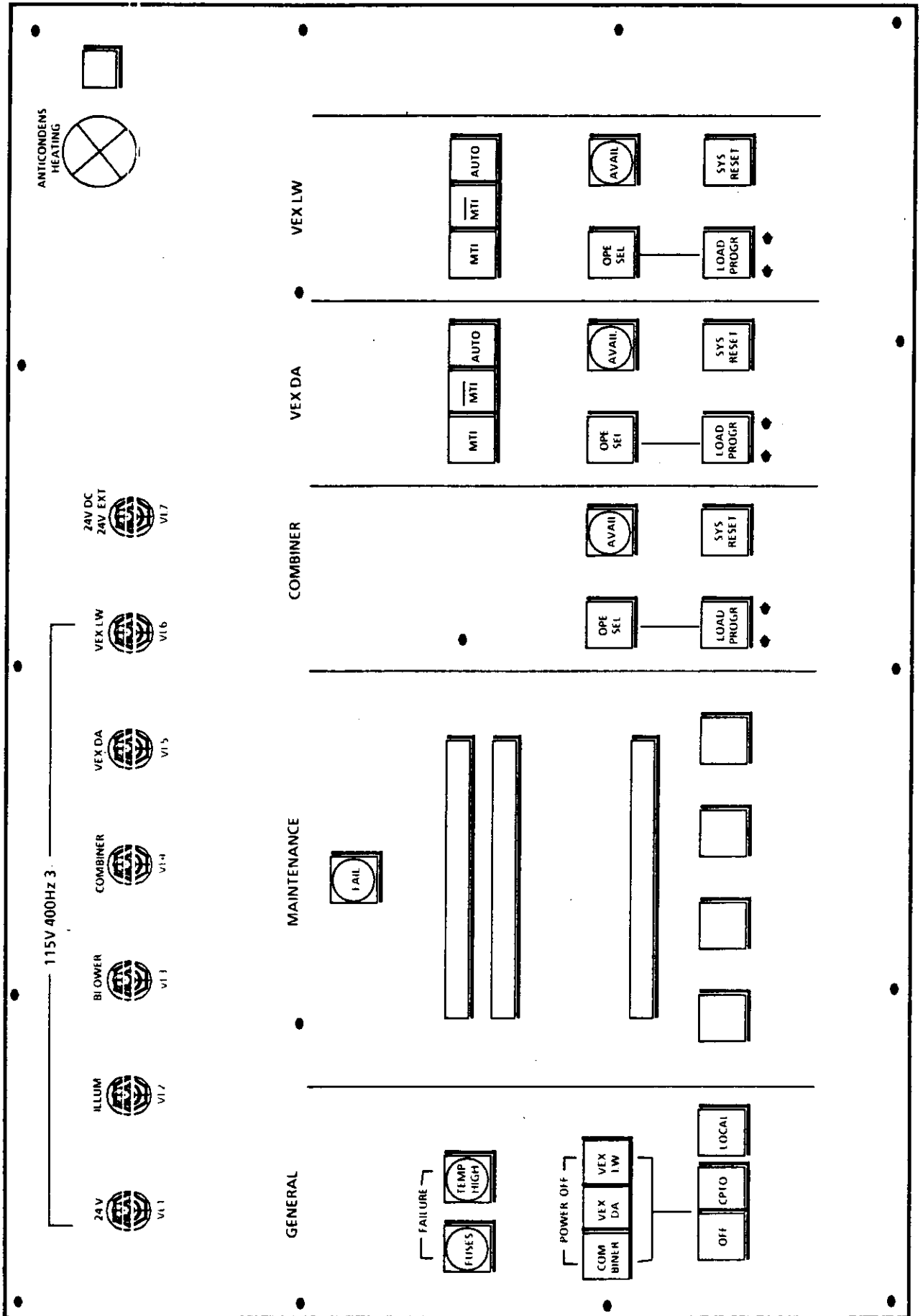
TEST IOC PF

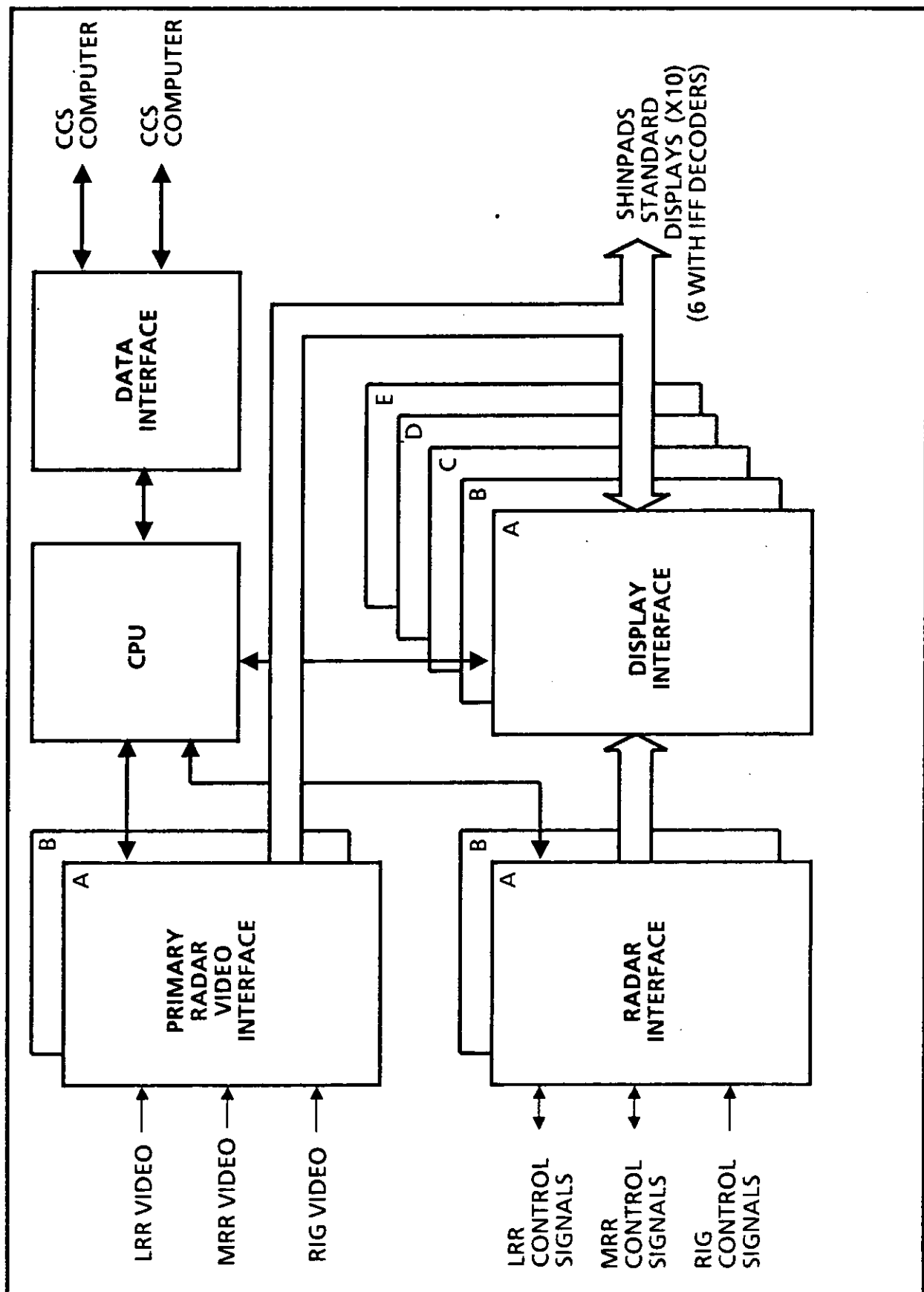
TEST IOS RESET

RCP

PICU

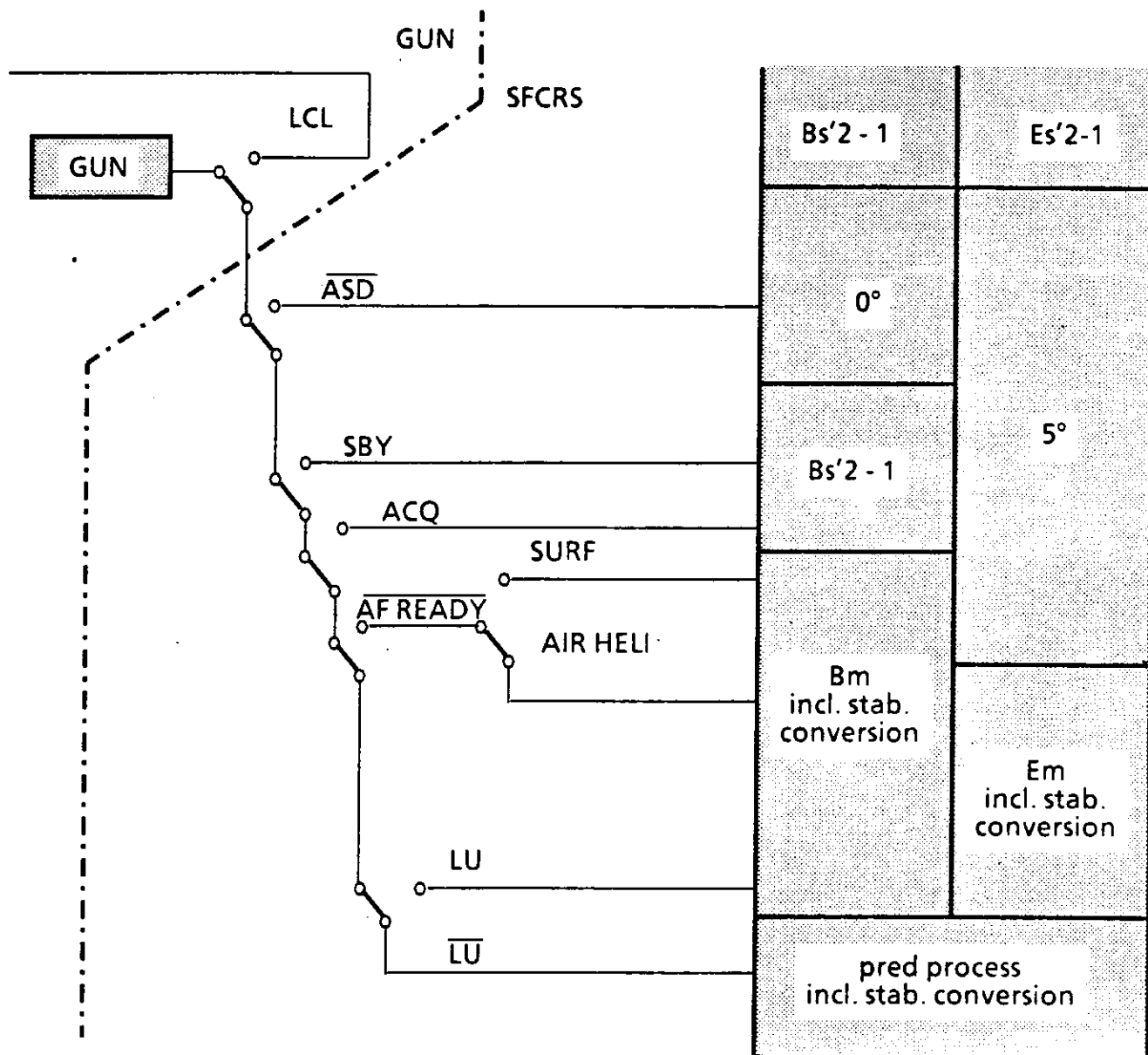
LOCAL CONTROL PANEL ATMS





RDDS FUNCTIONAL BLOCK DIAGRAM

ATTACHMENT 4
FIRE CONTROL SYSTEM



Legend

ACQ = Acquiring	Bm = Target bearing (hor)
LCL = Local	Em = Target elevation (hor)
ASD = Assigned	Bs'2 - 1 = Previous gun bearing
SYS = Stand-by	Es'2 - 1 = Previous gun elevation

(SWITCH CONTACTS ARE SYMBOLIC*)

GUN CONTROL DIAGRAM

OPTRONIC TRACK

TV CAMERA

The TV Camera will supply a CCIR standard TV video signal, 625 lines, 25 pictures/sec, 2:1 interlaced.

The scanning of the total "picture" will be done by 2 frames (even and odd). The even frames cover the lines 2 until 576 and the odd frame cover the lines 1 until 575 (note: line 1 and line 576 are displayed during the time of a half line).

At the end of every line a synchronization pulse occurs (called Horizontal Sync - HS -). The time between two HS pulses is 64 μ sec (equal to 1 scan line including its sync pulse). The scanning beam will be fed back to the left side of the scanning area and starts again with the next line (Horizontal flyback).

At the bottom of a frame a Vertical Sync (VS) pulse exists (every 20 msec). This sync pulse forces the scanning beam back to the top of the picture (Vertical flyback). The Vertical Sync occurs after line 575 or 576.

The camera video contains the total video signal including the Horizontal and Vertical sync pulses.

TV TRACK UNIT

The TV track unit receives the video signal from the TV camera. The video signal is transmitted to the video circuit. This video circuit eliminates the common noise, brings the black level of the video signal to a zero voltage level and separates the HS and VS sync pulses from the video signal, which can be used inside the track unit.

Because a digital Center of Gravity calculator is used in this track unit, the analogue TV video is converted into a digital signal. This job is done by the video processor.

Two types of processing systems are available:

- Differentiation process
- Quantization process

The differentiation process will generate a digital video, based on the contrast differences of the analogue video. This process results in a video which represents the contours of the TV video signal.

The Quantization process builds up a threshold that depends on the total picture (target as well as background). All the video greater than this threshold becomes bright, remaining video becomes dark. This process makes it possible to separate a target inside a background with a relative small contrast difference (for instance a target inside a foggy background where the differentiator would not work very well).

For the Quantization process it will be necessary to have a brighter target in respect to its background (for the case of differentiation process this is not necessary). In case the target is darker than the background the track will be lost.

The Quantization process can be handled in a inversed mode. Before Quantization the video is inverted.

The operator selects which video should be used by the track unit.

In very weak cases the Quantization process should be used which means the operator has to pay special attention.

The different types (3) of processed video which are available are:

- Differentiated video -TVD
- Quantized video -TQ1
- Quantized video inverted -TQ2

The selection which video should be used is done by the operator and depends on the situation.

For this reason the operator can select on the 15" monitor, along with Normal video (DSPVID), 3 kinds of processed videos (SYNTVD) and has the possibility to assign one of these 3 processed videos to the track calculation function.

The processed video will be connected to the correlator (one for track and one for display). The correlator filters the input video. Filtering suppresses spurious interference pulses and short noisy phenomena. This is done by comparing the current video against a one line delayed video. Video which exists in both lines will pass, all other video is suppressed.

The correlator divides the video into quants of 100 nsec (pixels).

Video quants are supplied two at a time to the center of gravity calculator for reasons of speed (VID1 and VID2; the parallel processing of these two quants allows processing to be done in 200 nsec instead of 100 nsec, so the bandwidth needed is 5 MHz not 10 MHz).

The Center of Gravity is calculated for Bearing and Elevation separately.

The calculation is done in 2 steps:

- summation of all the pixel coordinates inside the track gate for bearing and elevation.
- Division of this sum by the total amount of pixels inside the track gate.

In formule:

$$C_b = \frac{\sum \text{horizontal pixel coordinates}}{\text{total amount of pixels}}$$

$$C_e = \frac{\sum \text{vertical pixel coordinates}}{\text{total amount of pixels}}$$

C_b : Center of Gravity Bearing
 C_e : Center of Gravity Elevation

The summation takes place during the Track Gate. The division will be executed during the vertical flyback, just after the track gate that precedes the next picture.

This results into an "average" pixel for the bearing as well as elevation coordinates, with a coordinate system origin at the lefthand top side of the screen.

The input control moves this origin to the center of the track gate, and these values represent the error values of Bearing and Elevation, which is then sent to the computer.

The communication with the computer will be handled by the DCL TV TRACK (Device Control Logic). With a frequency of 64 Hz, the computer receives these error values from the TV track and the computer sends, with the same frequency, control data to the TV track. This is done by 6 data words (3 output words from the computer and 3 input words to the computer).

The input and output words are:

Input to the computer:

1. Error signals Bearing and Elevation.
2. Time of calculation of these error values (computer communications is not timed with the calculation frequency of 50 Hz).
3. Video counter contents, for controlling the gate size.

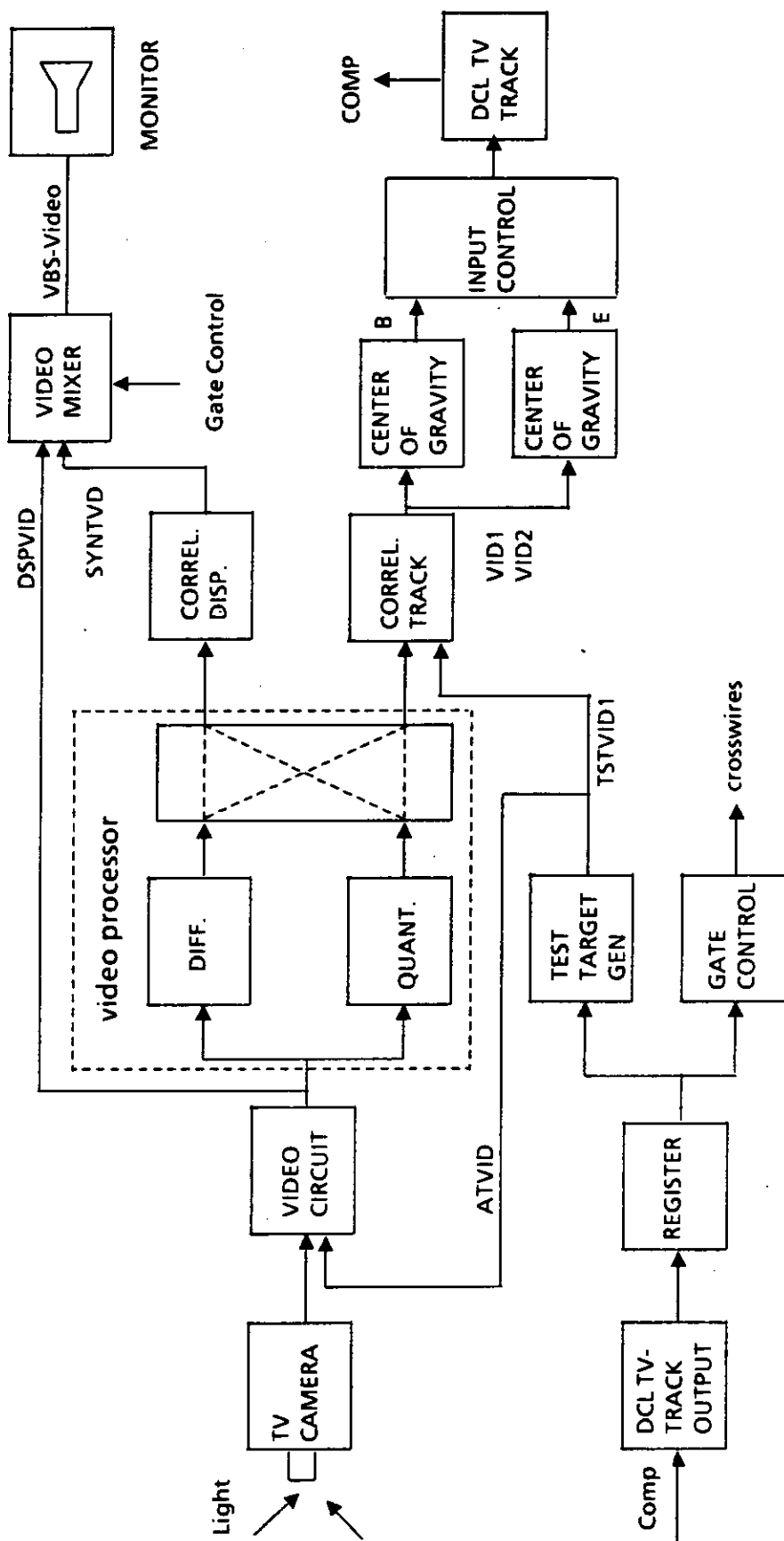
Output from the computer:

1. Command word
Contains: Gate size, display and track modes and a few general control bits.
2. Test target information (bearing) and offset value (bearing) for track gate.
3. Test target information (elevation) and offset value (elevation) for track gate.

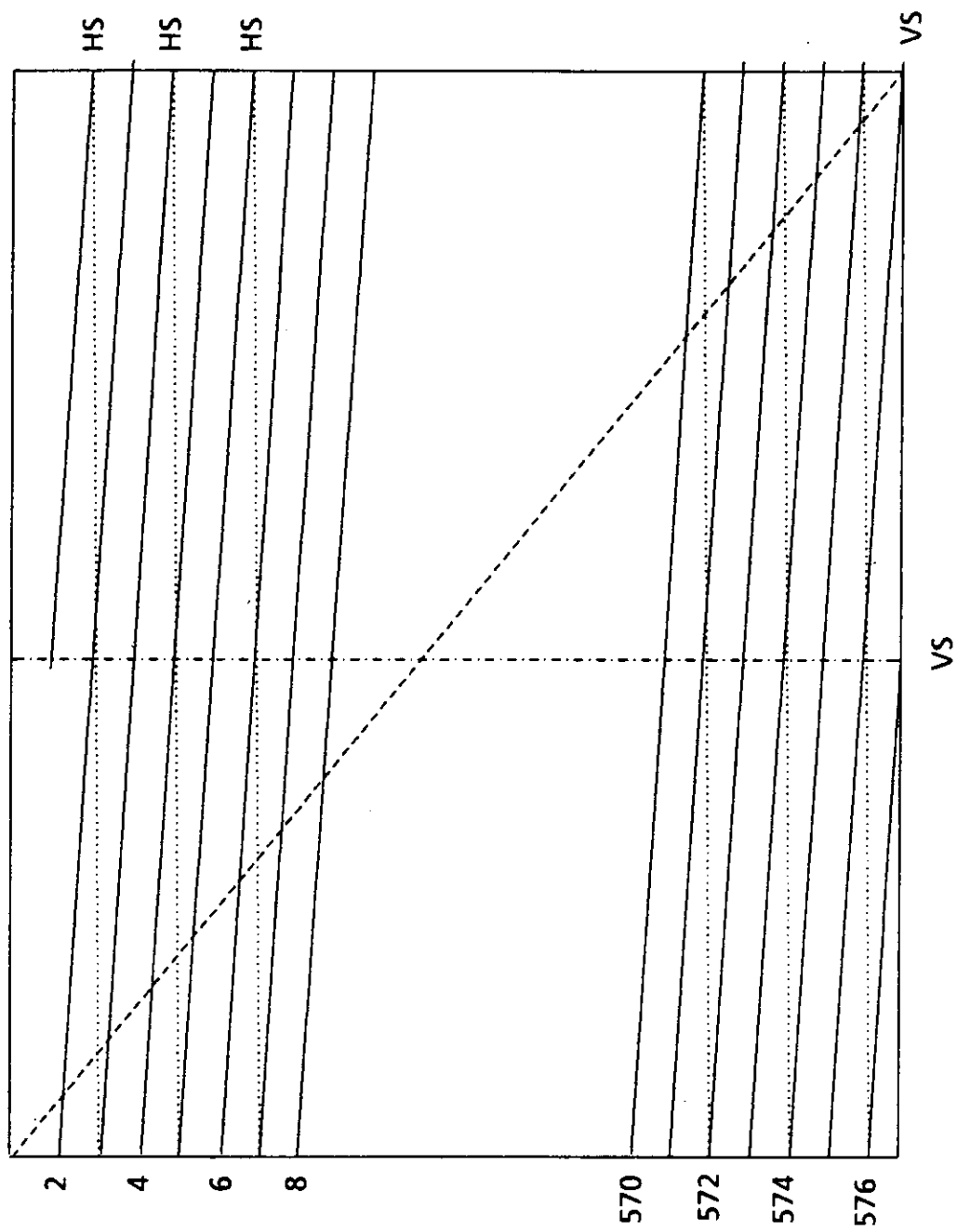
For test purposes two test videos are available (ATVID = analogue test video and TSTVID1 = digital test video).

ATVID will be supplied to the input of the TV track instead of camera video. A bright test block appears on screen and can be used by the TV track to execute all the operations. Examples are Quick Operability Test (QOT) and some system proving program (SPP) test jobs.

The digital test video will be fed directly into the correlator track by-passing the video processor. This checks the digital "calculator". This test is executed during the Stand-by mode and should be started by the computer with help of one of the control bits inside the command word.



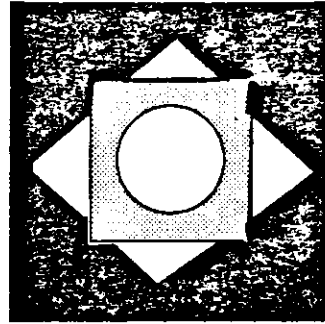
BLOCK DIAGRAM TV - TRACK



2:1 INTERLACED TV-PICTURE

TVN consists of 3 levels:
 -grey
 -black
 -white

TVN

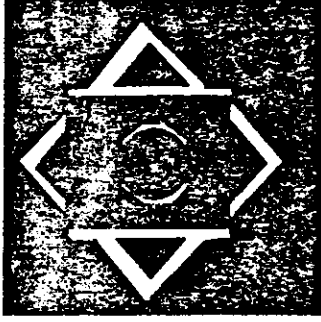


differentiate

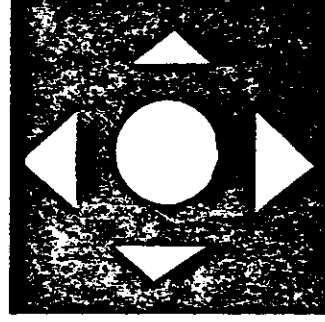
quantize the
non-inverted video

quantize the
inverted video

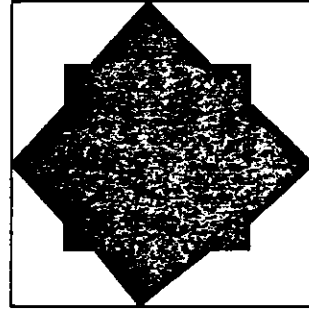
TVD



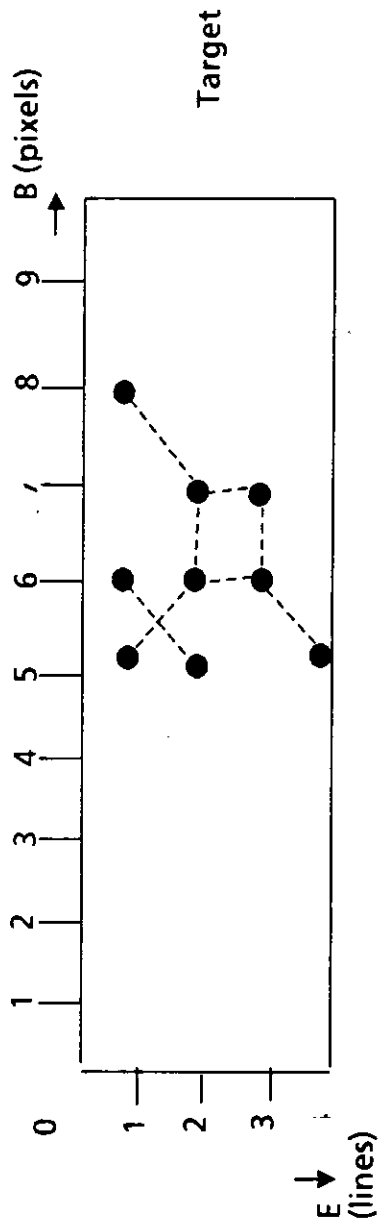
TQ1



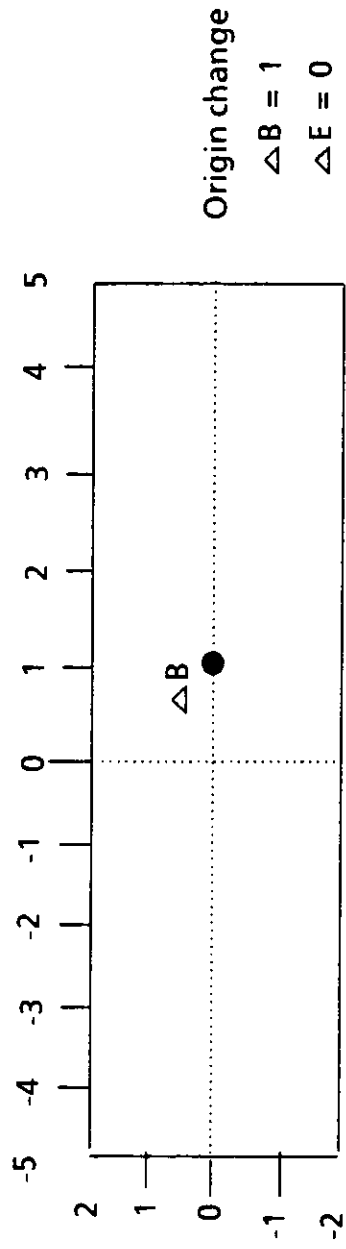
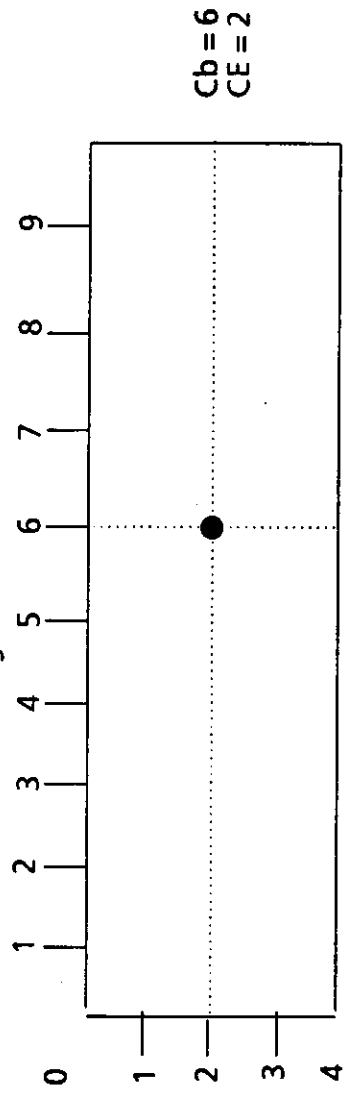
TQ2



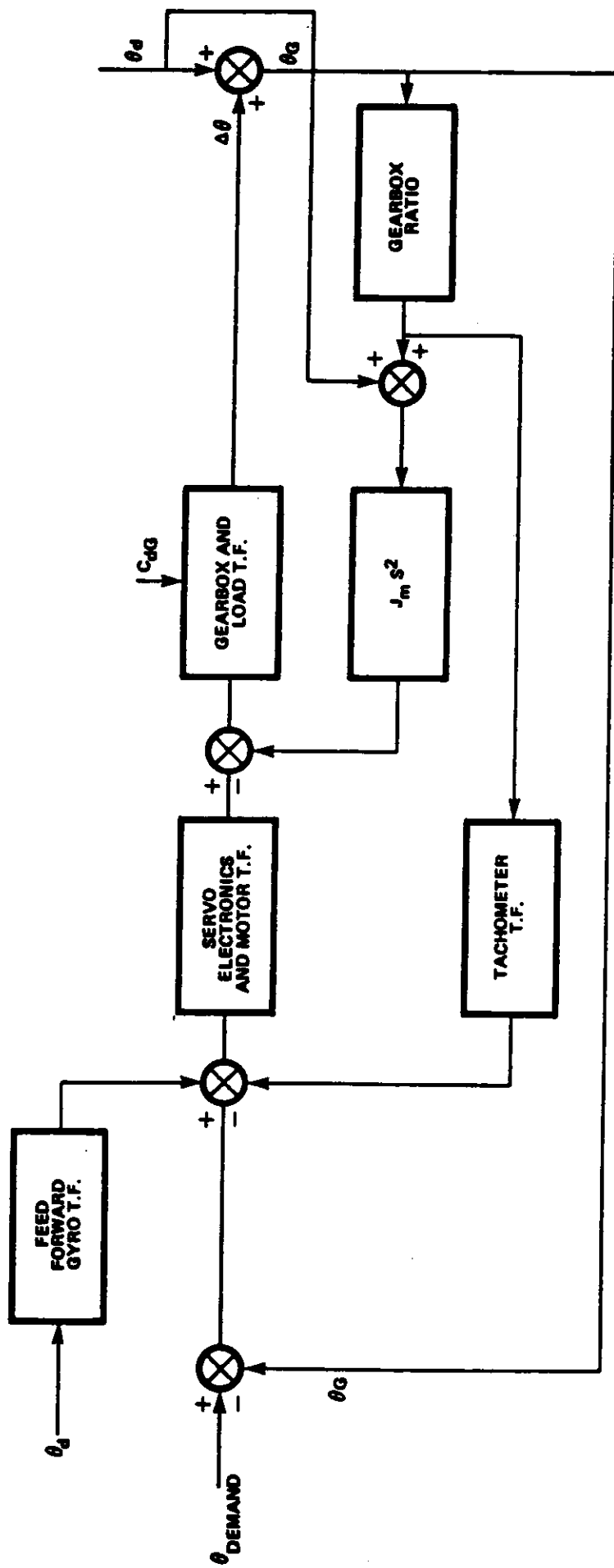
The quantization level is
just above the grey level.



$$C_B = \frac{(5+6+8) + (5+6+7) + (6+7)+5}{9} = 6.11$$



Center of Gravity Calculation



C_{dg} - LOAD TORQUE DISTURBANCE

θ_d - BASE MOTION

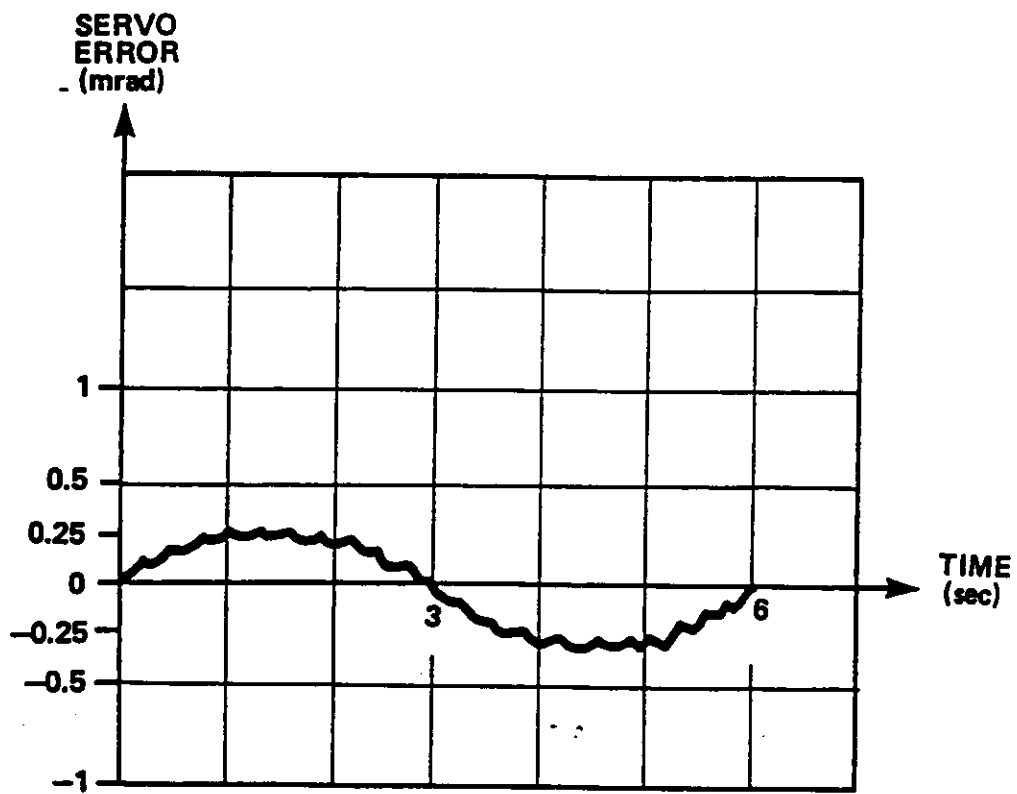
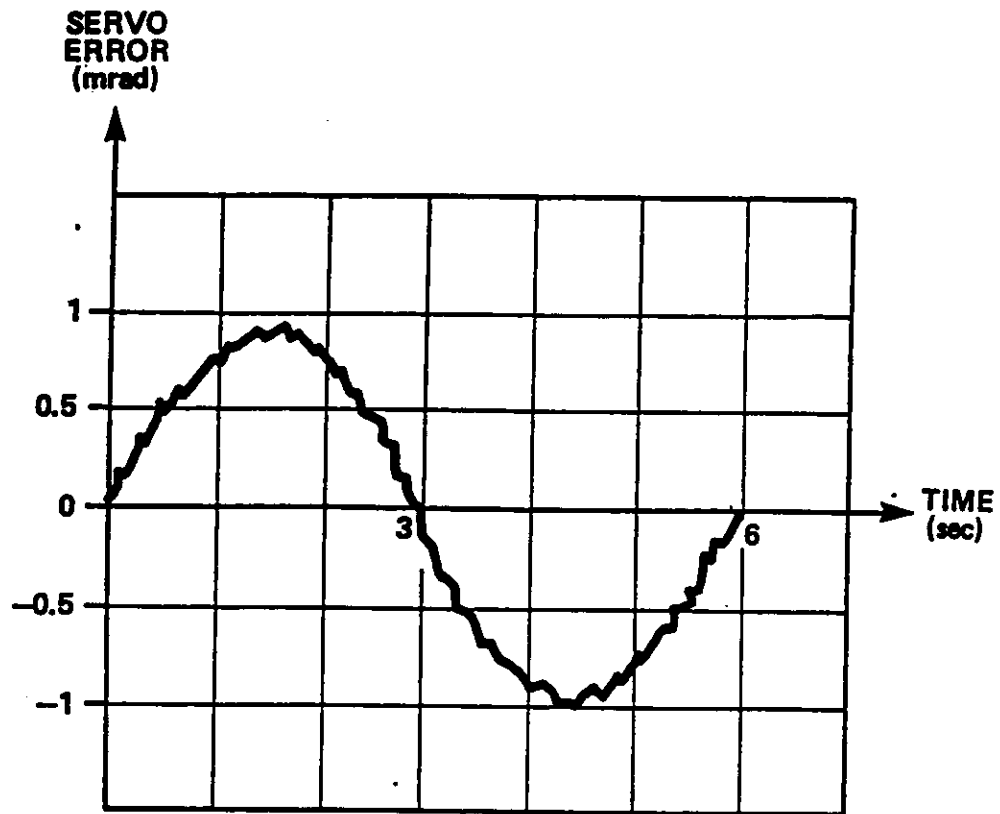
θ_G - GUN POSITION

$\Delta\theta$ - STABILIZATION ERROR

J_m - MOTOR INERTIA MOMENT

θ_{DEMAND} - FCS DEMAND ANGLE

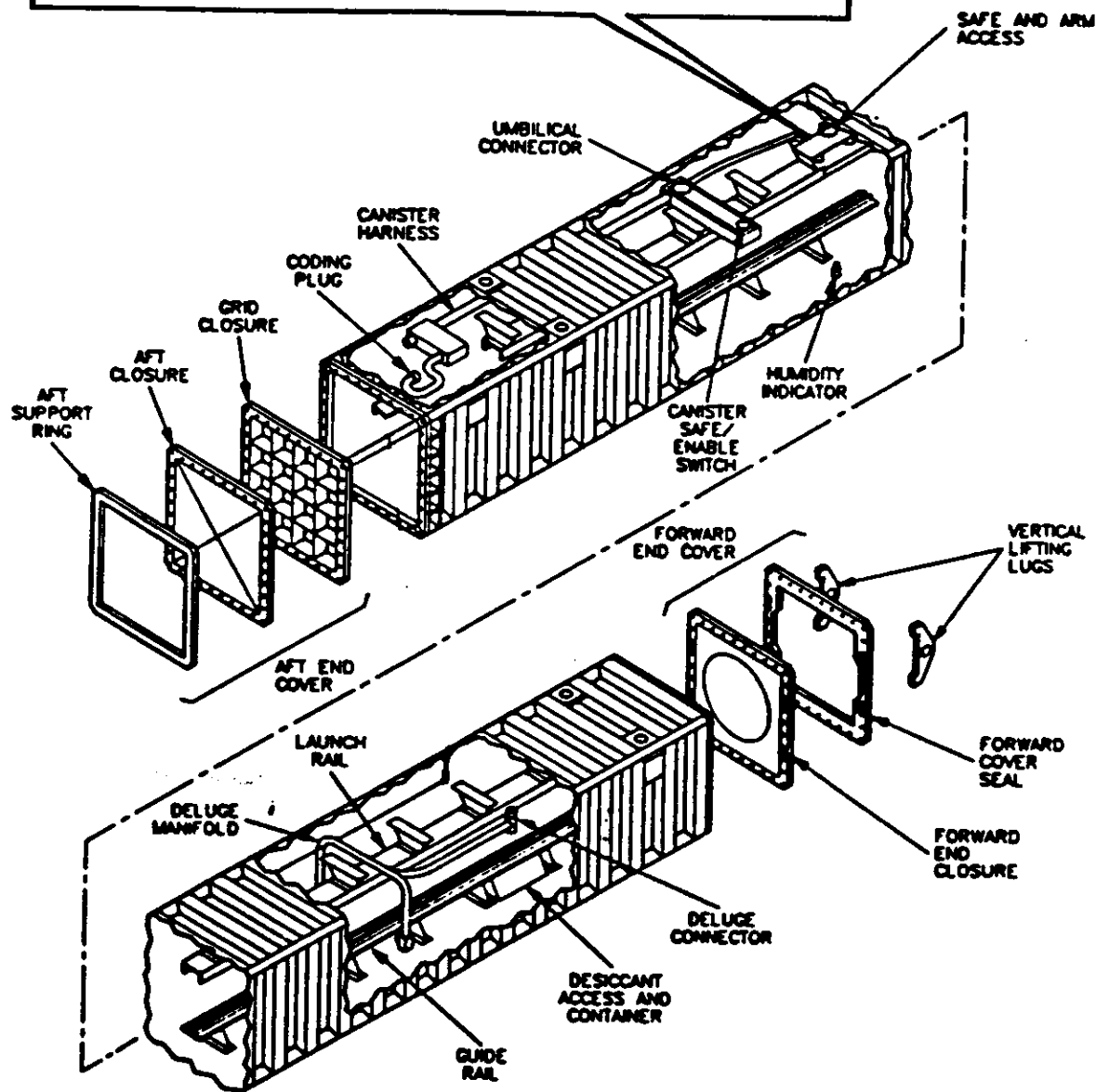
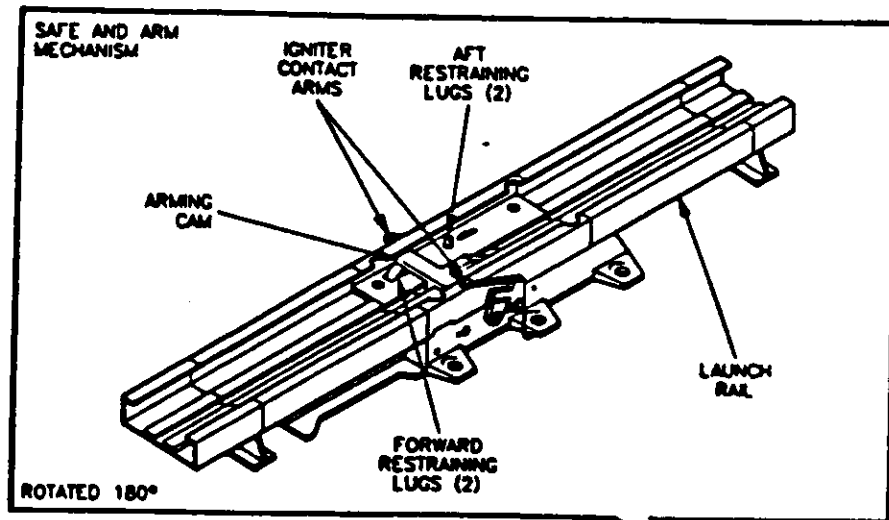
76/52 Gun - Stabilization and Servo Transfer Function - Block Diagram (OneAxis)



INPUT AMPLITUDE = ± 15 deg
 FREQUENCY = 0.16 Hz

Servo Errors with and without Local Stabilization System

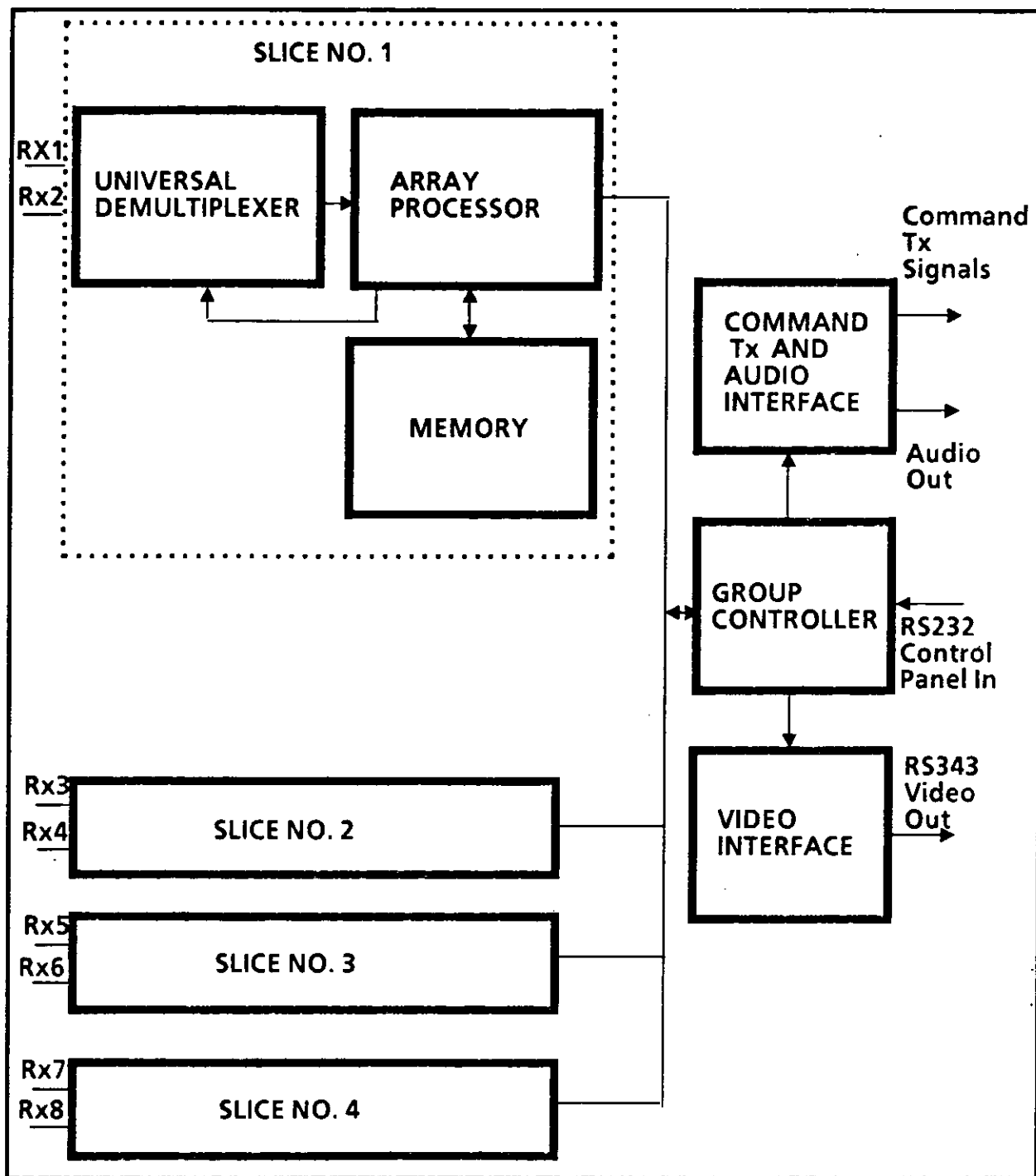
ATTACHMENT 5
VERTICAL LAUNCH MISSILE SYSTEM



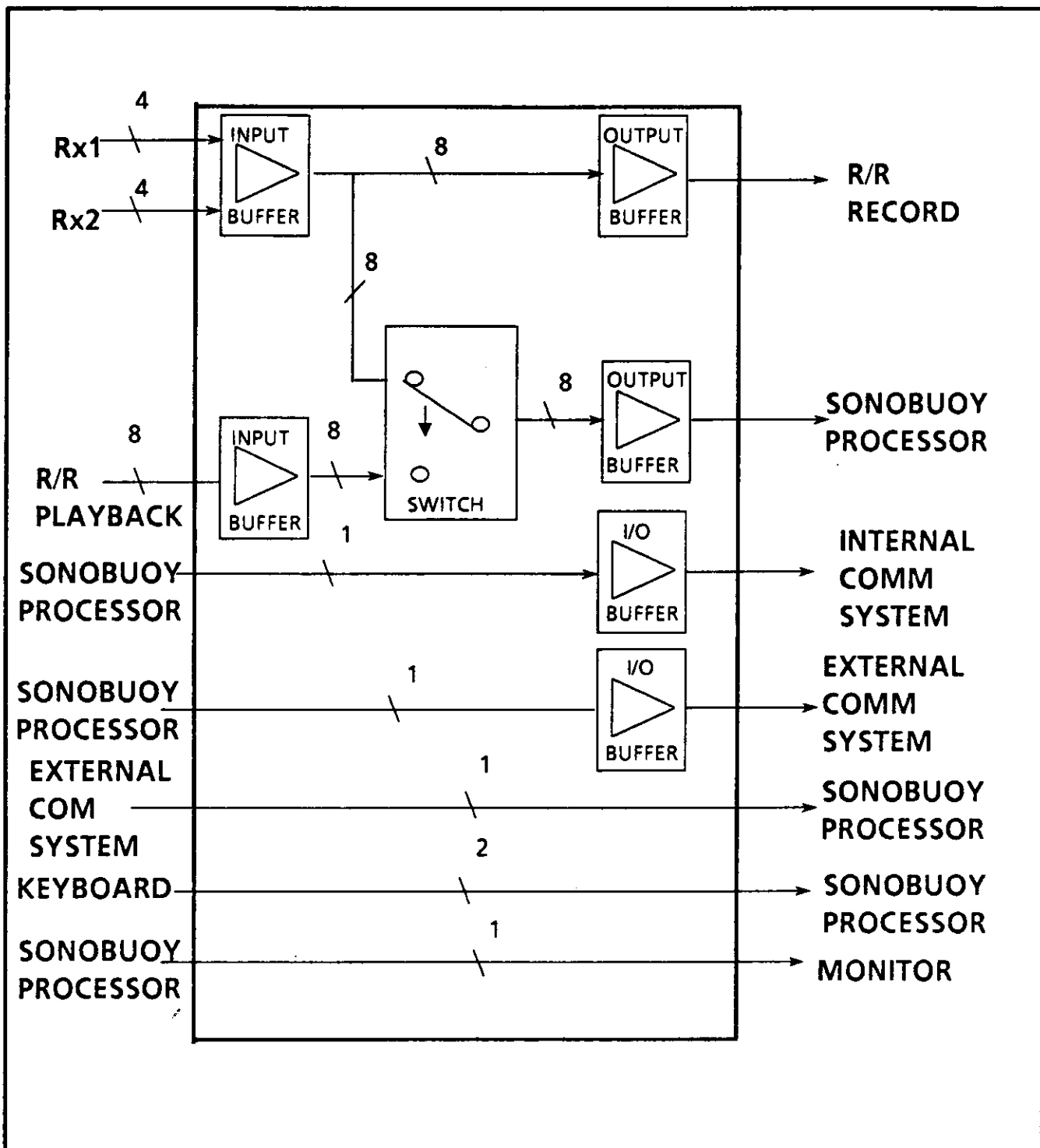
MK 13 MOD 0 CANISTER

CBS-T0363

ATTACHMENT 6
SONOBUOY PROCESSING SYSTEM



SONOBUOY PROCESSOR



AUDIO CONTROL BOX

MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY	
8:15	Introduction			Describe the CCS to a system level (Trevor Luxton)		Describe the major units of the Fire Control System (Jim Stewart)		Describe the major units of the SRGM System (Jim Stewart)	
8:45	Describe TRUMP Project Approach (Dale Schnurr)	Describe the changes to the Under Water Sensors (Gary Stone)	Describe the CCS to a system level (Trevor Luxton)	Describe the major units of the Fire Control System (Jim Stewart)		Describe the major units of the SRGM System (Jim Stewart)			
9:15	Describe TRUMP Project Approach (Dale Schnurr)	Describe the changes to the Under Water Weapons (Debbie Stein)	Describe the CCS software functions (Trevor Luxton)	Describe the major units of the Fire Control System (Jim Stewart)		Describe the major units of the SHIELD II (Jim Stewart)			
9:45	Describe the changes to the Above Water Weapons (Jim Stewart)	Describe the changes to the Integrated Navigation System (Gary Stone)	Describe the CCS software functions (Trevor Luxton)	Describe the major units of the Fire Control System (Jim Stewart)		Describe the major units of the SHIELD II (Jim Stewart)			
10:15	BREAK	BREAK	BREAK	BREAK		BREAK		BREAK	
10:30	Describe the changes to the Above Water Weapons (Jim Stewart)	Describe the changes to the Interior Comm Systems (Debbie Stein)	Questions & Answers	Describe the major units of the Radar System (Gary Stone)		Describe the major units of the Sonobuoy Processing System (Gary Stone)			
11:00	Describe the changes to the Above Water Weapons (Jim Stewart)	Describe the changes to the Interior Comm Systems (Debbie Stein)	Questions & Answers	Describe the major units of the ATMS & RDDS Systems (Gary Stone)		Describe the major units of the Sonobuoy Processing System (Gary Stone)			
11:30	Describe the changes to the Above Water Weapons (VLS) (Grace Dammato)	Describe the changes to the Command & Control System (Trevor Luxton)	ADMIN	Describe the major units of the ATMS & RDDS Systems (Gary Stone)		Describe the major units of the Integrated Navigation System (Gary Stone)			
12:00	LUNCH	LUNCH	LUNCH	LUNCH		LUNCH		LUNCH	
1:00	Describe the changes to the Fire Control System (Jim Stewart)	Describe the changes to the Command & Control System (Trevor Luxton)	Describe the major units of the SSD (Debbie Stein)	Describe the major units of the Vertical Launch System (Grace Dammato)		Describe the major units of the Integrated Navigation System (Gary Stone)			
1:30	Describe the changes to the Fire Control System (Jim Stewart)	Describe the changes to the Command & Control System (Trevor Luxton)	Describe the major units of the SSD (Debbie Stein)	Describe the major units of the Vertical Launch System (Grace Dammato)		Questions & Answers			
2:00	Describe the changes to the Radar System (Gary Stone)	Describe the changes to the Command & Control System (Trevor Luxton)	Describe the major units of the SHINCOM (Debbie Stein)	Describe the major units of the Close In Weapon System (Jim Stewart)		Questions & Answers			
2:30	Describe the changes to the Radar System (Gary Stone)	Describe the changes to the Radar System (Gary Stone)	Describe the major units of the SHINCOM (Debbie Stein)	Describe the major units of the Close In Weapon System (Jim Stewart)		WRAP UP			
3:00	BREAK	BREAK	BREAK	BREAK		BREAK		BREAK	
3:15	Questions & Answers	Questions & Answers	Questions & Answers	Questions & Answers		Questions & Answers		WRAP UP	



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