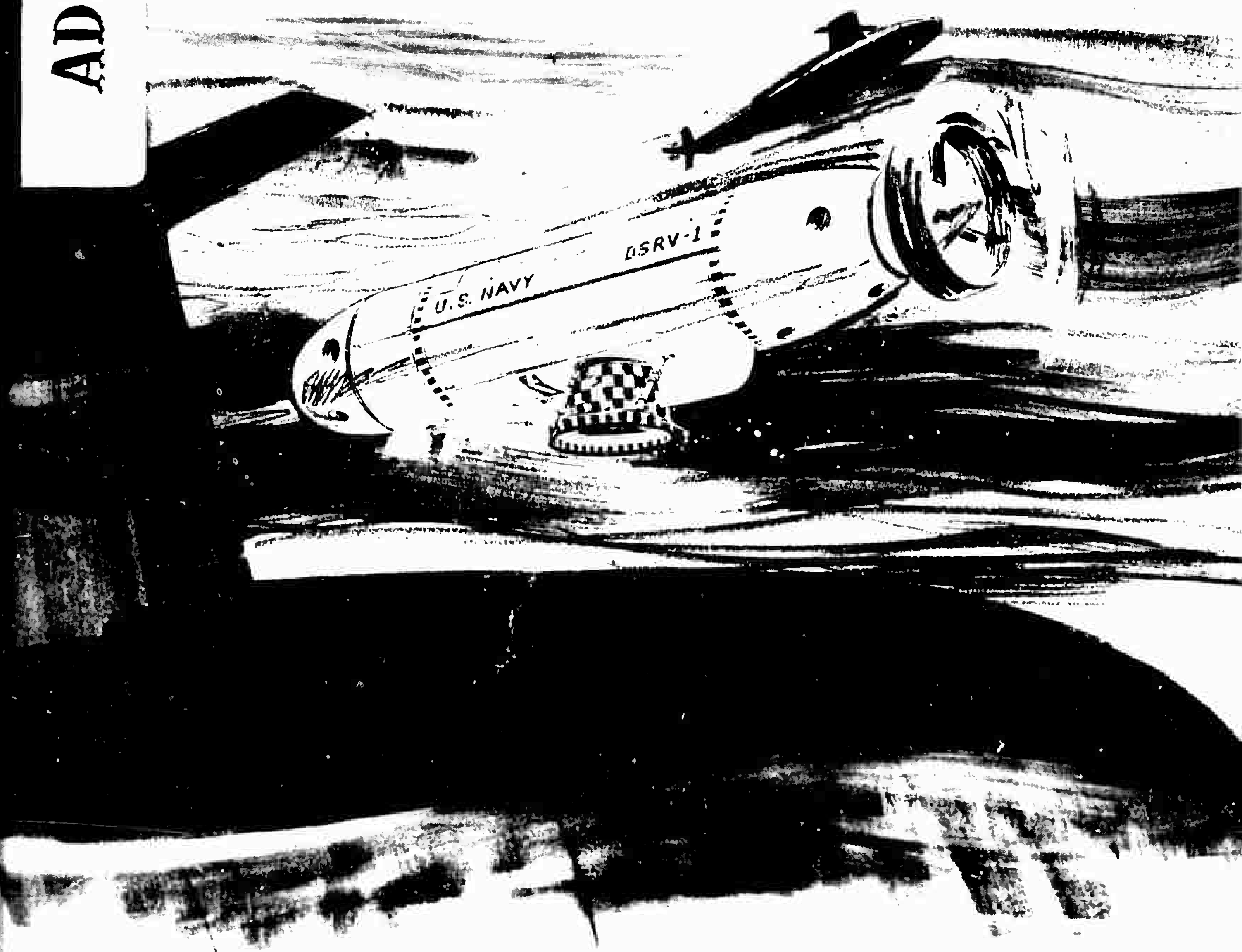
DSSP

DEEP SUBMERGENCE RESCUE VEHICLE SENSOR AND CONTROL SUBSYSTEM TECHNICAL DESCRIPTION



Naval Applied Science Laboratory

DSSP

DEEP SUBMERGENCE RESCUE VEHICLE (DSRV)
SENSOR AND CONTROL SUBSYSTEM
TECHNICAL DESCRIPTION

Lab. Project 950-23-11 Integration Study No. 2

May 1969

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ABSTRACT

This document is the second progress report which presents the functions, configuration, and performance parameters of the Sensors and Controls Subsystem of the Deep Submergence Rescue Vehicle (DSRV). This includes only the equipments required for performing the primary (rescue) mission functions. The major equipment subdivisions are the sensors, operator control and display, and data-processing systems. Sensor systems include both the electronic assemblies installed within the control sphere and the transducers and units mounted externally.

ADMINISTRATIVE INFORMATION

Since June 1965, the Naval Applied Science Laboratory has performed the coordination and integration tasks associated with the Sensors and Controls Subsystem for the Deep Submergence Rescue Vehicle. The Laboratory's efforts were defined by the Deep Submergence Systems Project Office (PM-11) task 11894 of R&D project S4607-001.

This document has been prepared to define the Sensors and Controls Subsystem configuration and design concepts as of 1 March 1969. The Laboratory has kept in continuous contact with the cognizant submanagers (Sonar: DSSP-231; Navigation, Ship Control & ICAD: Massachusetts Institute of Technology/ Instrumentation Laboratory; Optics: Naval Undersea Research & Development Center; Communications: NASL Code 926) to provide the latest information available.

ACKNOWLEDGMENT

Acknowledgment is given to Messrs. R. Ellermann, J. Nichols, A. Horbach and G. Guarrella for their assistance in the preparation of the text material and verification of technical content.

Additionally, the author wishes to express his appreciation to the Sensors & Controls Submanagers for their assistance in the preparation of this document.

INTRODUCTION

The limitations of the present United States capability for deep ocean rescue, location and recovery were manifest during search operations subsequent to the sinking of the submarine U. S. S. Thresher in more than 8,000 feet of water in April 1963. This was further evidenced during the 80 day search and recovery operations following the loss of a thermonuclear weapon in 2,500 feet of water off Palomares, Spain, in January 1966. These events have precipitated a comprehensive effort by the Navy in deep ocean technology. On May 28, 1964, the Deep Submergence Systems Project (DSSP) was established to increase and develop the Navy's deep ocean engineering capability. After two years under the management of the Navy's Special Projects Office, DSSP was officially established as a Navy Field activity and a separate project under the Chief of Naval Material.

Development of deep submergence vehicle systems to enable man to explore and work in the depths of the ocean are part of two major DSSP programs in which the Naval Applied Science Laboratory (NASL) is presently engaged. These are the "Submarine Location, Escape and Rescue System" (Rescue), and the "Object Location and Small Object Recovery System" (Search).

The Rescue System, currently in the construction stage, is based on the development of a Deep Submergence Rescue Vehicle (DSRV), capable of accomplishing a personnel rescue mission, under all weather conditions, under ice, and at collapse depths of present military submarines. The DSRV will be supported by either a specially designed surface ship (ASR), or by a submerged nuclear-powered (Mother) submarine capable of transporting the DSRV in a "piggy-back" fashion. After locating the distressed submarine, the DSRV will "mate" or attach itself to the escape hatch of the submarine, take aboard survivors and shuttle them to the support ship.

This document is the second progress report which presents the functions, configuration, and performance parameters of the Sensors and Controls Subsystem of the Deep Submergence Rescue Vehicle.

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1.0 SUBSYSTEM COMPLEMENT

1.1 GENERAL

The DSRV S&C subsystem in conjunction with the vehicle subsystem provides the means of controlling and navigating the submersible. The S&C design includes those sensors necessary to locate and mate with a distressed submarine. These sensors can home on remote acoustic signals, measure vehicle attitude and rates, and provide the means of viewing the surrounding environment. They also include sensor systems for surface and underwater voice communications with the support ship. A ship control subsystem provides the primary instrumentation for all maneuvers, from search to mating with a submarine, including emergency maneuvers deemed necessary for mission safety and success. Display and control equipment provides the visual/audio information to the human operators, and relays commands to each appropriate subsystem. Provision is also made for various automatic modes, at the selection of the pilots, to simplify hovering or auotpilot functions. The equipments which comprise the Sensors and Controls Subsystem can be separated into the following five functional Sensor groupings:

a. Navigation

b. Ship Control

c. Obstacle Avoidance

d. Rendezvous and Mating

e. Communication

and two non-sensor groups:

f. Data Processing

g. Integrated Controls and Displays.

The subsystem equipments are detailed in this report. A complete list of equipment is presented as Appendix A.

1.2 FUNCTIONAL DESCRIPTION

The simplified subsystem block diagram, Figure No. 1.1, represents the interrelation between the Sensors, the Controls & Displays, the vehicle and the pilot.

a. The sensors receive inputs from such physical phenomenon as ship's motion, acoustic signals, optic or RF signals and pressure levels. Other external inputs to the S&C Subsystem are alarms and electrical signals from ship's equipment indicating status, motor speed, and other equipment parameters.

b. Displays receive the processed sensor outputs as electrical signals to drive meters, recorders, or video presentations. For purposes of simplicity, this diagram treats headsets and their associated audio outputs as displays. Critical parameters are preserved by magnetic tape recordings.

c. Selected sensor outputs are also fed directly to the Data Processing Group wherein the navigation computations, alarm status and display processing are effected. Range gates for eliminating false sonar returns are computed

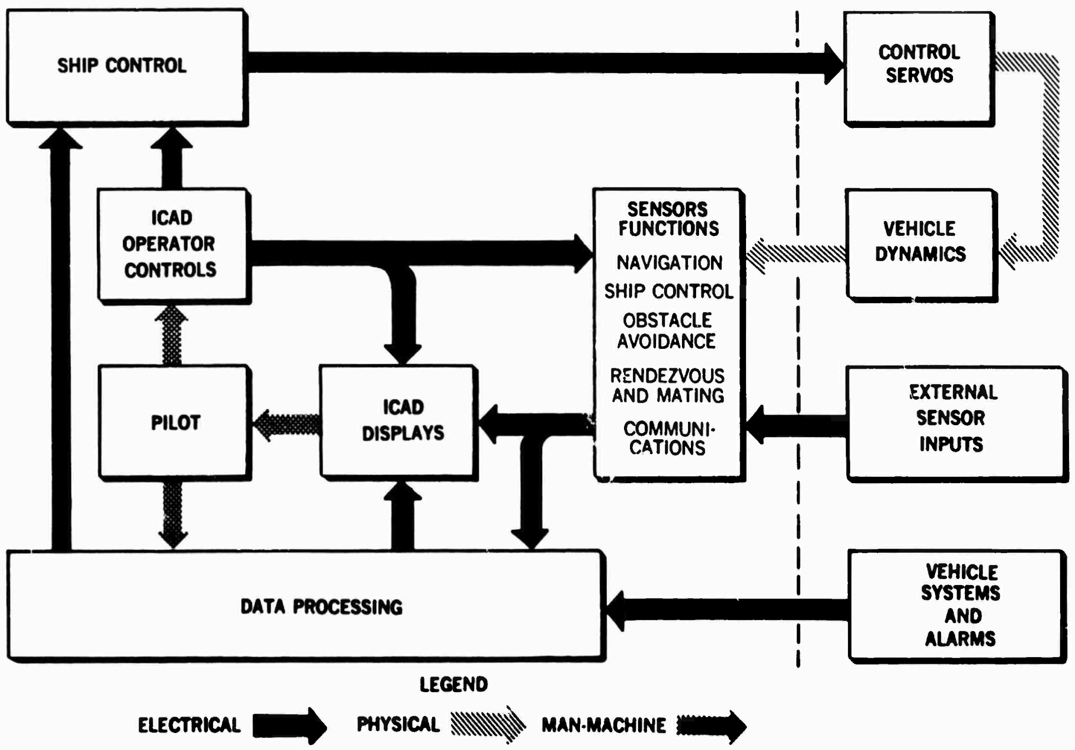


Figure No. 1.1 DSRV Sensors & Controls Subsystem Functional Block Diagram and used for signal processing and if applicable, displayed on a recorder. Some of the outputs are used for displays; other outputs, such as navigation data, are available for use in automatic-control modes. Data Processing also controls the sampling of life support, equipment status and diagnostic routines; and alerts the pilot of abnormal conditions via the Alarm Panel. Direct entry of data or commands by the human operators is made via a computer keyboard.

(d) The ship control subsystem provides manual and automatic control of the vehicle. Sensor information is processed by the Autopilot Digital Differential Analyzer to achieve an uncoupled response in each of the vehicle's six degrees of freedom.

1.3 OPERATIONAL PROCEDURE

The S&C subsystem will meet the requirements imposed on it in the various phases of the rescue mission. A pictorial diagram of the rescue mission is shown in Figure No. 1.2. The function of each equipment during the localization and the initial rendezvous and mating phases is of prime importance.

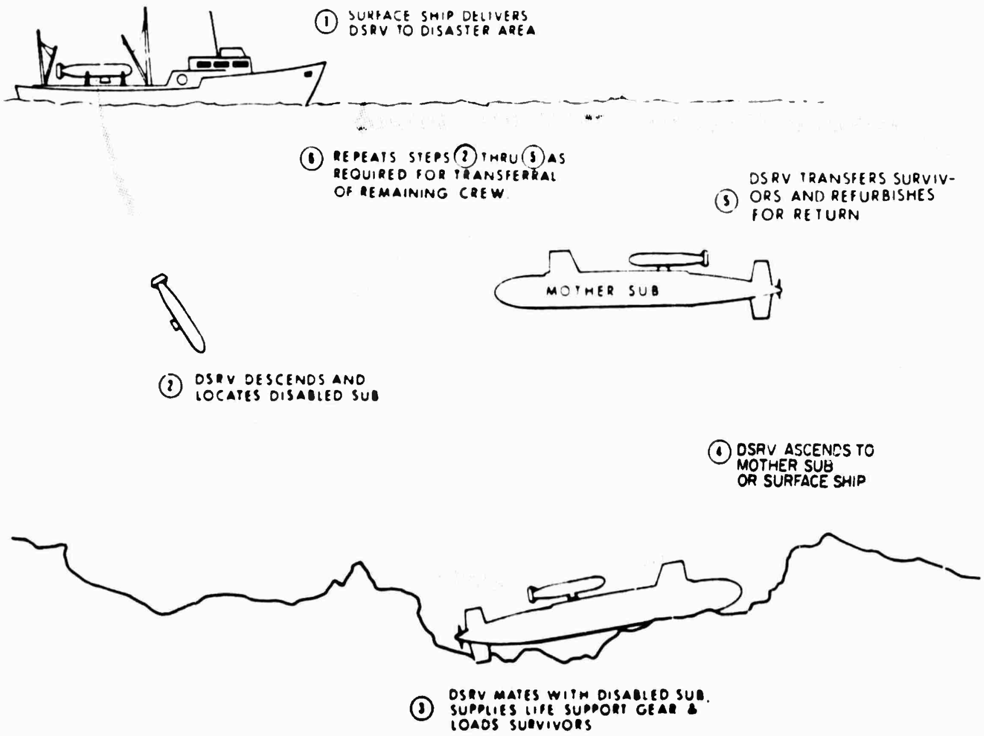


Figure No. 1.2 DSRV Rescue Phase Mission Sequence

At the start of the localization phase, the support ship, with the DSRV on board, has reached the area of the distressed submarine. The support vessel will have the capability to deploy navigation transponder(s) to provide a relative reference for navigation of the submersible and station-keeping for the support ship. Following launch, and prior to leaving the surface, functional checks are made, using the submersible's operator controls and displays.

The submersible begins its descent under control of the human operators via the ship control subsystem. If automatic guidance is desired, the Central Processing Computer is used to replace the operator in generating commands for ship control. The DSRV will, where possible, home on the acoustic signals emanating from the distressed submarine with its Directional Listening Hydrophones.

In addition to direct homing, the DSRV can effect a predetermined limited search pattern using the navigation transponder(s) as a relative reference to locate the distressed submarine. It is necessary to establish the exact location of the submarine as soon as possible, due to the possibility of fading signals emanating from the submarine and non-continuous signal reception as in the case of spiral descent. As the DSRV nears the bottom, Doppler Sonar greatly increases dead-reckoning accuracy. During descent both Vertical and Horizontal Obstacle Sonars are active as a safety feature. Depth information is furnished by the Depth Pressure Transducers and the Altitude/Depth Sonar.

If contact is lost with the distressed submarine, the DSRV must conduct a limited search operation as stated above. This can be accomplished utilizing sonar, optics, or both. Of the sonar systems, the Horizontal Obstacle Sonar is the prime search device. Optical search will yield more positive identification, but necessitates covering the area at slower speeds with the submersible operating at very low altitudes.

To complete the localization phase, the DSRV must find and identify the distressed submarine. Details of the submarine heading, attitude, and the location of obstacles such as the sail and the messenger-buoy cable must be determined.

Initial rendezvous commences as the DSRV descends to within 100 feet of the disabled submarine. The DSRV will activate its sonar and optical systems. Obstacle avoidance is provided by the Altitude/Depth, Horizontal and Vertical Obstacle Sonars. (See Figure No. 1.3.) The Short Range Sonar's long range mode (150 ft) will be used to determine the distressed submarine's orientation. The DSRV descends slowly until at 15 feet above the submarine's deck, it switches to the short range mode of the Short Range Sonar. The short range (high-definition) mode provides sufficient resolution to give recognizable returns from the discontinuities on and around the escape hatch. Guided by the Short Range Sonar, the DSRV then descends to TV range, which is assumed to be three feet, under worst conditions. If visibility is fair to good, final localization of the escape hatch and mating will be conducted by the video presentation from the TV cameras on the monitors and/or direct viewing through the Viewport Optics. The position of the DSRV is adjusted in roll and pitch to align the hatch-mating surfaces. The DSRV can then descend to a level at which pre-mating operations with the manipulator can be carried out; namely clearing the hatch, cutting the messenger-buoy cable and if required, the attaching of haul-down cables. A Homing Transponder carried by the submersible is dropped near the submarine to mark its location.

At this point the mating phase commences. The DSRV, while hovering, uses its optical and sonar sensors as guides, to orient and lower itself (or haul itself down) and settle on the submarine's escape hatch. The DSRV then secures a pressure seal to the submarine and verifies the seal using the Skirt Pressure Transducer.

Once the S&C subsystem has guided the submersible to a successful mate with the distressed submarine, the initial rendezvous and mating phase is complete. Radiacmeters are used to check possible contamination as survivors are brought on board. Before decoupling from the submarine, several Sonar Hatch Markers are attached to the hatch. The Hatch Markers provide a good sonar reflecting surface to simplify the return mating phases.

The S&C functions are essential to other rescue phases, including return to the support vessel and later trips when rescuing additional survivors. The use of this equipment in later phases is essentially similar to that encountered in the phases described above.

Figure No. 1.3 DSRV Sonic Beam Patterns

2.0 INTEGRATED CONTROL AND DISPLAY (ICAD)

The DSRV consists of three interconnected pressure spheres encased in a lightweight hull and the necessary Sensor and vehicle subsystems to accomplish the mission. The aft and mid spheres, reserved for the transfer of personnel, will be capable of accommodating up to twenty-four evacuees at one time. The seven foot diameter forward sphere accommodates the display and control equipment necessary to carry out the submersible's mission and is a working station for the crew. A pictorial diagram of the control sphere is shown in Figure No. 2.1.

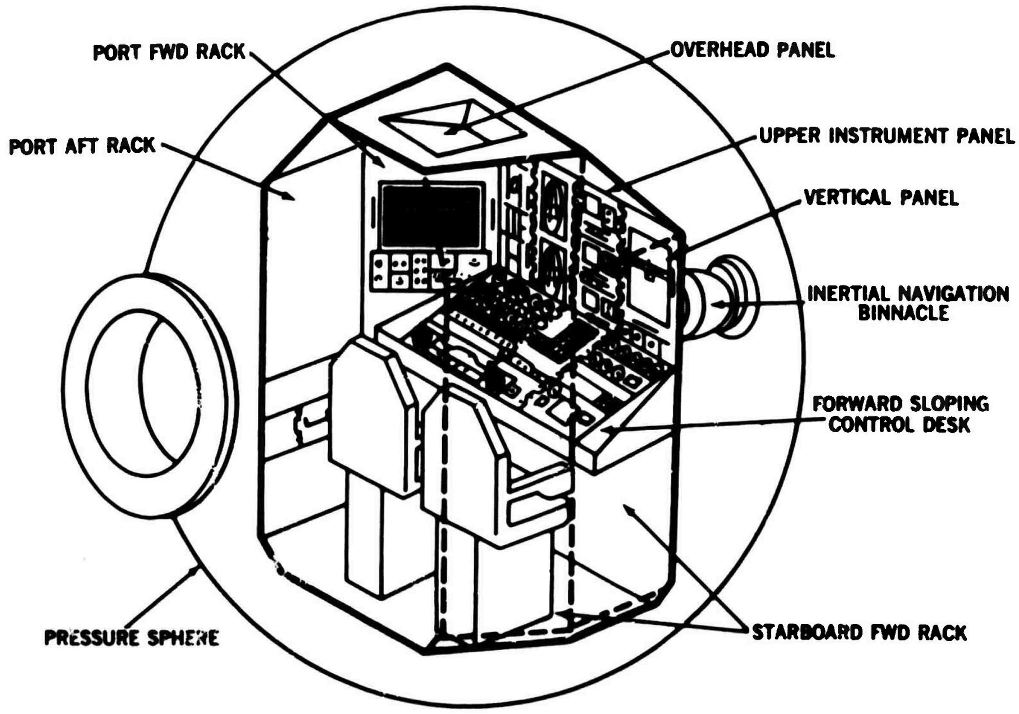


Figure No. 2.1 DSRV Control Sphere

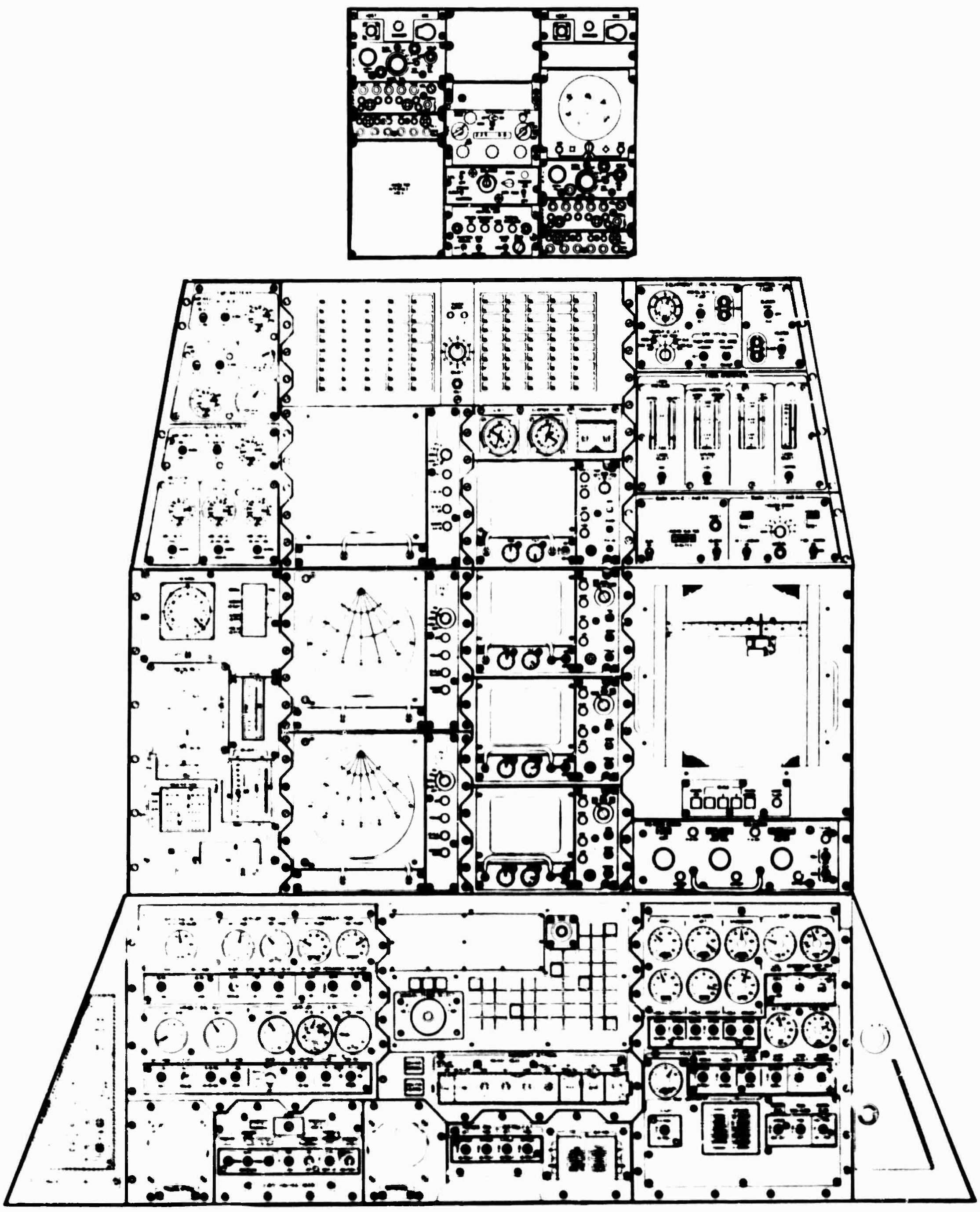
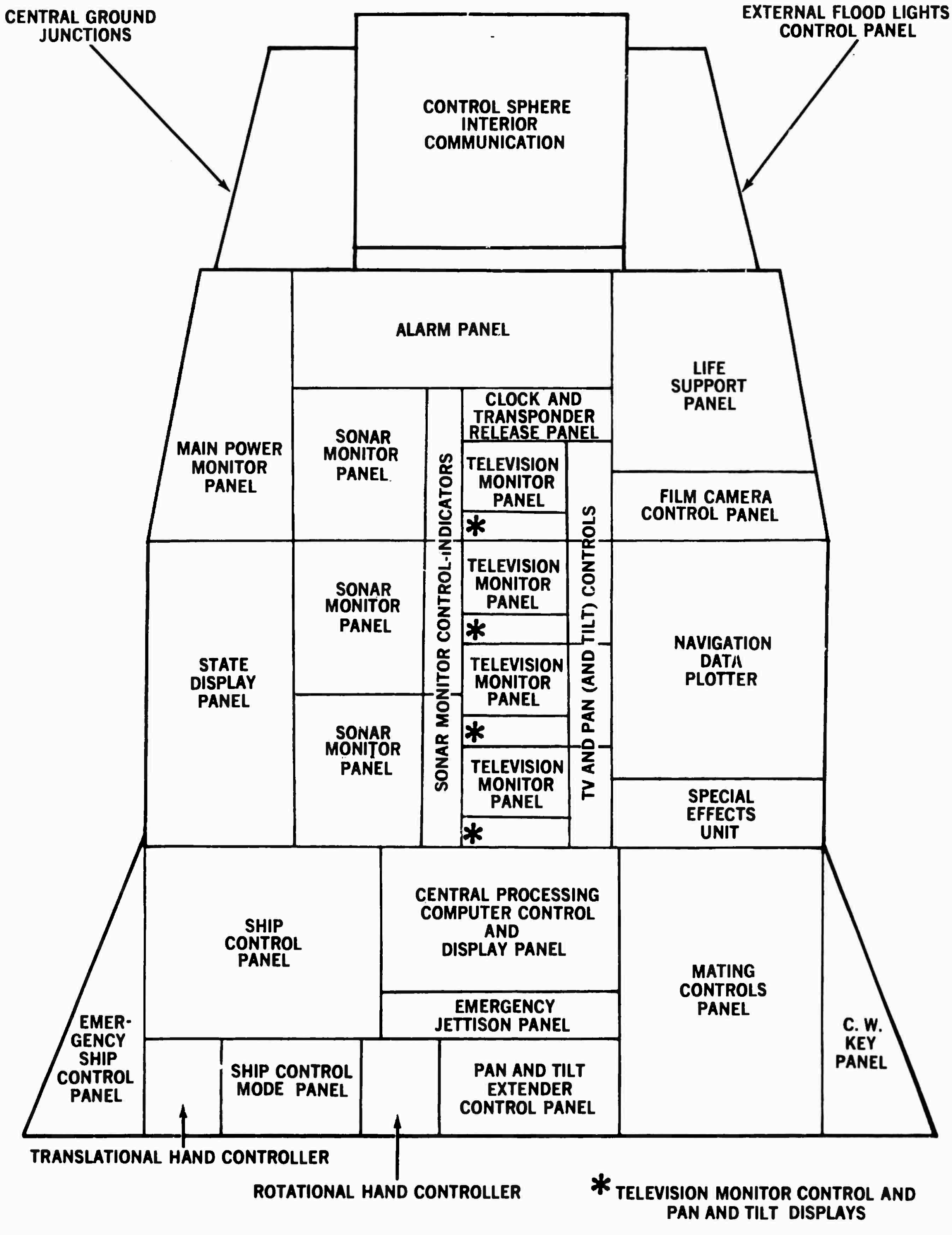


Figure No. 2.2 General Layout of the Integrated Controls and Displays



Key to Figure No. 2.2

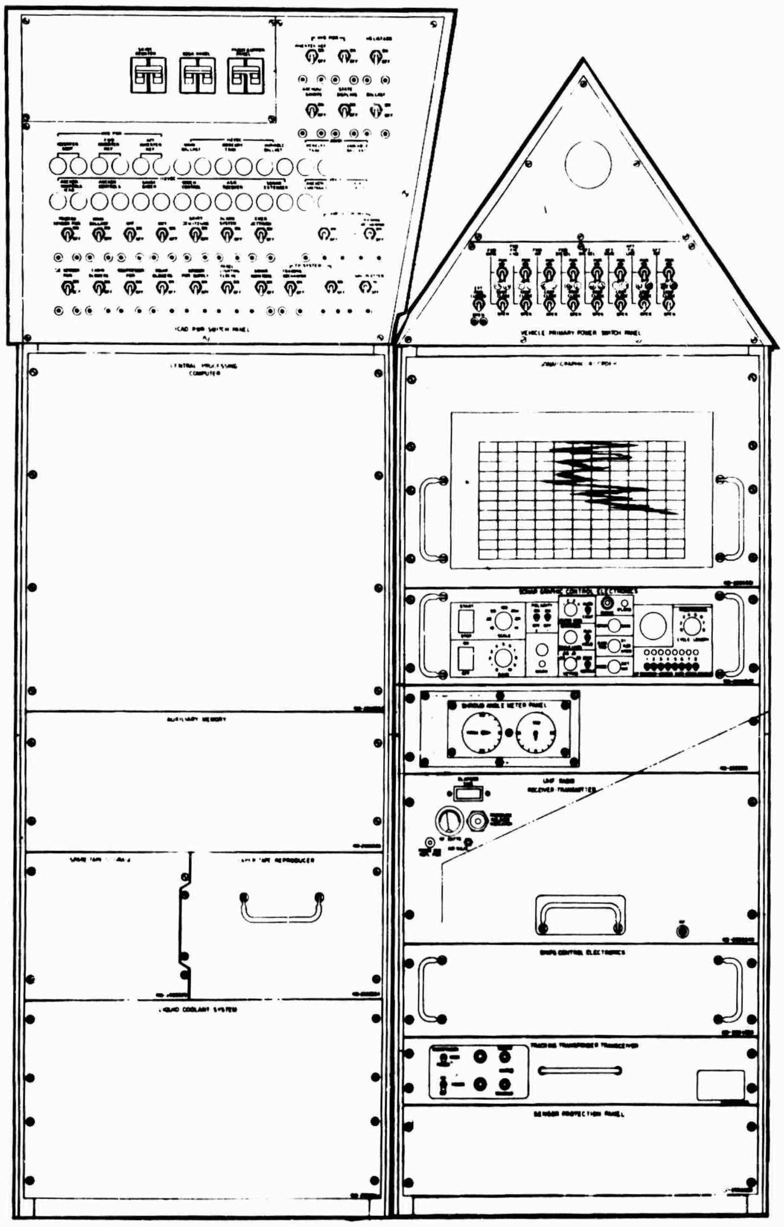
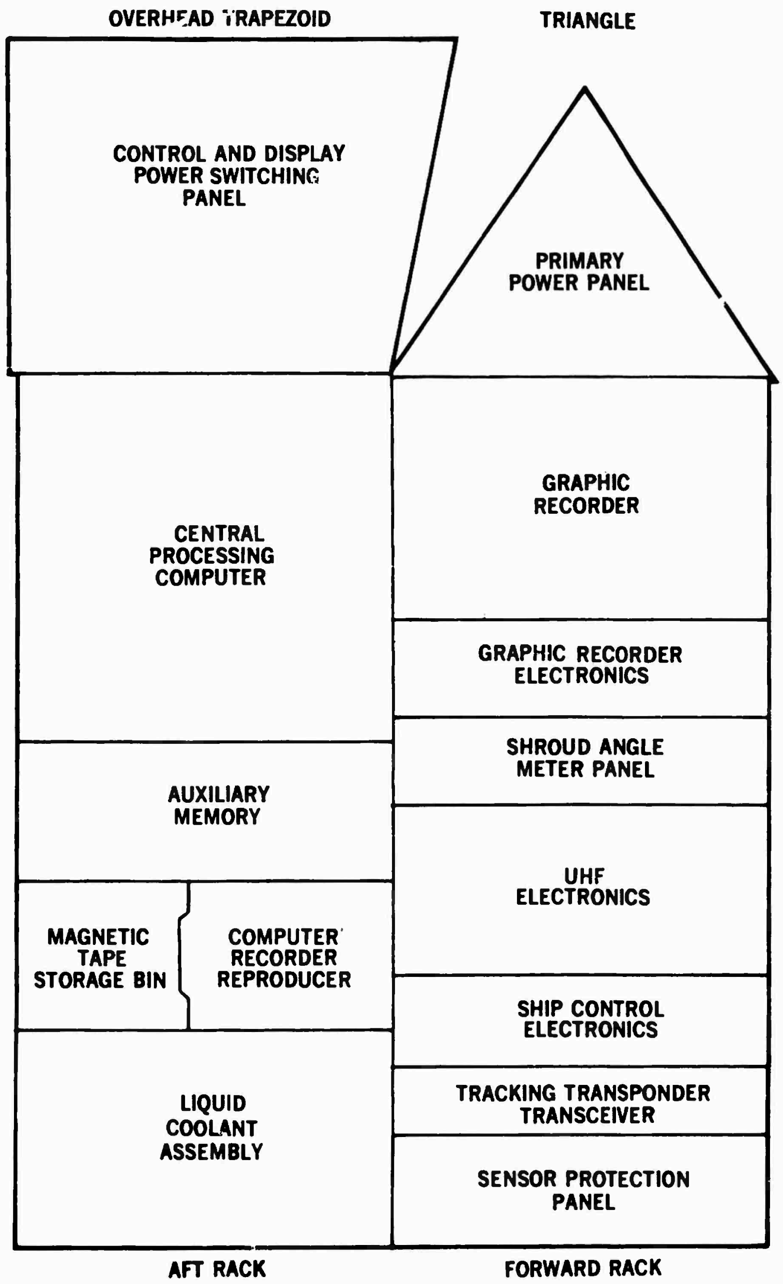


Figure No. 2.3 General Layout of the Port Side Racks



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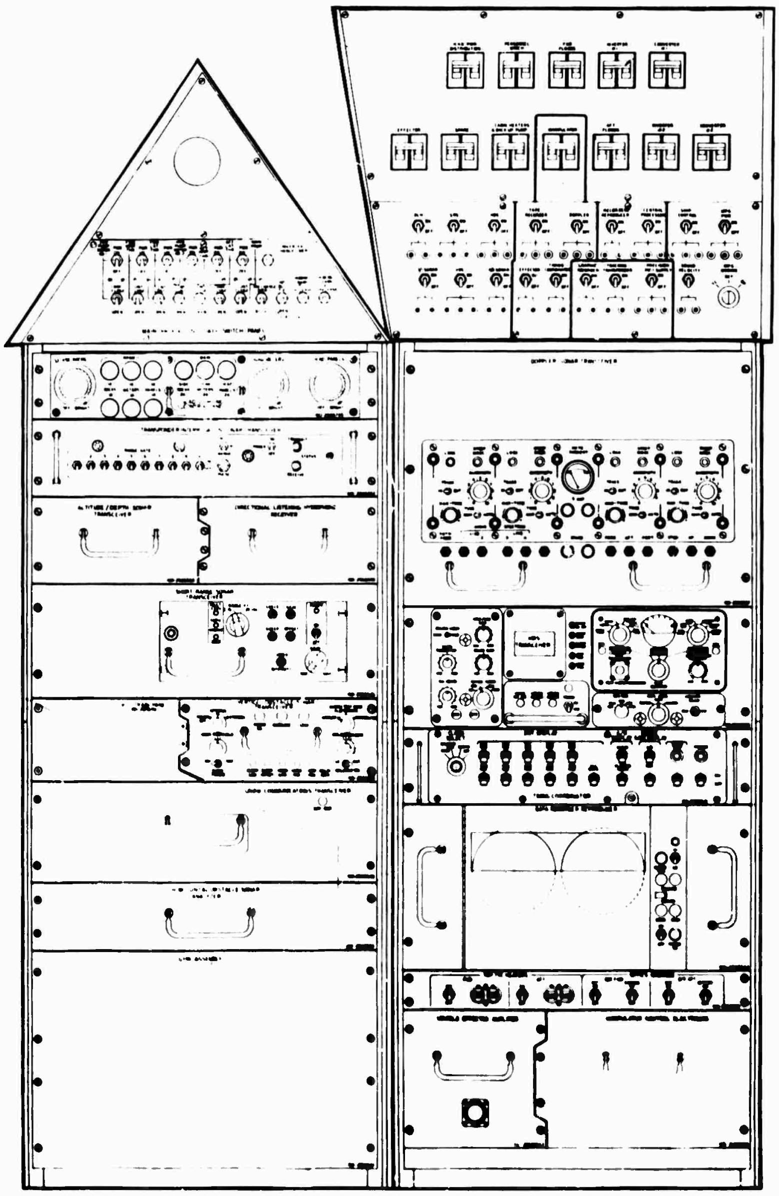
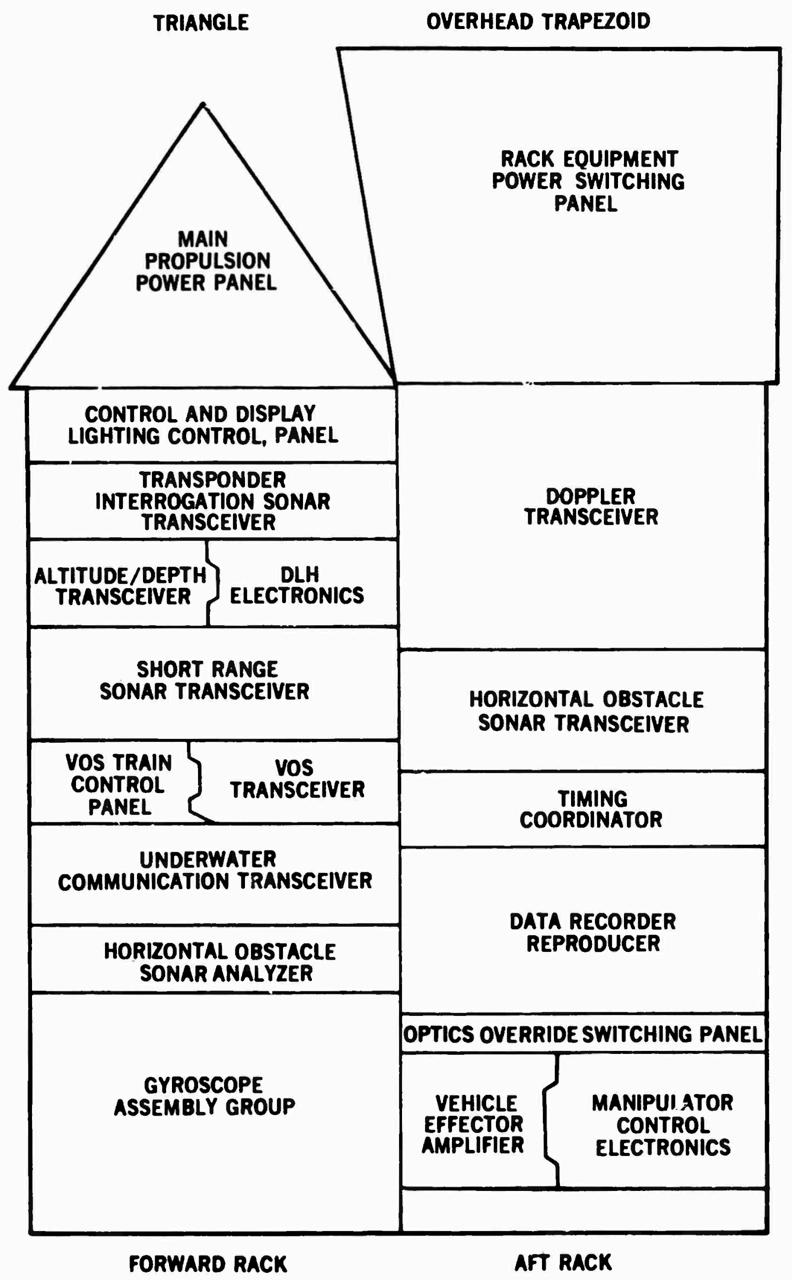


Figure No. 2.4 General Layout of the Starboard Side Racks



Key to Figure No. 2.4

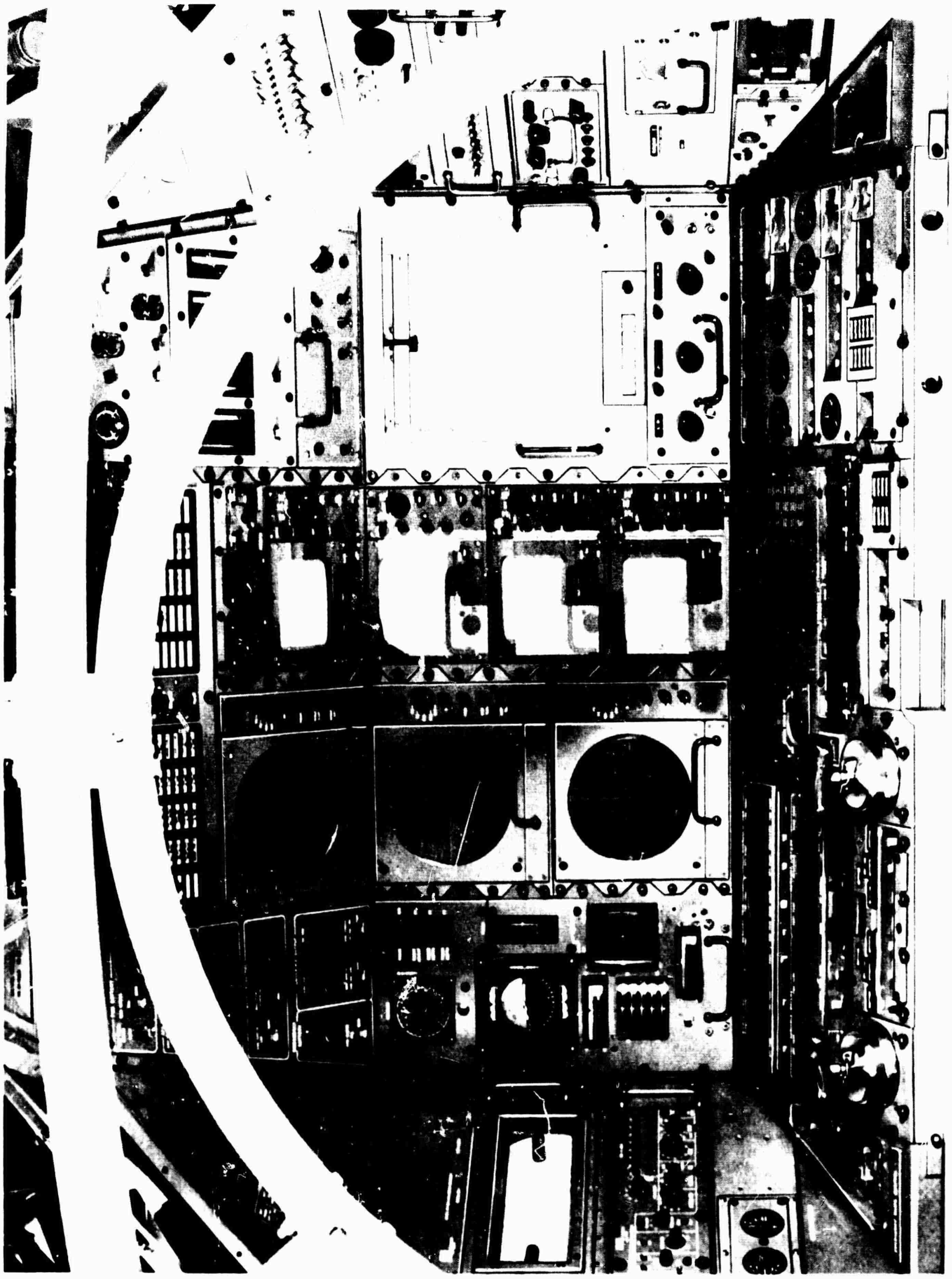


Figure No. 2.5 DSRV Integrated Controls and Displays

The working station in the forward control sphere consists of the front panel, as shown in Figure No. 2.2 containing the displays and actuators necessary for vehicle monitoring and control, as well as the side racks which contain auxiliary controls and electronics. The ICAD consists of all the controls and displays in the front panel, overhead and side racks. The front panel consists of three subassemblies: the forward sloping control desk, the vertical panel, and the upper instrument panel. The controls and displays located on these subassemblies, together with those in the side racks, constitute all the controls and information available to the operators. The location and arrangement of the controls and displays are in accordance with the best human engineering available. Figure Nos. 2.3 and 2.4 depicted the port and starboard side racks, respectively. The electronics packages located in the side racks are part of the individual equipments and will be discussed in the applicable sections. Figure No. 2.5 is a photograph of the DSRV Integrated Controls and Displays installed within a control sphere "birdcage" assembly.

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3.0 DATA PROCESSING

3.1 GENERAL

The function of the Data Processing group is to "interface" the Sensors and Controls vehicle subsystem, and the DSRV pilot as shown in Figure No. 3.1. The group automatically processes specific sensor output signals, computes navigation parameters, monitors alarm and subsystem status, records critical system parameters, and provides timing and frequency references. In addition, it furnishes command information, in proper interface format, to applicable operator displays. The heart of the subsystem is the Central Processing Computer Set, which consists of:

a. Central Processing Computer
b. Computer Recorder Reproducer
c. Auxiliary Memory
d. Central Processing Computer Control and Display Panel

The remaining Data Processing equipments are:

e. Data Recorder Reproducer
f. Timing Coordinator
g. Alarm Panel

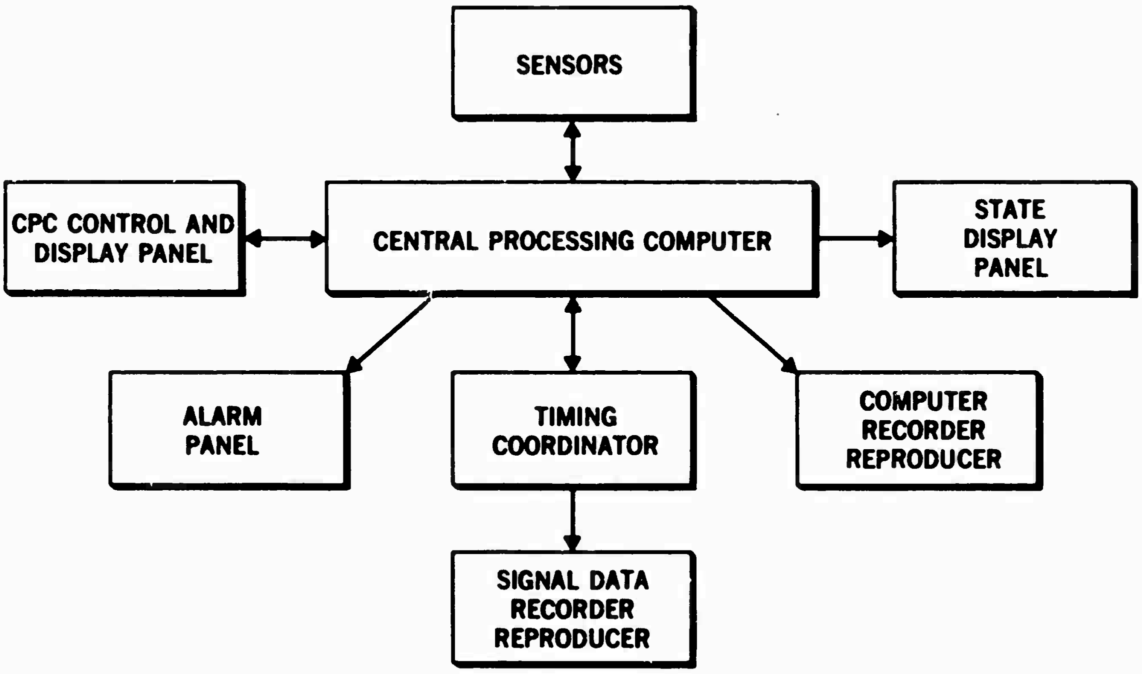


Figure No. 3.1 Data Processing Group Functional Block Diagram

The computer programs are loaded via the Computer Recorder Reproducer. Input data and Supplementary instructions are entered through the Central Processing Computer Control and Display Panel. All the needed sensor output and alarm/status signals are fed as analog or digital signals to the Timing Coordinator and/or the input/output unit of the Central Processing Computer. The signals are conditioned and converted to numerical values where necessary. The processed data is organized, conditioned and sent back to the sensor or the applicable display panels. A group of selected parameters are recorded on the Data Recorder Reproducer. All the equipments in the Data Processing Subsystem are housed within the Control Sphere.

3.2 CENTRAL PROCESSING COMPUTER

3.2.1 The Central Processing Computer (CPC) must perform all the types of computations required by the various equipments of S&C subsystem. The CPC is a combination of the Digital Differential Analyzer (CPC/DDA) and the General Purpose (CPC/GP) type Computer. This combination is used to perform the great variety of processing operations required. The CPC/DDA section will be used to solve high iterative, continuous real time computations for control purposes. The CPC/GP section will be used to solve low iterative, random in time computations and provide decision functions and interface servicing. The CPC/DDA will be addressed by the CPC/GP to accomplish two way transfer. A functional block diagram of the CPC is shown in Figure No. 3.2. The General Purpose section consists of several arithmetic units, the Control Unit and Core Memory Unit. The Control Unit directs the automatic operation of the computer, interprets computer instructions, and imitates the proper signals to the other computer units to execute instructions. The arithmetic units perform the arithmetic and logical operations. The Major units are indicated in Figure No. 3.2. The distinction between Task and Job is in the length of program and response time required. The Task is the small program - fast response - high priority service. The functions of the CPC/DDA are basically Navigation Subsystem service and will be shown in detail in section 4.0. In addition to the CPC/GP and CPC/DDA, the Computer package contains an input-output section (I/O) and a power supply.

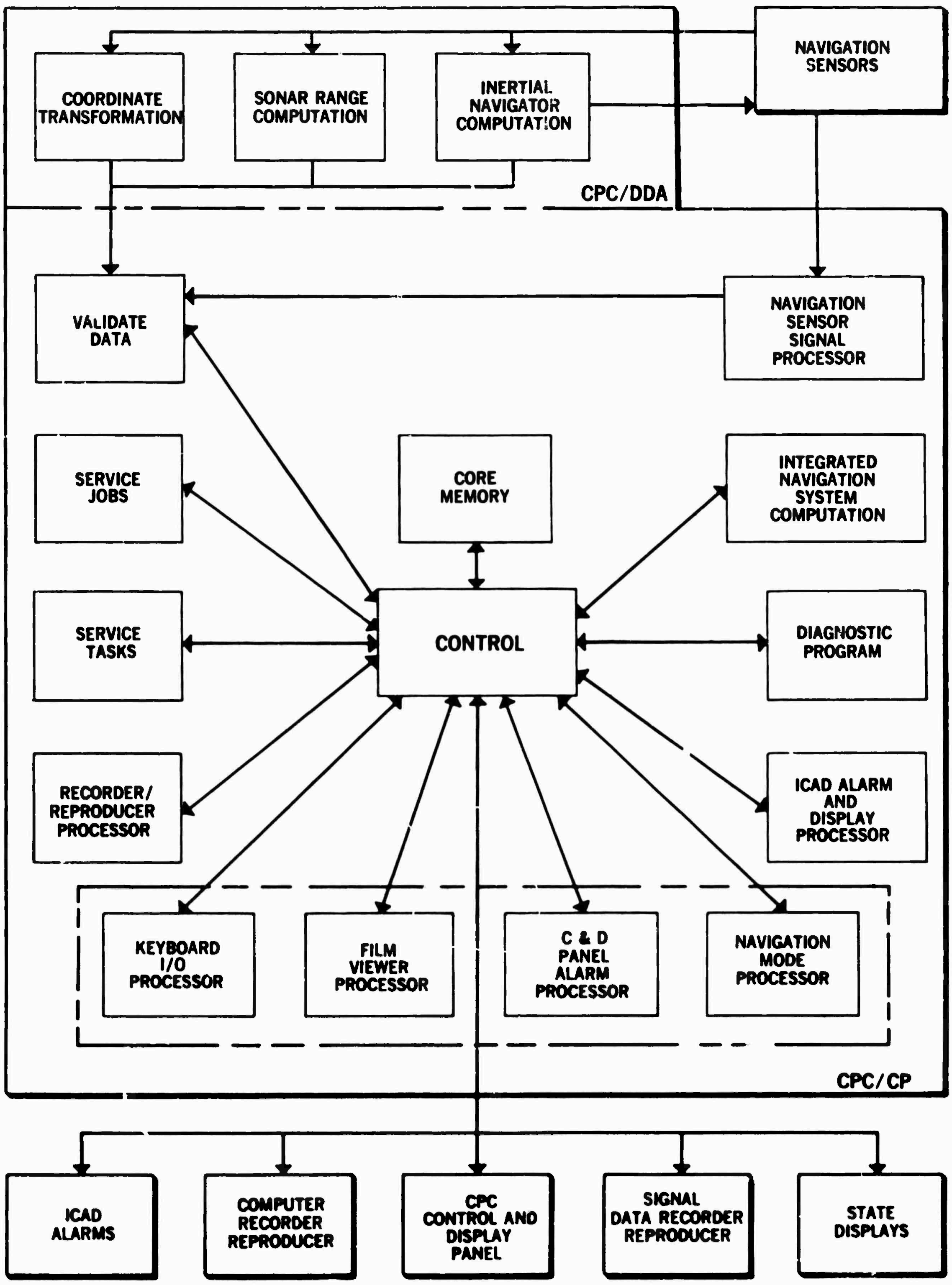


Figure No. 3.2 Central Processing Computer Functional Block Diagram

3.2.2 Data Processing/Sensor time is based on a precision 8 MHz crystal oscillator which is frequency divided to provide signals ranging from 0.1 Hz to 400 KHz at the CPC interface. The 400 KHz signal is used to synchronize the ship control Auto Pilot Digital Differential Analyzer (AP/DDA) clock. Synchronizing and timing pulses are also supplied to the navigation subsystem and to the vehicle's 400 Hz inverters. The Timing Coordinator receives a 1 pps reference signal from which the sonar gate signals can be derived. In addition a time reference signal is recorded on one track of the Data Recorder Reproducer.

3.2.3 Loading is effected via magnetic tape read into the CPC by the Computer Recorder Reproducer. Hard wired features within the CPC are used for initially loading the basic program into the core memory, loading, from magnetic tape on the Computer Recorder Reproducer. Loading routines are used to overlay specialized programs in the core at special times in pre-mission and mission phases of operation. In addition, the CPC/DDA and AP/DDA are initialized by other special programs. An automatic memory protection feature of the power alarm system provides the orderly saving of memory information. When securing, or in the event of a power failure, stored energy in the power supply filtering circuitry is used in the "save" sequence.

3.2.4 The Central Processing Computer is an integral package design incorporating 14 major integrated circuit elements. Semi-conductors and discrete components are used only where integrated circuits were not available. The electronic elements are packaged into 18 logic modules, 4 analog modules, 2 memory core units, 1 delay line and a power supply. The computer package is a sealed unit for protection against water and overpressure. A photograph of the Central Processing Computer is shown in Figure No. 3.3. The CPC's general characteristics are as follows:

Dimensions:	19" wide x 10" high x 13" deep
Volume:	1.4 cu. ft.
Weight:	95 lbs.
Power:	See Appendix B

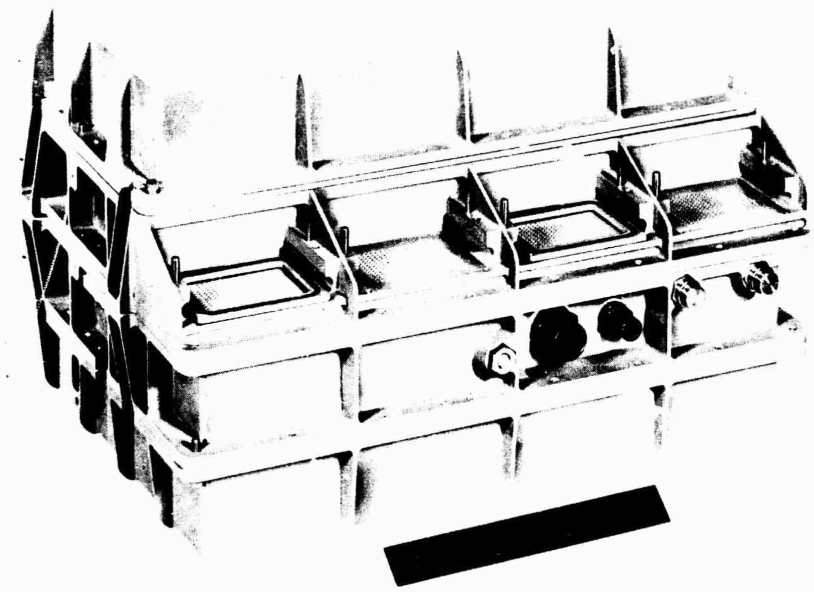


Figure No. 3.3 Central Processing Computer

Number System

CPC/GP:	2's complement
CPC/DDA:	2's complement; trinary increments

Word Length

CPC/GP:	20 bits including sign

Memory Features

CPC/GP:	8,192 words of random access co-incident current core memory, with direct addressing of up to 16,384 words; low voltage sensing to enable memory save protection; memory parity check.

Instructions

CPC/GP:	64 operation codes, 130 instructions
CPC/DDA:	Rectangular rule integration; decision-servo adder

Computation Speed

CPC/GP:	Add - 10 μs; Mult. - 20 μs; Machine cycle time - 5 μs.
CPC/DDA:	Complete 200 integrator/decision computation every 0.5 ms (2,000 iterations per sec.)

Indexing

CPC/GP:	Three hardware index registers
CPC/DDA:	None

Indirect Addressing

CPC/GP:	Hardware indirect addressing
CPC/DDA:	None

Interrupts

CPC/GP:	12 priority interrupt levels, with priority ordering established by internal program.
CPC/DDA:	Navigation mode changes

Input-Output Channels

CPC/GP:	64 analog multiplexed input channels. 16 analog multiplexed output channels. 184 discrete input switch closures. 16 serial input channels. 16 serial output channels. 16 OCT/BCD serial output channels. 92 discrete outputs. Time code generation for digital clock and magnetic tape logging.

CPC/DDA:	32 trinary incremental input channels, each at 2,000 inputs per sec. max. 1 precount input channel. 32 trinary incremental output channels, each at 2,000 outputs per sec. max. 3 resolver to digital multiplexed input channels, with a resolution of one part in 2^{17} and 1.5 ms iteration rate.

The word length chosen contains sufficient digits to obviate the need for double precision instructions. Where more digits are required, an equivalent capacity is accomplished in programming. The instruction list is intended to diminish the requirements for extensive memory and extremely high speed computation rates. The use of index registers and indirect addressing further accomplishes the goal. The use of multi-level interrupts allows for external device servicing and man-interfacing in real time. The I/O channels that require high iteration rates are in general, interfaced with the CPC/DDA. The I/O channels that are random in occurrence and low in iteration rates are, in general, interfaced with the CPC/GP section.

3.3 AUXILIARY MEMORY

The Auxiliary Memory is identical to the memory used in the Central Processing Computer and it therefore doubles the CPC Memory capacity. The unit consists of a pair of coincident current core memories with associated electronics, all housed within a pressure-tight enclosure. The Auxiliary Memory has the following characteristics:

Dimensions:	17.75" wide x 6.75" high x 5.3" deep
Weight:	20 lbs.
Power:	See Appendix B

(This equipment will not initially be provided for DSRV-1.)

3.4 COMPUTER RECORDER REPRODUCER

The Computer Recorder Reproducer (CRR) is a 7-channel, single-speed digital magnetic tape recorder. The CRR is used to load the various computer programs into the CPC. The system has the capability of both recording and reproducing 7 channels of synchronous digital data in the IBM format used in the CPC. The 7-channel recording/reproducing program loading scheme is a standard computer system. The CRR is shown in Figure No. 3.4. Its characteristics are as follows:

Dimensions:	9" wide x 7" high x 6" deep
Volume:	0.2 cu. ft.
Weight:	18 lbs.
Power:	See Appendix B
Bit Density:	556 bpi/track
Error Bit Rate:	Less than 1 bit per 10^6 characters
Recorder Tape Speed:	30 ips
Reproducer Tape Speed:	30 ips
Tape Length:	150-250 ft.

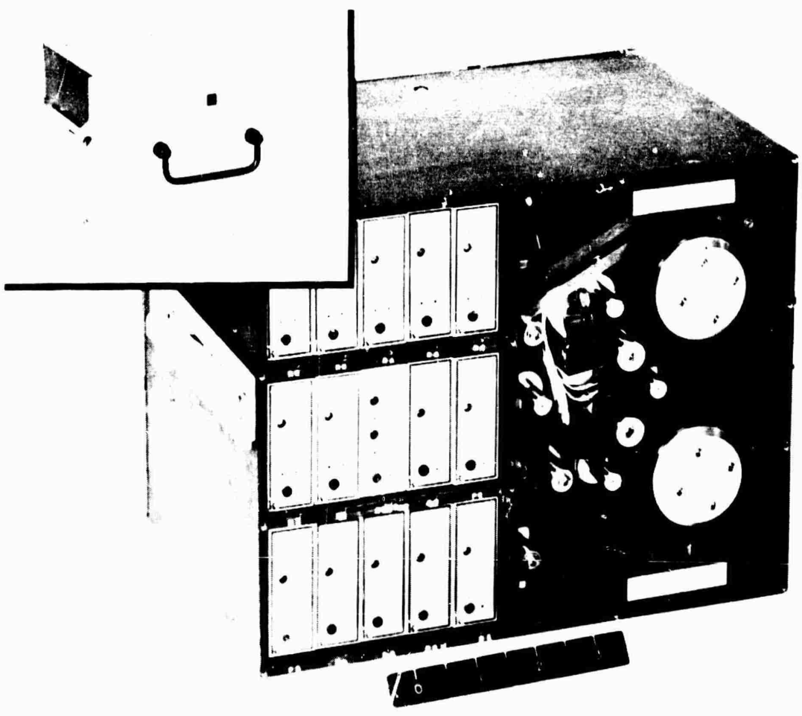


Figure No. 3.4 Computer Recorder Reproducer

3.5 TIMING COORDINATOR

3.5.1 The prime function of the Timing Coordinator (TC) is to reduce interference between several of the acoustic sensors by synchronizing and coordinating their transmissions. The sensors will not be described in this section. They are included in their respective subsystem description. The other functions of the TC include providing interface buffering between the CPC and the Data Recorder Reproducer and between the CPC and the Sound Velocimeter. A functional block diagram is shown as Figure No. 3.5.

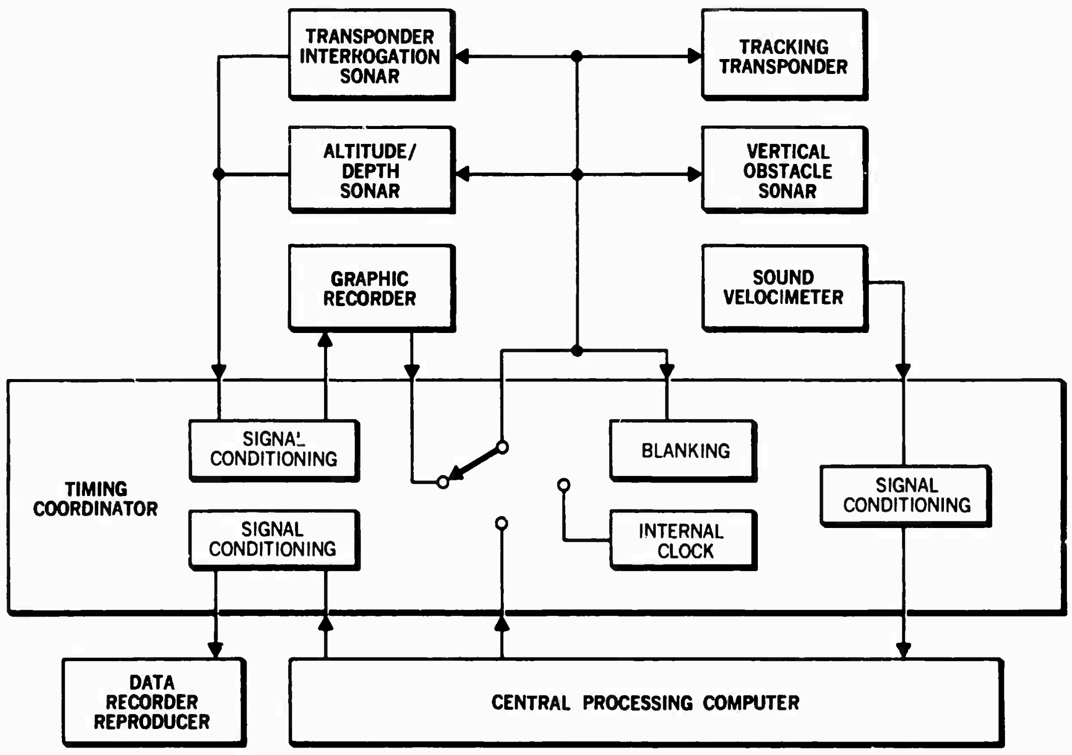


Figure No. 3.5 Timing Coordinator Functional Block Diagram

3.5.2 The Timing Coordinator in synchronism with the start of the sweep of the Graphic Recorder, generates gate signals to control the transmissions of the pulsed sonars. At the time of a pulsed sonar transmission, a signal is sent to the Timing Coordinator which, in turn, sends a "blanking" signal of 20 milliseconds to the receivers of each of the pulsed sonars. There are provisions to defeat the blanking signal to any or all of the sonars. Transmit gate signals are sent to the:

a. Altitude/Depth Sonar Transceiver every 1, 2 or 5 seconds

b. Transponder Interrogation Sonar Transceiver every 5 seconds

c. Vertical Obstacle Sonar Receiver every second.

d. Tracking Transponder Transceiver every 2 seconds.

In the event of a failure of the Sonar Graphic Recorder, the Timing Coordinator will utilize a backup 1 pps signal from the CPC. As a third standby, the TC is capable of internally generating a 1 pps signal but of reduced accuracy. The Timing Coordinator selects and sums: the audio and clipped audio signals of the Altitude/Depth Sonar; the 2 ms one-shot responses of the Transponder Interrogation Sonar; and the CPC generated range gates. These signals are selected by front panel switches and summed by both digital and analog means.

3.5.3 The interface buffering functions of the Timing Coordinator are:

a. To signal condition the TC processed Altitude/Depth Sonar and Transponder Interrogation Sonar output for recording by the Sonar Graphic Recorder.

b. To signal condition the CPC serial output channel for acceptance by the Data Recorder Reproducer.

c. To signal condition and scale the output pulses of the Sound Velocimeter for use by the CPC.

3.5.4 The Timing Coordinator is located in the Starboard Aft Rack in the Control Sphere, and is shown in Figure No. 3.6. The TC has the following characteristics:

Dimensions:	17" wide x 4" high x 8" deep
Volume:	0.5 cu. ft.
Weight:	25.5 lbs.
Power:	See Appendix B

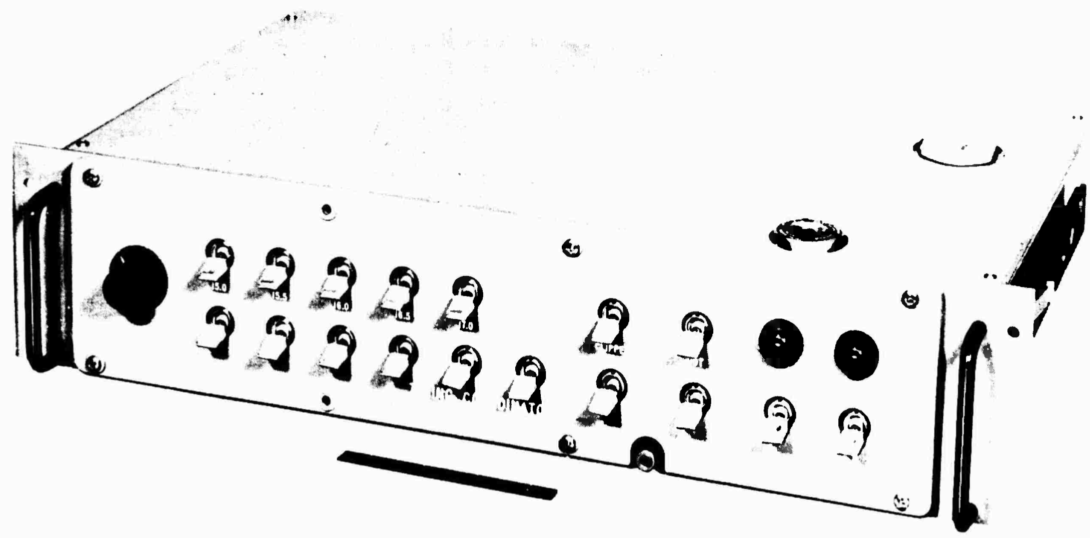


Figure No. 3.6 Timing Coordinator

3.6 SIGNAL DATA RECORDER REPRODUCER SET

3.6.1 The Signal Data Recorder Reproducer (SDR) is a 7-channel 2-speed magnetic tape recorder, intended to record speech and data signals on the DSRV during the entire rescue mission. The SDR has six analog channels, with the seventh being a digital channel. Three analog channels will be used to record speech within the DSRV, or from external sources via the Interior Communication Group. Two other analog channels will be used to record any signals received by the Directional Listening Hydrophone. The last analog channel will be used to record reference timing signals from the Central Processing Computer. The digital channel will be used to log various critical parameters including navigational, life support, and vehicle status information furnished from the Central Processing Computer via the Timing Coordinator. Digital data at a serial rate not to exceed 2,000 bits per second at a tape speed of 1-7/8" per second can be accommodated. The pilot can verify that the set is operating by playing back each channel (one at a time), through the Interior Communications Set (Section 8.3). The recorder will be turned on at the beginning of each mission, operated continuously during the mission, and will require replacement of magnetic tape every hour.

3.6.2 The controls and displays are mounted on the front panel of the Signal Data Recorder Reproducer Set which is mounted in the aft starboard rack. The Signal Data Recorder Reproducer is shown in Figure No. 3.7. The Magnetic Recording Tape will be stored for Co-Pilot accessibility in the starboard aft rack. The Signal Data Recorder Reproducer characteristics are as follows:

Dimensions:	17" wide x 8.75" high x 10" deep
Volume:	1.0 cu. ft.
Weight:	32 lbs. (including one tape and takeup reel)
Power:	See Appendix B

The analog channels' frequency response and signal-to-noise (S/N) ratio are as follows:

Tape Speed	Bandwidth + 3 db	S/N Ratio
1-7/8"/sec	300 Hz - 7.812 KHz	28 db
3-3/4"/sec	300 Hz - 15.625 KHz	28 db

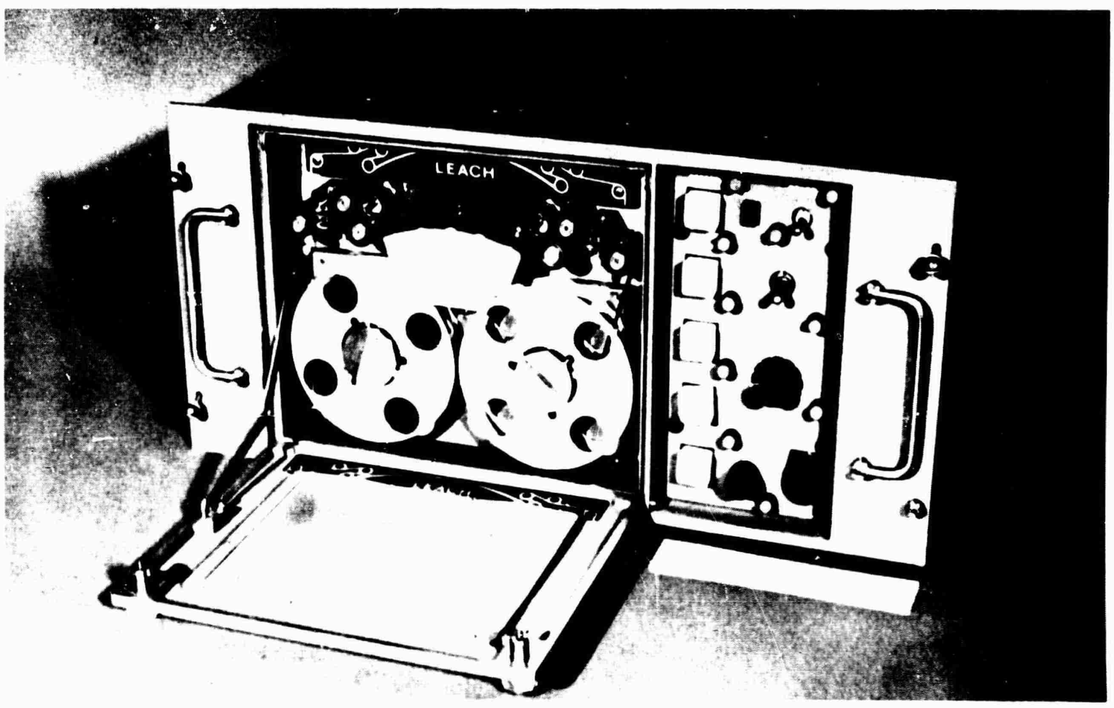


Figure No. 3.7 Signal Data Recorder Reproducer

This item is an existing equipment requiring modification in the recorder monitor section to enable the DSRV operator to verify that speech and data are being recorded. Packaging modifications were also necessary.

3.7 CPC CONTROL AND DISPLAY PANEL

The central Processing Computer Control and Display Panel (See Figure No. 3.8) is incorporated into the center section of the Control Desk and encompasses the following functional groups:

a. A three register numerical display; each register consists of 8 characters (octal or BCD) and can accommodate one 23 bit computer word.

b. A film viewer display encoder which either identifies the contents and units of the data contained in the three registers; identifies the contents and units of the data to be entered by the operator into the three registers; or informs the operator of an alarm or error condition or requests some operator action.

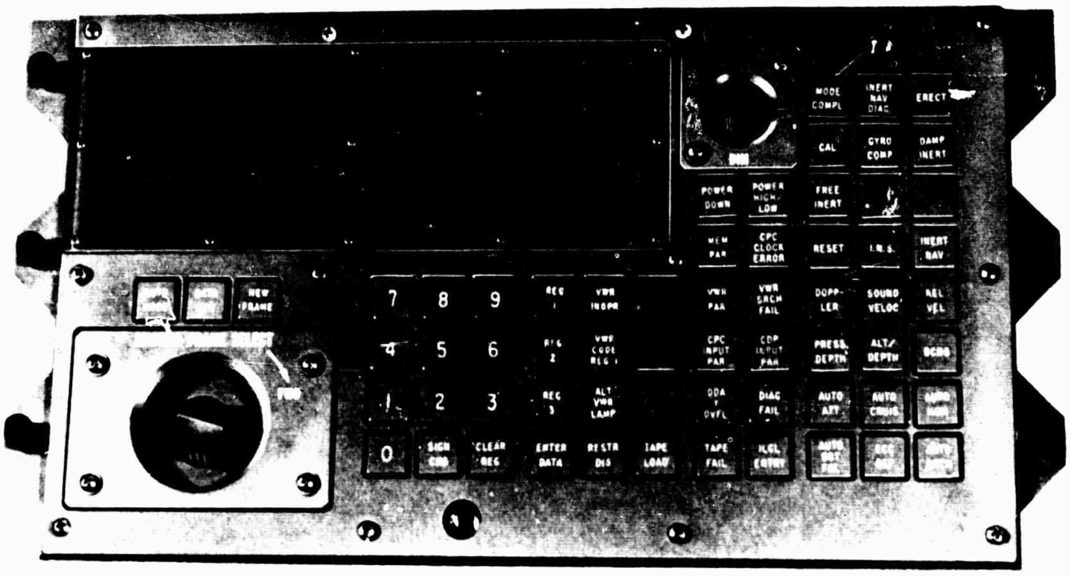


Figure No. 3.8 CPC Control and Display Panel

c. Illuminated push-button switches, indicators and a numerical keyboard.

d. Control buffering and storage logic which consists of the same integrated circuit flat packs, used in the computer.

The three register display in combination with the film viewer and numerical keyboard enables the operator to enter data into the CPC or display data from the CPC or otherwise utilize the CPC on-line. The film viewer, located in the upper left hand corner, is similar in operation to a film editor. The film is driven by a stepper motor which causes the film to move one frame at a time forward or reverse. Either the Central Processing Computer or the operator can control the motion of the film dependent on whether the AUTO MODE switch is lighted or not. A slewing knob located directly under the viewer controls the manual motion of the film. If the film viewer is under manual control, the CPC can flash the AUTO MODE switch indicating that it wishes to gain control of the viewer. In the event of a viewer failure an auxiliary method of performing display or enter functions is provided. The illuminated push-button switches enable the operator to control computer operation. In addition, the push-button switches at the right of the panel provide overall control functions for the Navigation Subsystem and in particular for the Inertial Navigator Set. The illuminated status indicators provide computer status information as well as indications of alarm and error conditions. Note that the expression "illuminated" push-button switches and indicators refers to the fact that they are lighted when activated. In reality however, the switches and indicators even when not activated will glow faintly so that the panel can be operated in a completely darkened environment; the activated and nonactivated states are then differentiated by two easily distinguishable levels of brightness. The CPC Control and Display Panel weighs 40 lbs.

3.8 ALARM PANEL

3.8.1 The Alarm Panel, together with a Master Flasher Display and a mating Annunciator Display, provides visual information of warning, caution and status conditions of Vehicle and S&C equipments. The panel consists of 100 lamp modules and their associated, replaceable, electronic packages. These electronic modules provide a Master Flasher signal together with lamp dimming capability, and a logging signal. In addition, the panel contains two double-pole double throw toggle switches, one 12-position rotary switch, and one push-button switch which are used in testing the Alarm Panel. The Alarm Panel shown in Figure No. 3.9, is located in the center of the upper instrument panel. The Master Flasher and Mating Annunciator Displays are located in the Emergency Jettison Panel (see section 9.2).

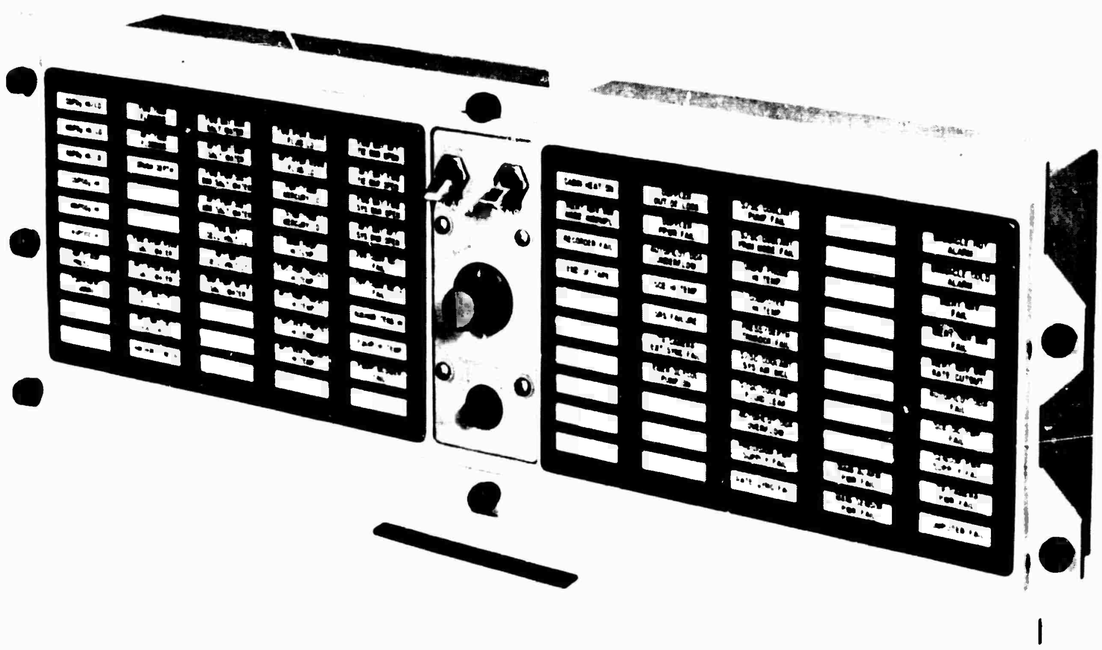


Figure No. 3.9 Alarm Panel

3.8.2 The functions alarmed are listed below. A Red display indicates a warning alarm; Amber, caution; and White, status. The numbers are correlated to the alarm position on the panel. The first number refers to the panel column and the second to the row.

00	Control Cabin O_2 Partial Pressure Hi/Lo	Red
01	Mid Cabin O_2 Partial Pressure Hi/Lo	Red
02	Aft Cabin O_2 Partial Pressure Hi/Lo	Red
03	Control Cabin CO_2 Partial Pressure Hi	Red
04	Mid Cabin CO_2 Partial Pressure Hi	Red
05	Aft Cabin CO_2 Partial Pressure Hi	Red
06	Air Flask Pressure Lo	Red
07	Equipment Smoke	Red
08	(Blank)	White
09	(Blank)	White
10	Forward Tank Flooding	Red
11	Aft Tank Flooding	Red
12	Crush Depth	Red
13	(Blank)	White
14	(Blank)	White
15	Forward Hydraulic Reservoir Salt Water	Red
16	Aft Hydraulic Reservoir Salt Water	Red
17	Forward Battery Cell Voltage Hi/Lo	Red
18	Aft Battery Cell Voltage Hi/Lo	Red
19	Anchor Tension Hi	Red
20	Forward Battery Box Salt Water	Red
21	Aft Battery Box Salt Water	Red
22	Forward Power Distribution Box Salt Water	Red
23	Aft Power Distribution Box Salt Water	Red
24	Forward Battery Cell Voltage Lo	Red
25	Aft Battery Cell Voltage Lo	Red
26	Shore Power Interlock Salt Water	Red
27	Emergency Bus Transfer	Amber
28	Inverter No 1 Hi Temperature	Amber
29	Inverter No 2 Hi Temperature	Amber
30	Forward Hydraulic Reservoir Fluid Lo	Amber
31	Aft Hydraulic Reservoir Fluid Lo	Amber
32	Port Tank Mercury Lo	Amber
33	Starboard Tank Mercury Lo	Amber
34	Main Propulsion Hi Temperature	Amber

35	Forward Horizontal Thruster Hi Temperature	Amber
36	Aft Horizontal Thruster Hi-Temperature	Amber
37	Forward Vertical Thruster Hi Temperature	Amber
38	Aft Vertical Thruster Hi Temperature	Amber
39	28V Converter No 1 Hi Temperature	Amber
40	Forward Battery Aft Tie Line Breaker Open	Amber
41	Aft Battery Forward Tie Line Breaker Open	Amber
42	Forward Battery Forward System Breaker Open	Amber
43	Aft Battery Aft System Breaker Open	Amber
44	28V Converter No 1 Failure	Amber
45	28V Converter No 2 Failure	Amber
46	Anchor Tension Hi	Amber
47	Equipment Hi Temperature	Amber
48	Equipment Blower Failure	Amber
49	28V Converter No 2 Hi Temperature	Amber
50	Cabin Heat On	White
51	Inertial Navigation Binnacle Mode Incomplete	White
52	Signal Data Recorder-Reproducer Failure	White
53	End of Tape (SDR)	White
54	(Blank)	White
55	(Blank)	White
56	(Blank)	White
57	(Blank)	White
58	(Blank)	White
59	(Blank)	White
60	Doppler Sonar Out of Lock	Amber
61	Doppler Sonar Power Failure	Amber
62	Autopilot DDA Underflow	Amber
63	Ship Control Electronics Hi Temperature	Amber
64	Short Range Sonar Failure	Amber
65	TV Camera External Sync Failure	Amber
66	Emergency Glycol Pump On	Amber
67	(Blank)	White
68	(Blank)	White
69	(Blank)	White
70	S&C Coolant Pump Failure	Amber
71	S&C Coolant Primary Mode Failure	Amber
72	Underwater Phone Hi Temperature	Amber
73	CPC Hi Temperature	Amber
74	Pressure/Depth Transducer Failure	Amber

75	S&C Coolant System Air Inclusion	Amber
76	S&C Coolant Fluid Leak	Amber
77	Autopilot DDA Overflow	Amber
78	Ship Control Electronics Precision Power Supply Failure	Amber
79	Rate Gyro Failure	Amber
80	(Blank)	White
81	(Blank)	White
82	(Blank)	White
83	(Blank)	White
84	(Blank)	White
85	(Blank)	White
86	(Blank)	White
87	(Blank)	White
88	Main Alarm Power Failure	Amber
89	Main Sensor Power Failure	Amber
90	Inertial Navigator Binnacle Hot Alarm	Red
91	Inertial Navigator Binnacle Cold Alarm	Red
92	Inertial Navigator Failure	Red
93	Inertial Navigator Binnacle Failure	Red
94	Inertial Navigator Binnacle Rate Cutout	Red
95	Autopilot DDA Failure	Red
96	Ship Control Electronics DC Power Failure	Red
97	Sensor Power Supply Failure	Red
98	TV Camera Power Failure	Red
99	Central Processing Computer Failure	Red

The Alarm Panel weighs 16.5 lbs.

4.0 NAVIGATION

4.1 GENERAL

In deep ocean environments, the piloted submersible is subjected to severe limitations of visual observation and electro-magnetic energy propagation for radar or radio type aids. For this reason, it is essential that accurate navigation information is available to the pilots at all times. The critical navigation task for rescue operations is the ability to return to a given location to within optical viewing distance. The navigation group developed for the DSRV will be discussed in this section. The equipments comprising the group are:

a. Inertial Navigator
b. Central Processing Computer
c. Doppler Sonar
d. Altitude/Depth Sonar
e. Transponder Interrogation Sonar
f. Sound Velocimeter
g. Depth Pressure Transducer
h. Navigation Data Plotter (ancillary equipment)
i. Sonar Graphic Recorder (ancillary equipment)

The subsystem configuration is shown in Figure No. 4.1.

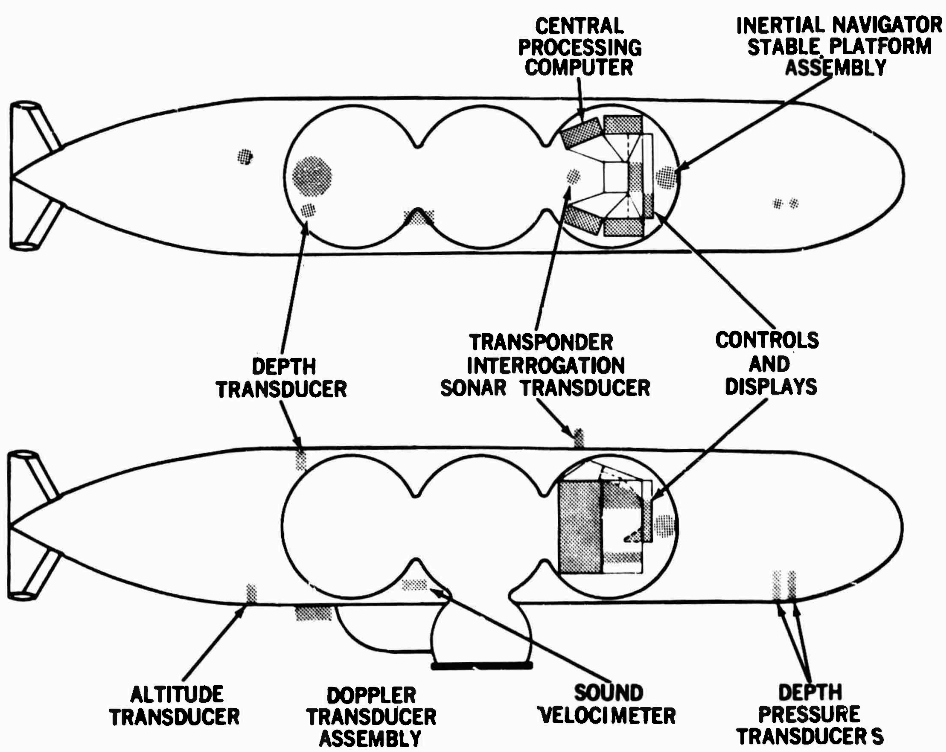


Figure No. 4.1 Navigation Group Configuration

Each navigation sensor provides a measurement of a particular parameter with an accuracy and a noise value associated with it. A functional block diagram of the navigation system is shown in Figure No. 4.2. It is evident that there is redundancy in the information available from the sensors, and that there are a large number of possible choices in the utilization of and relative importance given to the outputs of the sensors. The navigation computations for the DSRV will be accomplished in a Kalman filtering formulation. This technique provides a method by which navigation data, as it becomes available, may be processed in a logical and orderly manner to provide a "best estimate" of the position and velocity of the vehicle. The principal utility of the method is in handling inputs from a variety of navigation sensors, defining the way in which such inputs are to be used, and in setting the relative weight to be given to each input. Application of the technique requires specification of the interaction of each navigation sensor with its noise sources, and specification of certain parameters of the noise. The Kalman filtering technique, therefore, provides the means for integrating the various navigation sensors into a single navigation system. A simplified description of navigation computation process is as follows: A measurement is obtained from one of the sensors. An estimate of the measurement based on previous solutions, is made and is compared with the actual measurement. The measurement is adjusted as a function of the error between the estimated and actual values, and then applied to generate a statistical "best estimate" of the position and/or velocity of the DSRV. The technique is a learning process, which is based on the maximum-likelihood principle of statistics. The computer keeps a running figure-of-merit on the conformity of the measured values to the corresponding calculated values, and continually readjusts the credibility coefficients on this basis. The regime provides position and velocity of the DSRV with errors less than those associated with any individual sensor.

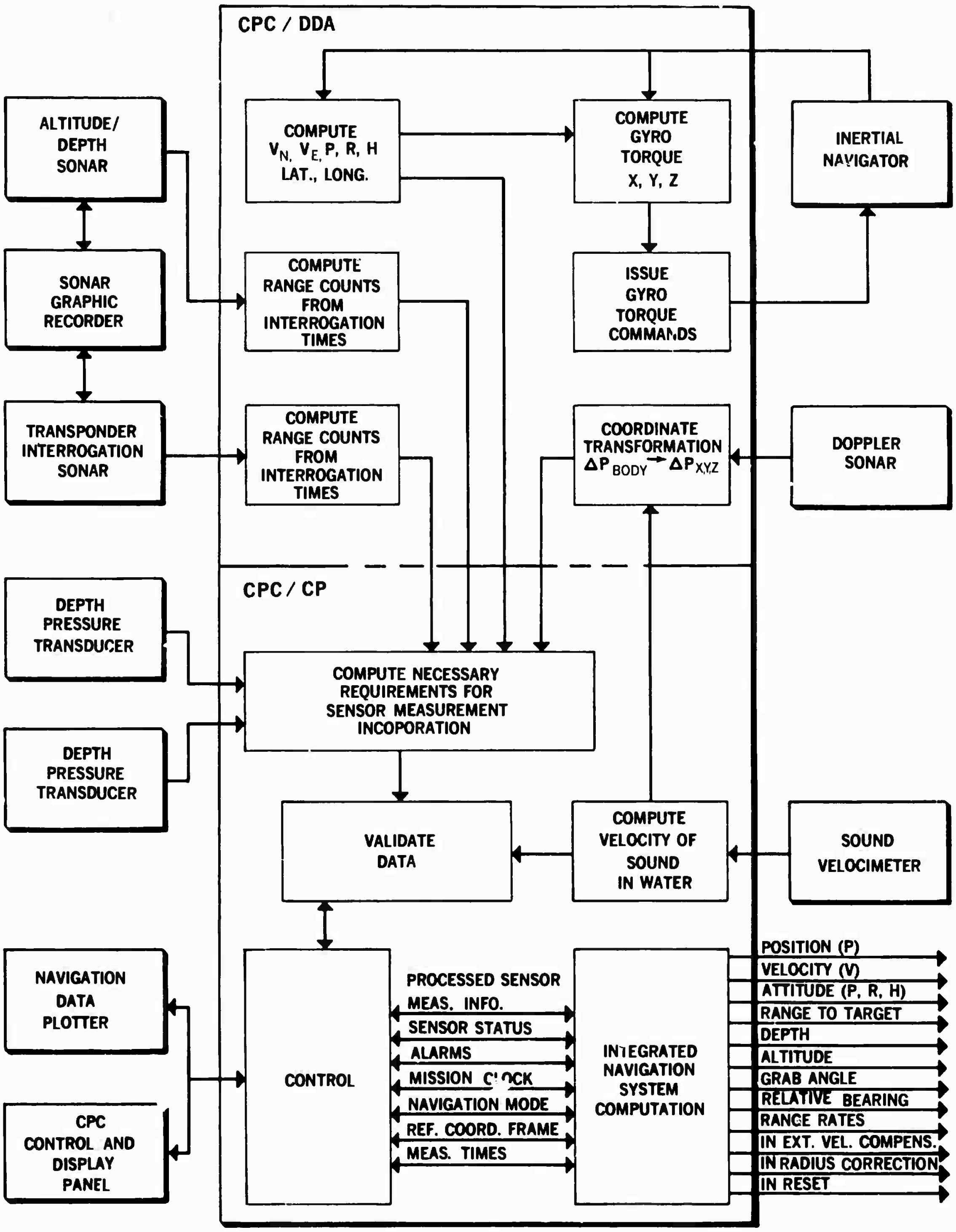


Figure No. 4.2 Navigation Functional Block Diagram

4.2 INERTIAL NAVIGATOR

4.2.1 The Inertial Navigator (IN) will furnish attitude information for the vehicle's ship control group and for the CPC computation of position from the integral of Doppler-derived velocity. The IN, as part of the integrated navigation system, can operate in either Gyrocompass Mode or Damped Inertial Mode. Free Inertial Mode is available for polar region operations. Complete navigator capabilities will not be mechanized in DSRV-1 because the CPC will not be programmed to substitute inertial velocity information for Doppler velocity inputs. The Inertial Navigator consists of two major units: the Stable Platform Assembly and the Control Electronics. The units are shown in Figure 4.3. The Stable Platform Assembly is a three-axis gimbal system using three gyros and two accelerometers. A pictorial drawing is shown in Figure No. 4.4. The assembly will be oriented so that the outermost gimbal axis is parallel with the vehicle's athwartships axis. The center gimbal axis is parallel to the horizontal component of the vehicle's longitudinal axis in the deck normal plane. The innermost (azimuth) gimbal axis is parallel to the local vertical. The Azimuth Gimbal is shown in Figure No. 4.5. The three

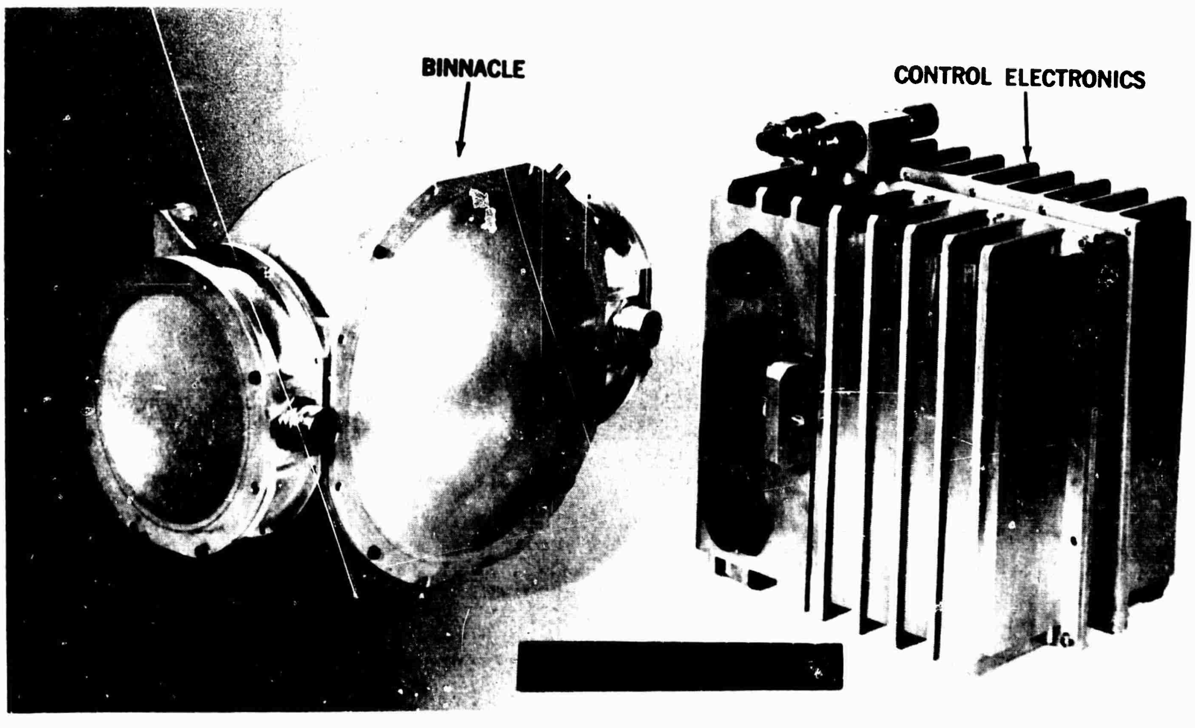


Figure No. 4.3 Inertial Navigator

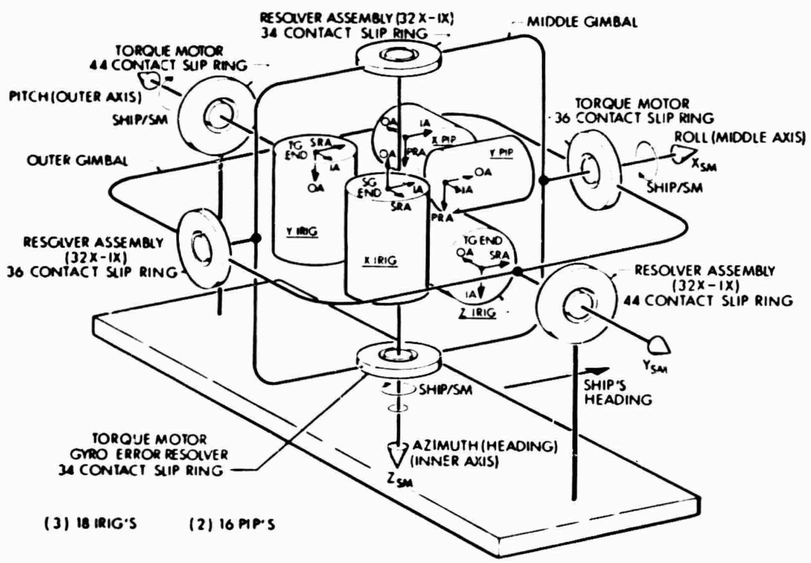


Figure No. 4.4 Pictorial of the Stable Platform Assembly

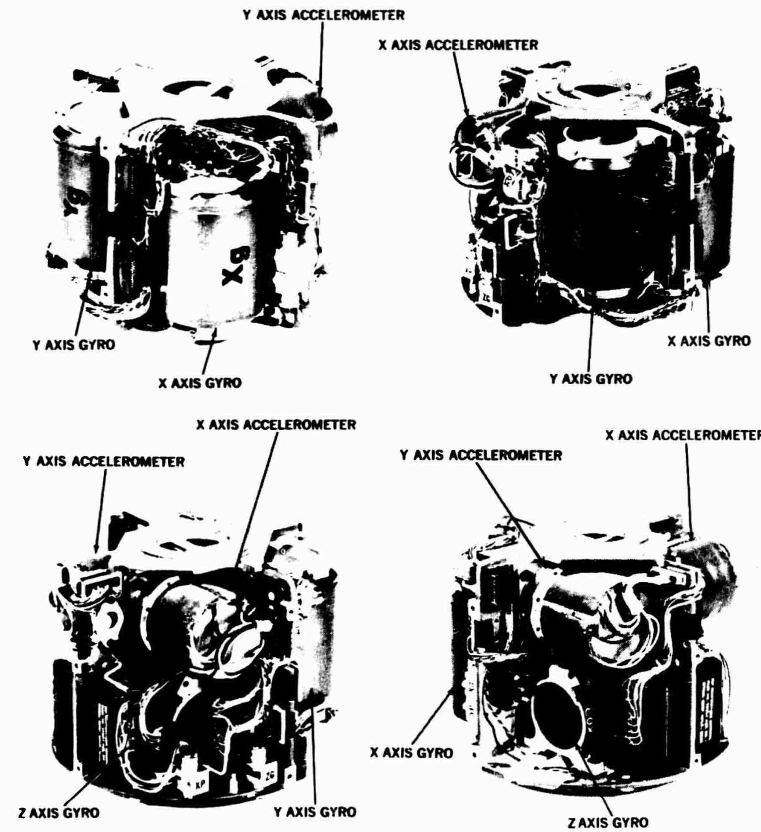


Figure No. 4.5 Azimuth Gimbal of the Stable Platform Assembly respective gimbal resolver outputs are Pitch, Roll and Heading (as defined in the FBM Navigation Subsystem Glossary). The Control Electronics provides the Stable Platform with the appropriate excitations for the gyros, accelerometers and resolvers. Gimbal drive servo amplifiers, and gyro and accelerometer torquing electronics are also housed in the Control Electronics.

4.2.2 The Inertial Navigator Set has the following characteristics:

<u>Stable Platform Assembly</u>

Dimensions:	9.25 inches diameter sphere with overall length along outer axis of 12.25 inches. This includes sealed case.
Volume:	1.9 $ft.^3$
Weight:	31.5 lbs. This includes sealed case.
Power:	See Appendix B.
Type:	3 gimbal system: azimuth, roll and pitch.
Location:	On the Fore-Aft Axis of the vehicle behind the ICAD panels in the control sphere.
Mounting:	Mounted on the Stable Platform Mount which is attached to the pressure hull. The vehicle mounting surface is machined to within 30 min. of the Doppler axis and then measured to 3 min. in vertical and 1 min. in azimuth.
Mirrors:	2 mirrors, one on stable member (azimuth) and one on outer axis (pitch) for assembly alignment.
Material:	Aluminum gimbals; beryllium bearing mount and stub shaft.

Gimbal Inertia:	azimuth	1 in. oz-sec^2
	roll	2.1 in. oz-sec^2
	pitch	4.2 in. oz-sec^2
Stiction Levels:	9 oz-in	
Max. Unbalance Torque:	1 oz-in	
Max. Torque of Gimbal Torques:	55 oz-in	
Housing:	Stable platform is housed in a sealed case which has integral (roll bond) coolant passages with quick disconnects.	
Coolant:	Water-Glycol solution - .06GPM at 50° $\pm$ 5°F.	
Component Alignment:	All inertial components and resolvers are pre-aligned to the assembly's mounting surfaces.	

<u>Gimbal Angle Readouts</u>

Resolvers:	1x and 32x resolvers located on each gimbal axis.
Analog to Digital Converter:	Located in Central Processing Computer.
Accuracy:	10 sec at a maximum rate of 2°/sec.

<u>Inertial Component, Gyroscope</u>

Type:	Floated, single-degree-of-freedom inertial rate integrating gyro (IRIG).
Size:	18
Wheelbearing:	Gas

Flotation Temperature:	+135°F.
Case:	Completely enclosed in hermetically sealed, evacuated Mu-metal jacket, to provide magnetic shielding and axial thermal flow.
Electrical Connections:	All electrical connections made at signal generator end of shroud.
Suspension:	Ducosyn Type-Signal generator Ducosyn Type-Forcer generator
Pickoff Signal Generator:	Microsyn, Multiple "E", 20 mu/mrad.
Torque Generator:	Two stage permanent magnet; high torque - 6600°/hr. low torque - 100°/hr.
Torque Summing Member:	Magnetically suspended radially and axially to eliminate friction uncertainties.
Spin Element (Wheel):	Gas bearing spin element with compliance torque less than $0.015°/hr/g^2$
Input Rate:	Maximum angular input rate about IA or OA: 5 rad/sec.
Temperature:	Capable of withstanding temperature excursion from +20°F to +170°F.
Quantity per System:	Three (3), North (X), East (Y), and Azimuth (Z).
Maximum random drift:	(Classified)

<u>Inertial Component, Accelerometer</u>

Type:	Floated, single-degree-of-freedom, viscous damped magnet, pulsed integrating pendulum (PM PIP).
Size:	16

Weight:	270 gm with shroud and mounting rings.
Torque Generator:	Permanent magnet.
Docusyn Type:	Suspension - signal generator Suspension - torque generator
Threshold:	Less than 0.2 sec.
Shielding:	Magnetic shielding by mu-metal shroud (also used as thermal insulator.
Alignment/Mounting Ring:	Permits PIP Axes adjustment to system axes.
Operating Temperature:	130°F.
Quantity per System:	Two (2), North (X), and East (Y).

Inertial Component Thermal Control

Control Accuracy:	Gyro: ± 0.01°F. Accelerometer: ± 0.01°F.
Type Controllers:	Magnetic Amplifier with power transistor output.

Stabilization Servo

Torque Stiffness:	10 oz-in/sec (input axis).
Maximum Error Angle:	± 1 sec (input axis).
Servo Bandwidth:	100 Hz.
Coordinate Rotation Error:	Less than 5 min.

AC Supplies

Signal Output:	Sine Wave.
Output Stage:	Class "B", transformer coupled.

Frequency & Output Impedance (closed loop):	Wheels 1,000 Hz, 0.1 ohm Suspension 10,000 Hz, 0.1 ohm Gimbal Angle Resolvers 3,333 Hz, 1 ohm.

<u>Inertial Component Torquing</u>

Type:	Pulse Torquing.
Torque Stability:	PIP - 200 ppm Gyro - 10 ppm
Bias Stability:	PIP - 5 sec for 3 months.
Current Regulator:	Time Shared.
Output Switch:	"H" Type.
Torquing Electronics Location:	In oven to maintain stability.
Oven Temperature:	Stable to $\pm$0.1°F.

<u>D. C. Power Supply</u>

Type:	DC to DC pulse width modulated converter for providing the necessary system voltages.
Protection:	Overvoltage and overload.

<u>Diagnostics</u>

Type:	Pertinent system signals are fed to the computer as D. C. levels for evaluation.
Error:	Less than 2%.

<u>System Protection</u>

Stable Platform:	Resolver Rate Cutout.
Gyros:	Float Bottom Cutout.
Moding Interlock:	Automatic down moding upon system failure.

Control Electronics

Dimensions:	12" wide x 12" high x 12" deep.
Volume:	1.0 cu. ft.
Weight:	375 lbs.
Power:	See Appendix B.
Location:	Housed within a sealed case located below the Stable Platform Assembly behind the ICAD panels in the control sphere.
Heat Transfer:	Integral Liquid cooled plate.

4.2.3 The Inertial Navigator moding and operation is controlled initially by a switch on the Rack Equipment Power Switching Panel and then by push buttons on the Central Processing Computer Control and Display Panel. The Rack Equipment Power Switching Panel (power switching panels are discussed in section 9.1) contains a circuit breaker in addition to the three position mode switch (Temperature Control, Standby and Operate). The mode switch takes the system from a power off state with only the environmental controls activated to the completion of a coarse alignment mode. Further up-moding (to gyrocompass or inertial modes) is controlled from the CPC Control and Display Panel.

4.2.4 Five alarm and status lights are provided for the Inertial Navigator Set. These lights are located on the Alarm Panel in the upper instrument panel of ICAD and are as follows:

a. Hot Alarm: One or more of the inertial components has exceeded its nominal flotation temperature by 5°F. Temperature control circuitry immediately secured.

b. Cold Alarm: One, or more of the inertial components is more than 5°F below its nominal flotation temperature. Interlock will prevent up-moding of the system.

c. Rate Cutout: Excessive Stable Platform rates have occurred. Servo and wheel power is immediately secured.

d. IN Interlock Failure: Some abnormality in either the suspension or gyro wheel excitation has occurred. The system is immediately down-moded to non-stabilized mode.

e. Mode Incomplete: A status condition advising the operator that the desired automatic moding has not been completed.

4.3 DOPPLER SONAR

4.3.1 The Doppler Sonar (Doppler) is a velocity sensor which measures velocity in vehicle fixed coordinates. This corresponds to measurements in the fore-aft, port-starboard and deck-to-keel directions. The Doppler Sonar is designed to measure velocity from bottom returns in clear water at altitudes to 500 feet, and from returns off the water mass at altitudes in excess of 500 feet. Relative velocities from zero to 10 knots can be measured along each axis. Performance will not be degraded in the presence of vehicle angular rates of 10 degrees per second about any axis. Operation is possible in one of two modes, pulsed or continuous wave (CW). Pulsed operation is suitable for medium and high altitudes, while CW will be used at altitudes up to 75 feet. The rms velocity error averaged over a one-second interval will not exceed one foot per second at a velocity of 5 knots. The output at zero velocity will be zero. The Doppler Sonar beam pattern is shown in Figure No. 4.6.

4.3.2 The operation of the Doppler Sonar is based on measurement of the frequency difference of the echo relative to the transmitted signals. The Doppler Shift of each echo is determined. This information is combined to generate three sets of pulses. The frequency of the three pulse sets is proportional to surge rate, sway rate and heave rate. A given pulse measures an increment of translation in a given direction. The output signals from the Doppler Sonar for each measurement axis will appear on one of two lines depending on whether the measured velocity is positive or negative. The outputs are in pulse form, with each pulse equivalent to a distance travelled. The nominal output scale factors are as follows:

Fore-Aft	83 pulses/ft.
Port-Starboard	83 pulses/ft.
Deck-to-Keel	101 pulses/ft.

4.3.3 The Doppler Sonar external equipment consists of four sonar projectors and four hydrophones. The four Projector-Hydrophone pairs are assembled onto one housing and mounted on the bottom side of the Aft Sphere. The Doppler Sonar internal equipment consists of the Doppler Transceiver located in the Starboard Aft Rack. The Doppler Sonar is shown in Figure No. 4.7. The Transceiver provides driving signals for the projectors, receives the hydrophone signals and provides vehicle velocity signals to the Central Processing Computer for position computation. It will also contain tracking filters which are capable of automatically or manually sweeping and locking on the Doppler return signal. Manual controls will be provided for selection of pulsed or CW mode, filter bandwidth, sweep direction and desired trackers. Test jacks for monitoring various signals will be provided on the Transceiver.

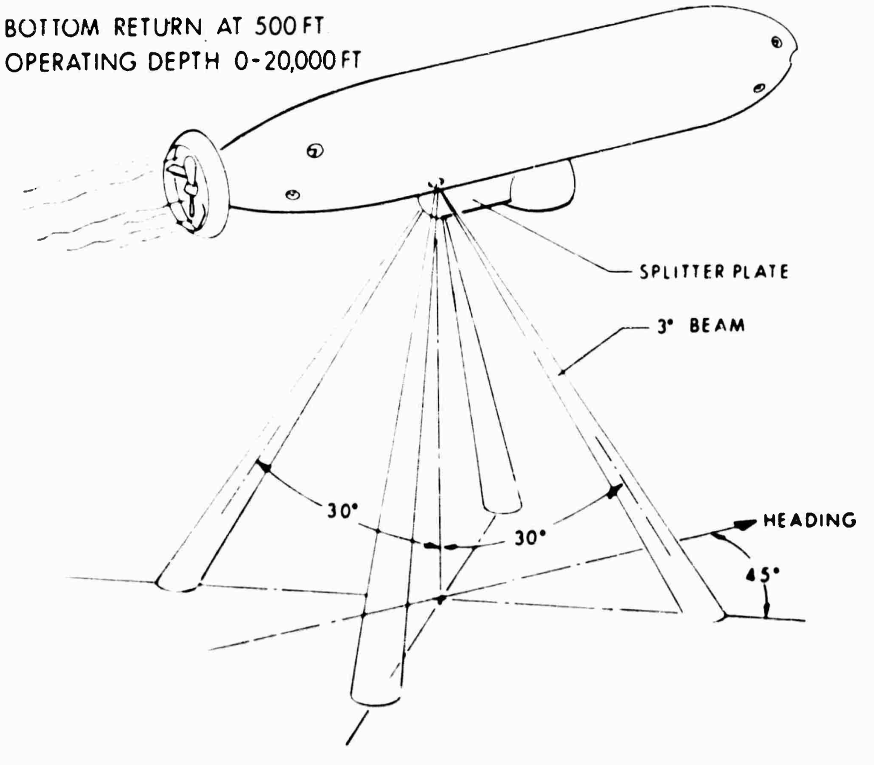


Figure No. 4.6 Doppler Sonar Beam Pattern

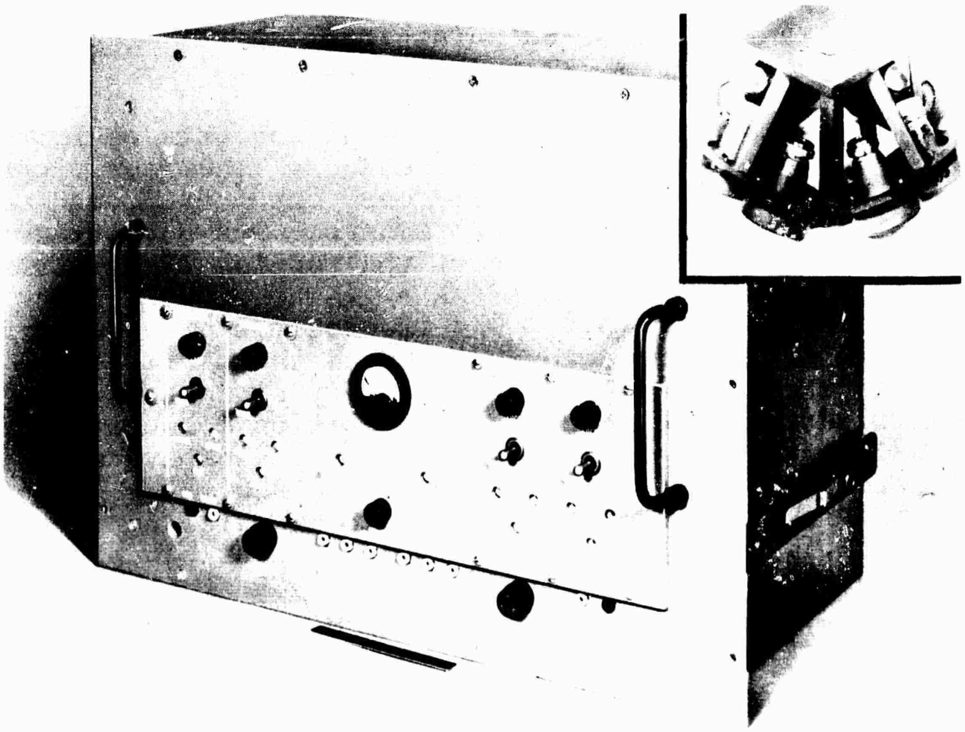


Figure No. 4.7 Doppler Sonar

4.3.4 The Doppler Sonar characteristics are as follows:

Maximum Range:	20,000 ft.
Range of Measurement:	0 to ± 10 kts. in each axis
Threshold Velocity:	0.05 fps at maximum altitude
Velocity Error:	0.1 pps RMS at 5 kts
<u>Output Scale Factor</u>	
Fore-Aft:	83 pps/ft/sec
Port Starboard:	83 pps/ft/sec
Deck-to-Keel:	101 pps/ft/sec

Doppler Transducer Assembly

Dimensions:	18.4" x 18.4" x 9.5" high
Volume:	1.5 cu. ft.
Weight:	80.5 lbs. (in air)
Maximum Pressure:	10,000 lbs/in^2
Frequency:	300 KHz
Pulse Length:	
Pulse Repetition Rate:	
Beam Pattern:	Four beams having a 3db beamwidth of 3° oriented 30° to the vehicle vertical and 45° to the vehicle Fore-Aft axis.

Doppler Transceiver

Dimensions:	17" wide x 13.5" high x 10" deep
Volume:	1.5 cu. ft.
Weight:	31 lbs.
Power:	See Appendix B

4.4 ALTITUDE/DEPTH SONAR

4.4.1 The Altitude/Depth Sonar (ADS) will be used to indicate DSRV altitude above the ocean bottom and depth from the surface. This indication is obtained by transmitting an acoustic pulse toward the surface (or the bottom) and measuring the total time required for the reflected signal to return. This transmit to receive time is converted to range data which is sent to a digital display, to the Graphic Recorder and to the CPC. Three measurement modes can be selected: altitude only, depth only, or automatically alternating altitude and depth. The equipment consists internally, of an electronics assembly (located in the starboard forward rack of the Control Sphere) and externally, of a bottom mounted transducer and a top mounted transducer. The ADS is

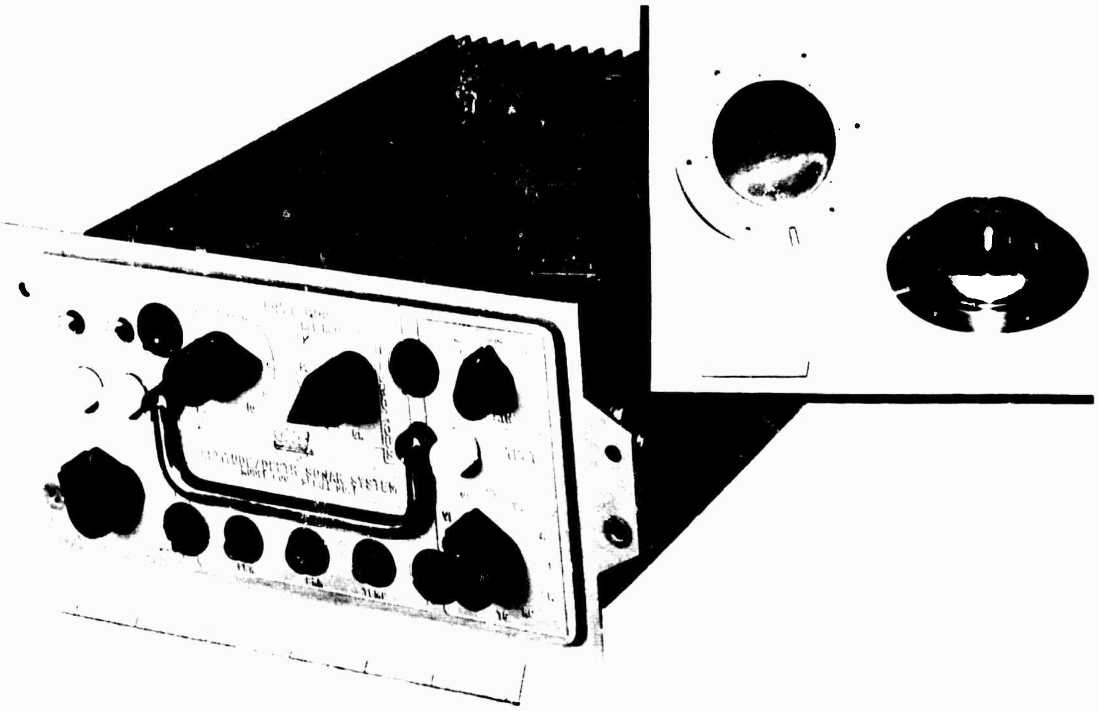


Figure No. 4.8 Altitude/Depth Sonar

shown in Figure No. 4.8. The bottom and top transducers insonify 15° cones below and above the DSRV, respectively. The internal equipment provides the output pulses and the pulse-echo timing for the ADS and processes the return signals. The transceiver will provide an analog signal to the Graphic Recorder and a digital (serial binary) signal to both the CPC and the State Display Panel. Two four-digit digital readouts mounted in the State Display Panel (see Section 5.4.7) indicate vehicle altitude and depth in units of 1 foot. In the integrated mode, the CPC controls the timing and processes the return signals. The Sonar Graphic Recorder is described in Section 4.8.2.

4.4.2 A functional block diagram is shown in Figure No. 4.9. A keying pulse from the Graphic Recorder through the Timing Coordinator triggers a pulse generator and also sets a time interval gate. (This gate remains set until a return signal has been detected by the system.) The pulse generator output is applied to the transducer driver whose output is in turn sent to the transducer through a power amplifier. (A protection circuit prevents

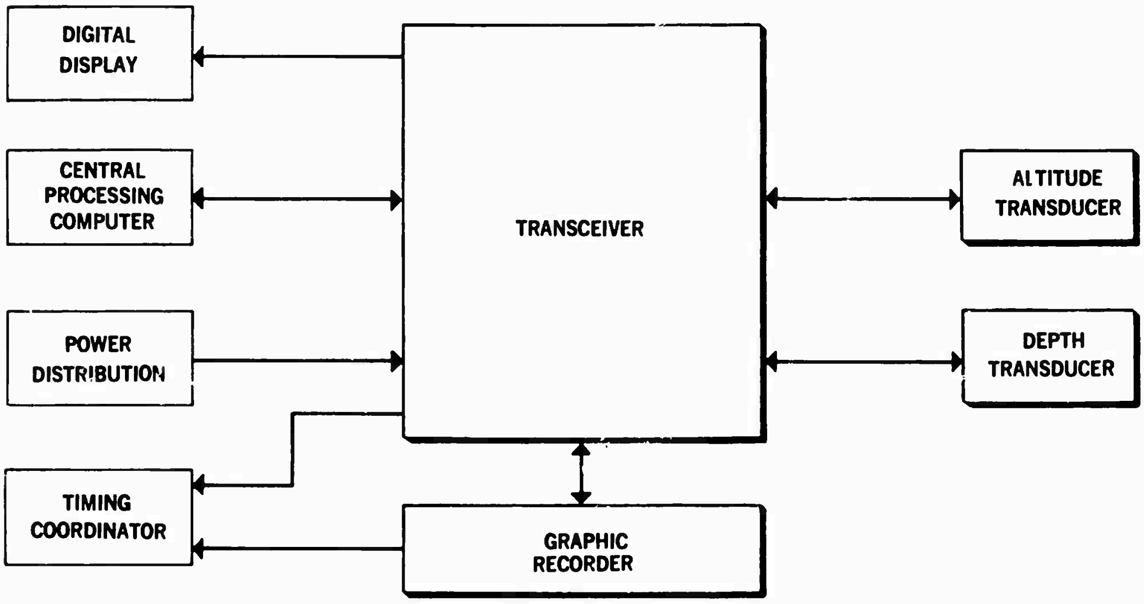


Figure No. 4.9 Altitude/Depth Sonar Functional Block Diagram

overloading the receiver during a signal transmit.) When the transducer receives a return signal it is sent to a time varied gain preamplifier. (This time varied gain function has been initiated by the output of the pulse generator.) The signal is then filtered and amplified. The output of this amplifier is applied to a detector and is also sent to the Graphic Recorder through the Timing Coordinator. The detector sets a flip-flop which in turn resets the time interval gate. Thus the time interval gate has an output duration equal to the difference between the time of transmission and the time of reception. This time is proportional to range and in this system corresponds to altitude or depth. A measurement mode switch selects the transducer to be used. When data is required at a different rate, a pulse rep rate switch selects the pulse generator trigger signal at either 1 pulse per second, 1 pulse every two seconds or 1 pulse every five seconds. Under varied acoustic conditions, it is desirable to use different pulse lengths. A switch at the pulse generator enables the selection of a 1, 2, 5 or 10 millisecond pulse.

4.4.3 The Altitude/Depth Sonar Set has the following characteristics:

Dimensions, Transceiver:	7.9" wide x 4.6" high x 10" deep
Dimensions, Transducer:	8.8" diameter x 4" long
Volume, Transceiver:	0.2 cu. ft.
Volume, Transducer:	0.9 cu. ft.
Weight, Transceiver	14 lbs.
Weight, Transducer:	30 lbs. (in air) 27 lbs. (in water)
Power:	See Appendix B
Maximum Range:	10,000 feet
Frequency:	24 KHz ± 10%
Wavelength:	6 inches
Transmitting Source Level:	+ 105 db re 1 ubar and 45 db re 1 ubar
Pulse Length:	Selectable - 1, 2, 5 and 10 milli-seconds (4.8, 9.6, 24 and 48 feet)
Pulse Repetition Rate:	1 pulse/sec, 1 per/2 secs, 1 per/5 secs
Transmit Duty Cycle:	1% (maximum)
Beam Pattern:	15° cone, centered about a line perpendicular to the horizontal plane of the DSRV. Maximum side lobes: 10db down in all directions. (Both transducers.)

Sensitivity:	Limited to receiver self-noise; less than an equivalent isotropic acoustic noise pressure of -40 db re 1 ubar for a 1 KHz band.
Accuracy:	±24 feet (minimum), 12, 48, and ±2.4 feet.
Resolution:	The digital display will read out altitude (or depth) to the nearest foot. The computer will receive a 4-digit input carrying altitude (or depth) to the nearest foot. The Graphic Recorder will plot altitude or depth to within the nearest foot.

The ADS in the depth mode duplicates the function of the Depth Pressure Transducer. The Depth Pressure Transducer is the primary depth-measuring sensor.

4.5 TRANSPONDER INTERROGATION SONAR

4.5.1 The function of the Transponder Interrogation Sonar (TIS) is to interrogate homing and navigation transponders. With this system, the DSRV can use range information from a single transponder to improve its dead-reckoning or it can navigate precisely from a net of transponders (three or more). The TIS will transmit, upon command from the Timing Coordinator, an interrogation pulse of 7 KHz to the transponders which will, in turn, reply at any one of ten preset frequencies between 12.5 to 17 KHz. The receiver section detects and identifies each transponder reply. These signals are then sent to the Graphic Recorder for time-range conversion and range display and to the Central Processing Computer for navigational computations and range gating. Figure No. 4.10 is a functional block diagram of the TIS.

4.5.2 The TIS external equipment consists of a two element interrogation sonar mounted to the top of the DSRV outer hull. The projector and hydrophone beam patterns are similar; toroidal shaped, and omnidirectional in the horizontal plane. The TIS internal equipment is a transceiver located in the starboard forward rack of the

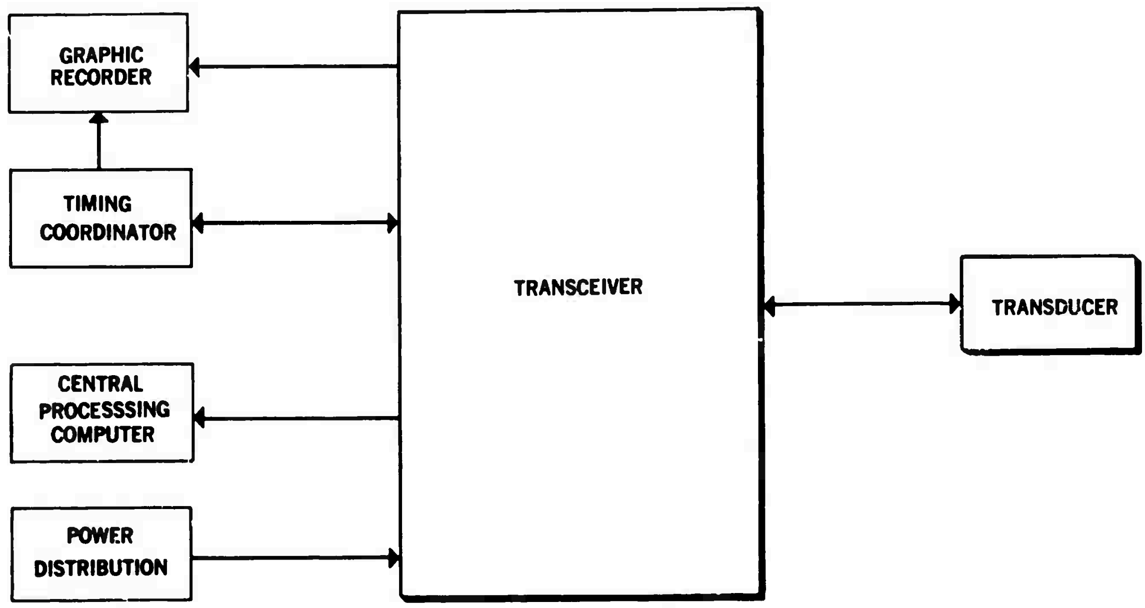


Figure No. 4.10 Transponder Interrogation Sonar Functional Block Diagram

control sphere. The Transceiver is shown in Figure No. 4.11. The Transponder Interrogation Sonar has the following characteristics:

Dimensions, Transceiver:	17" wide x 3.8" high x 9" deep
Dimensions, Transducer:	8" diameter x 13" long
Volume, Transceiver	0.3 cu. ft.
Volume, Transducer	1.5 cu. ft.
Weight, Transceiver:	23 lbs.
Weight, Transducer:	34.5 lbs. (in air) 24.0 lbs. (in water)
Power:	See Appendix B

Figure No. 4.11 Transponder Interrogation Sonar Transceiver

Operating Source Level:	+95db re 1 ubar at 1 yard
Transmitting Duty Cycle:	Less than 1%
Frequency:	Transmit: 7 KHz Receive: 12.5, 13, 13.5, 14, 14.5 15, 15.5, 16, 16.5, 17 KHz (all ±50 Hz)
Pulse Length:	4 milliseconds ± 0.5 milliseconds
Pulse Repetition Rate:	1 pulse/second
Beam Pattern:	Toroidal, omnidirectional (±2db) in the horizontal plane.
Sensitivity:	Will provide a signal-to-noise ratio of greater than zero db for acoustic noise (compared to electrical noise) with an acoustic noise field having a spectrum level of -53db re 1 ubar^2/cycle over the band of 12 KHz to 17 KHz.

Accuracy:	$\pm$20 feet
Resolution:	On long-range scales, recorder limits resolution. On short-range scales, resolution is limited by accuracy of return signal (approx. 1.2 ft.).
Range:	27,000 feet.

No other DSRV equipment duplicates the function of the TIS. The TIS is a developmental item.

4.6 SOUND VELOCIMETER

The sound Velocimeter (SV) provides a continuous measurement of sound in water in a form suitable for digital analysis. The Velocimeter output is a train of pulses whose frequency is used to compute the speed of sound. Sound velocity is required for the computation of vehicle velocity by the CPC from the output of the Doppler Sonar. The signal is routed to the CPC through the Timing Coordinator. The unit consists of an acoustic transmitter, a reflector, an acoustic receiver and an electronic package. It operates by transmitting a sound pulse over a known distance to a reflecting surface. The receiver receives and detects the reflected pulse and simultaneously sends a pulse to the output circuitry and activates the transmitter to start the cycle over again. The Sound Velocimeter is a modified commercially available item and is shown in Figure No. 4.12. The Assembly characteristics are as follows:

Dimensions:	4" diameter x 17" overall length
Volume:	0.5 cu. ft.
Weight	20.5 lbs. (in air) 16.0 lbs. (in water)
Power:	See Appendix B
Sound Velocity Range:	4500-5500 feet/sec
Output Frequency:	6800-8300 Hz
Output Voltage:	3.4-5.2v p-p square wave
Output Impedance:	600 ohms for 3.4v output

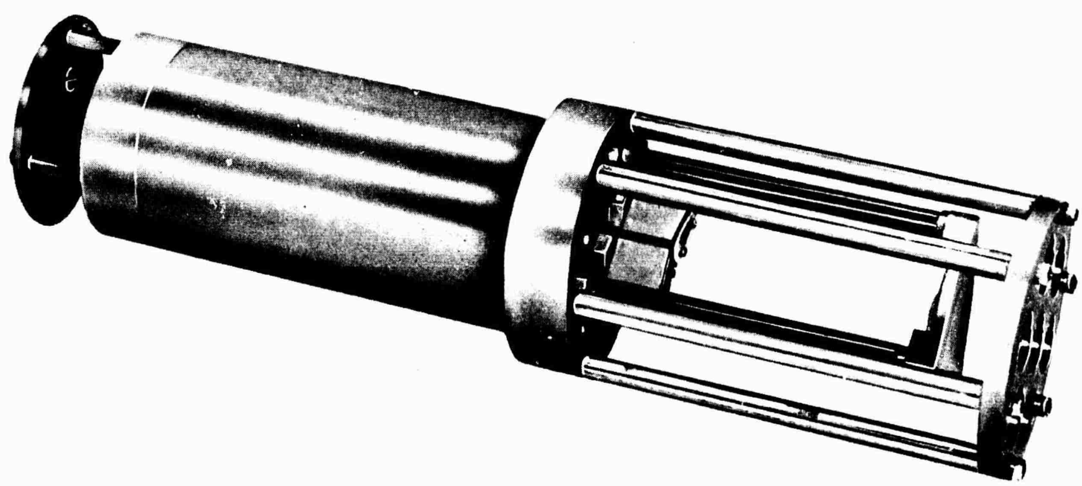


Figure No. 4.12 Sound Velocimeter

Maximum Pressure:	20,000 psi
Operating Temperature Range:	-2°C to +50°C
Storage Temperature Range:	-50°C to +100°C
Response Time:	140 microseconds
Electronic Time Delay:	Less than 0.25 microseconds
Overall Accuracy:	±0.01% (±.5 fps)
Stability:	Better than 1 part in 150,000
Resolution:	1 part in 50,000
Calibration Error:	Less than 1 part in 25,000
Temperature Error:	Less than 1 part in 50,000 per 10°C
Pressure Error:	Less than 1 part in 150,000 per 1000 psi
Plane Error:	Less than 1 part in 100,000 per foot per second

Non-Linearity:	Less than 1 part in 12,500
Error due to changes in Acoustic Signal Level:	Less than 1 part in 20,000 for 3db decrease in signal level

4.7 DEPTH PRESSURE TRANSDUCER

4.7.1 Two Depth Pressure Transducers are used to measure ambient ocean pressure. Each transducer is housed in its own protective case. The transducers have voltage regulators so that variations in the excitation voltage do not effect the output. The output is processed by the CPC to provide depth information to the DSRV pilots. Each transducer measures absolute pressure from 0 to 4000 psia (9,000 feet) to an accuracy of ±0.3% of full scale output. Through continuous comparison by the computer of depth transducer outputs, the computer automatically selects one of the two as the operating transducer. Redundancy is provided to enhance system reliability. The output reading of depth in feet is displayed on a 4 digit digital display on the State Display Panel (see Section 5.5.5). The Altitude/ Depth Sonar Set depth determination is the backup for the Depth Pressure Transducers. The Depth Pressure Transducers are located in the bow flooded area, between the DSRV outer fairing and pressure spheres.

4.7.2 The Depth Pressure Transducer consists of a vacuum deposited thin film pressure sensor, and associated, integral, amplifier-bridge electronics supplying a 5 volt signal directly proportional to applied pressure.

The Depth Pressure Transducer characteristics are as follows:

Dimensions:	3.4" diameter x 9.3" length
Weight:	13 lbs. (in air)
Power:	See Appendix B
External Case Material:	CRES 316L protected by anti-corrosion and anti-fouling coatings
Case Sacrificial Anode:	Aluminum QQ-A-250/1b

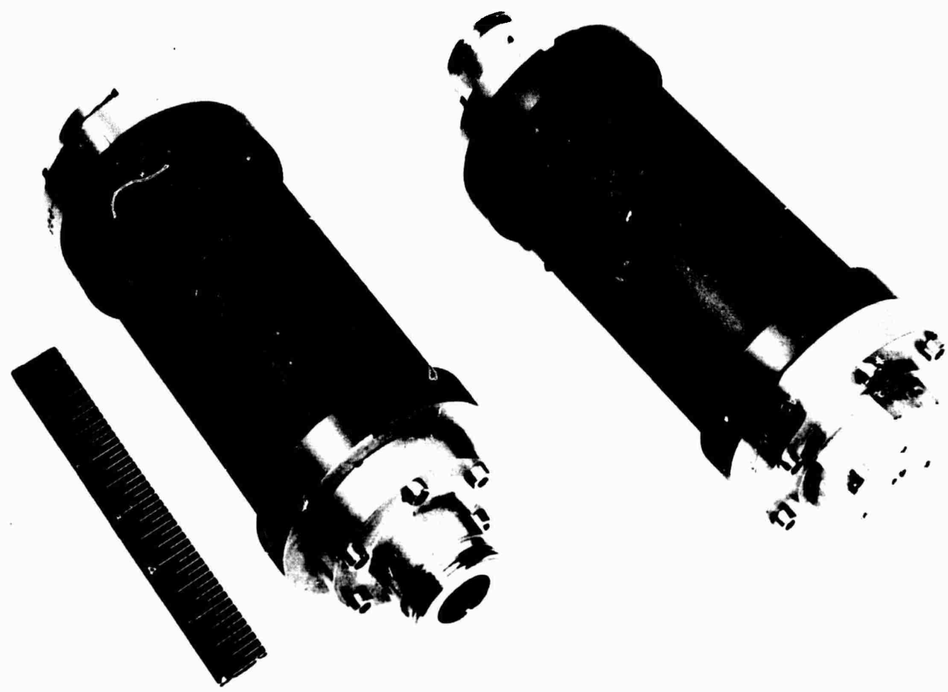


Figure No. 4.13 Depth Pressure Transducers

Pressure Range:	0-4000 psia
Combined Non-Linearity and Hysteresis:	Less than ±0.2% FSD
Non-Repeatability:	Less than 0.1% FSD
Combined Thermal Error: (including sensitivity and zero shift in the temperature interval +28°F to +90°F)	Less than +0.4% FSD

The Depth Pressure Transducers are shown in Figure No. 4.13.

4.8 DISPLAYS

4.8.1 Navigation Data Plotter

The Navigation Data Plotter (NAV PLOTTER) will present a visual display of the DSRV's position in the horizontal plane. This information will be derived from doppler

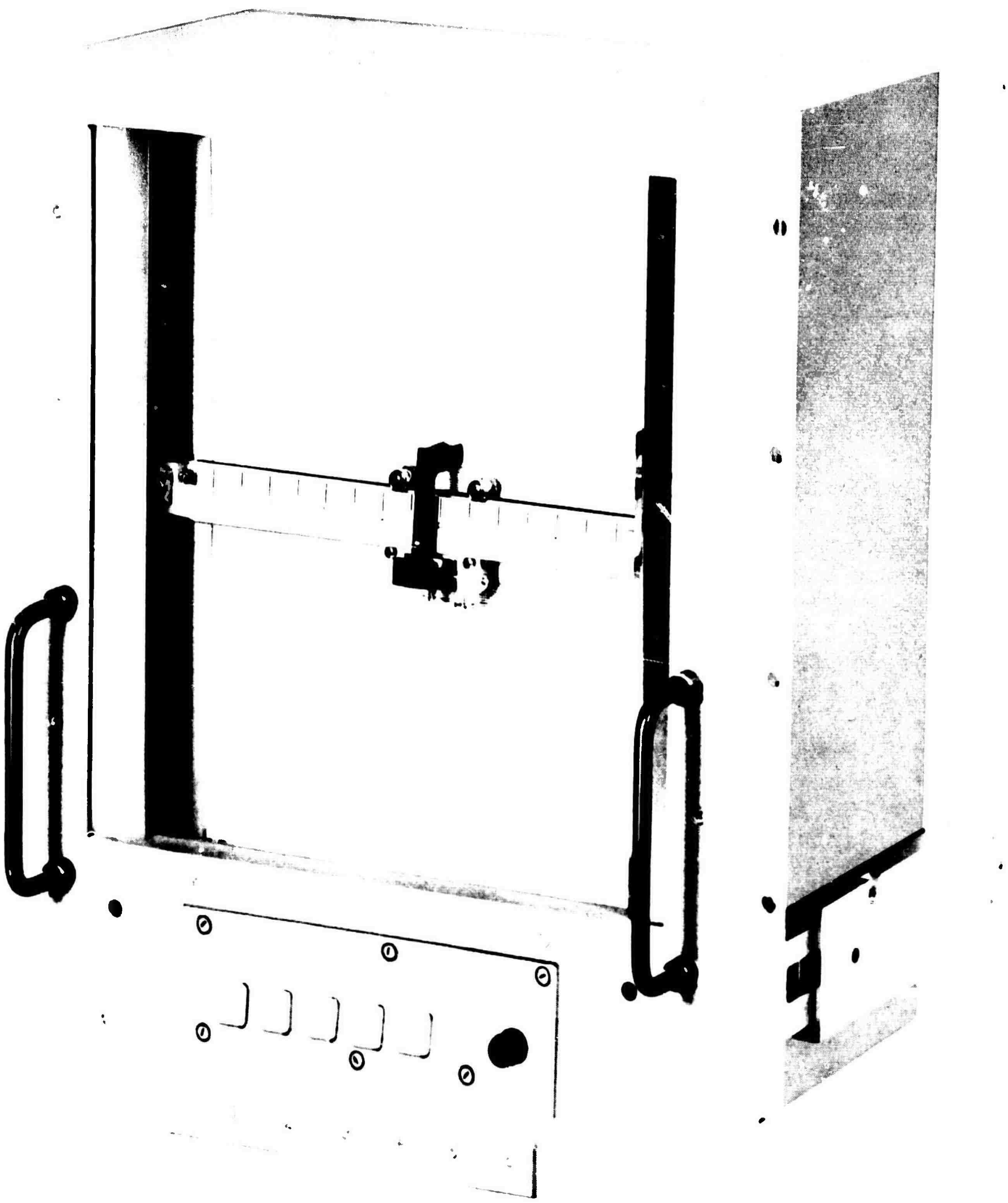


Figure No. 4.14 Navigation Data Plotter

velocities and attitude information by the CPC. The Plotter will operate directly on Central Processing Computer commands to plot a permanent trace of the vehicle's track and a symbol plot of selected targets. It is an anlog plotter accepting analog values of position expressed in x and y coordinates from the CPC. The 7 inch by 10 inch plotting surface will be marked upon by a discrete point character printer. Pen down signal will originate in the CPC. The plotting area will be illuminated by a source which can be dimmed manually. The controls, situated on the face of the plotter, include provision for range-scale adjustment. A photograph of the Navigation Data Plotter is shown in Figure No. 4.14. The carriage speed is less than one second for full scale travel. The plotter is mounted on the Vertical Panel of ICAD to the right of the co-pilot. In the event of plotter failure, the operator can acquire DSRV position from the Central Processing Computer and manually plot his position on the plotting surface.

The Navigation Data Plotter has the following characteristics:

Dimensions:	13.9" wide x 14.5" high x 6.5" deep
Volume:	0.8 cu. ft.
Weight:	25 lbs.
Power:	See Appendix B
MTBF:	2000 hrs.
Accuracy:	0.3% FSD in each axis

4.8.2 Graphic Recorder

The Graphic Recorder (GR) will be used to plot data from the Altitude/Depth Sonar and the Transponder Interrogation Sonar. The plot will present an analog trace of DSRV altitude, depth and range to one or more transponders. The GR supplies the primary timing signals to the Timing Coordinator. An 80 Hz signal in synchronism with the recorder sweep is supplied and counted down by the Timing Coordinator to generate gating signals to the Altitude/Depth, Vertical Obstacle and Transponder Interrogation Sonar Sets. The GR internal clock is accurate to within 10 parts per million.

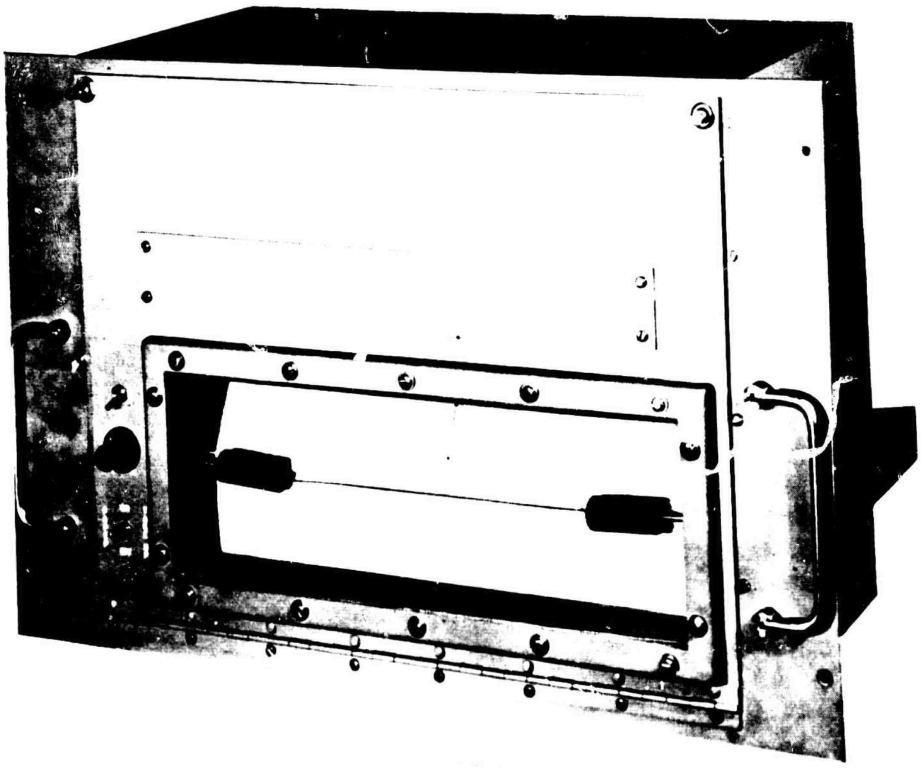


Figure No. 4.15 Graphic Recorder

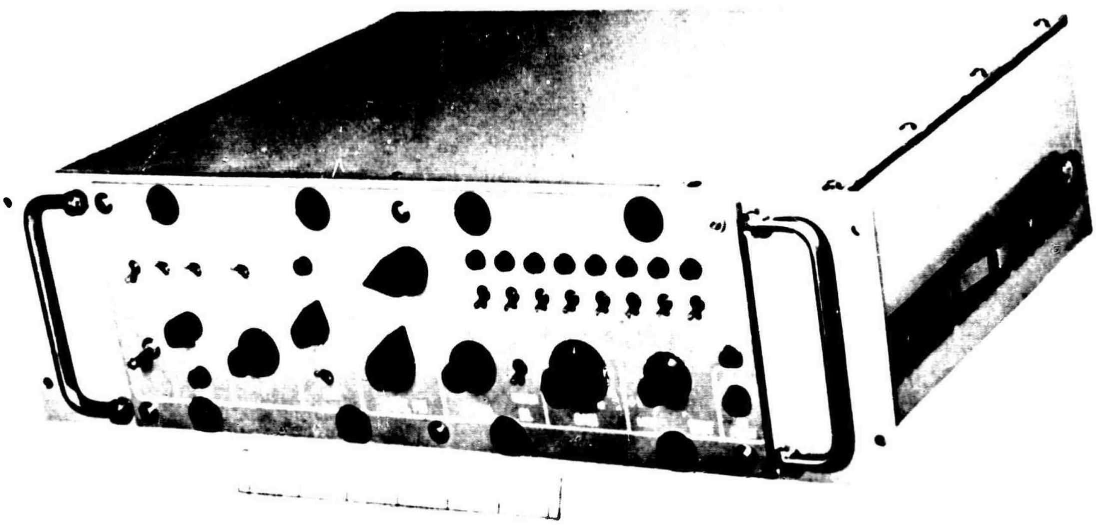


Figure No. 4.16 Graphic Recorder Electronics

The Sonar Graphic Recorder is located in the port forward rack of the control sphere and consists of the Recorder section and Control Electronics. These units are shown in Figure Nos. 4.15 and 4.16, respectively. The Recorder section is a wet-paper type that is non-toxic. The physical characteristics are as follows:

Size, Electronics:	17" wide x 4.84" high x 12" deep
Size, Recorder:	17" wide x 11.84" hgih x 7.5" deep
Weight, Electronics:	31.5 lbs.
Weight, Recorder:	40.0 lbs.
Power:	See Appendix B

The Sonar Graphic Recorder is a modified version of an existing equipment.

4.8.3 Clock Set

The DSRV Clock Set consists of two clocks, namely:

a. Universal Time (GMT) Clock

b. Elapsed Time Clock

Each of these is a 24 hour, mechanical, illuminated unit, with numerals in white, and background in black. The faces are round, and set in a rectangular mounting. Each clock employs its own manual time set control, and on/off switches. The characterisitcs are as follows:

Size:	2.4" wide x 2.4" high x 2.5" deep
Weight:	3 lbs.
Power:	See Appendix B

The Clock Set is mounted in the Clock and Transponder Release Panel on the upper instrument panel of ICAD. The panel is shown as Figure No. 4.17.

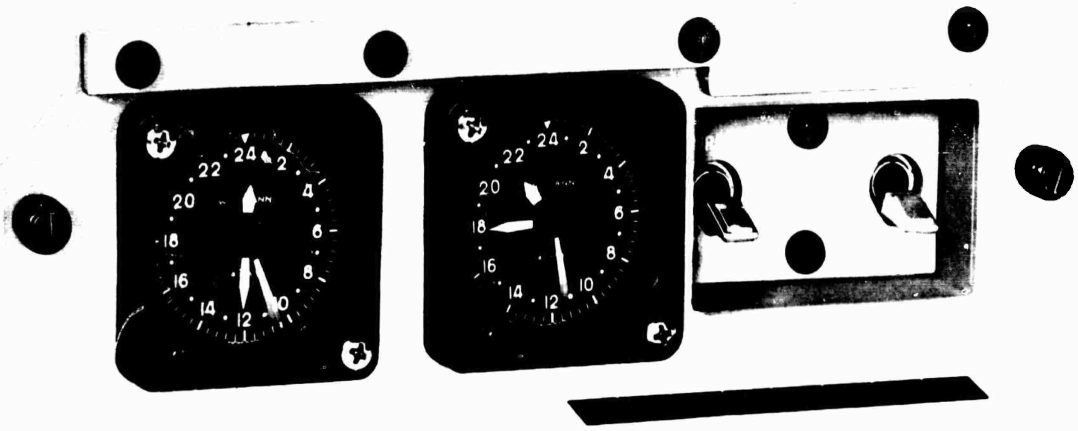


Figure No. 4.17 Clock and Transponder Release Panel

5.0 SHIP CONTROL

5.1 GENERAL

The Ship Control System provides the means of manual and automatic control of the DSRV in six degrees of freedom, namely: pitch, roll, yaw, surge, sway, and heave. The function of the Ship Control Group is to computer process rate commands so as to achieve an uncoupled response in each of the six degrees of freedom and to be invariant with respect to environmental disturbances. A functional block diagram is shown in Figure No. 5.1. The technique used by the system to generate vehicle linear and angular rates in agreement with the rate commands (designated the Primary inner loop) is as follows:

a. To measure the vehicle rates in each degree of freedom. The Rate Gyro Assembly measures the rotational rates. The Doppler Sonar provides the translational velocities.

b. To compare these rates with the commanded rates. This is accomplished in the Auto Pilot DDA. The rotational rate signal inputs are first conditioned by the Ship Control Electronics.

c. To drive the effectors with signals proportional to the difference between commanded and measured rates. The Auto Pilot DDA generates vehicle command signals. The Ship Control Electronics receives the vehicle command signals and converts them to vehicle effector, ballast, trim and list drive signals.

Undesired cross-coupling among the degrees of freedom arises from gravitational, inertial, hydrodynamic and effector moments. The effects of cross-coupling on the dynamics of the vehicle depend upon initial displacements, rates, and effector command signals. The effector command signals are computed in such a manner as to cancel these cross-coupling effects. The primary ship control loop can also be closed to effect and maintain desired linear and angular displacement (Primary outer loop). The mechanization sequence is similar to the inner loop and is as follows:

a. To measure the vehicle attitude and position. The Central Processing Computer computes position from Inertial Navigator and Doppler Sonar inputs. Attitude is provided by the Inertial Navigator.

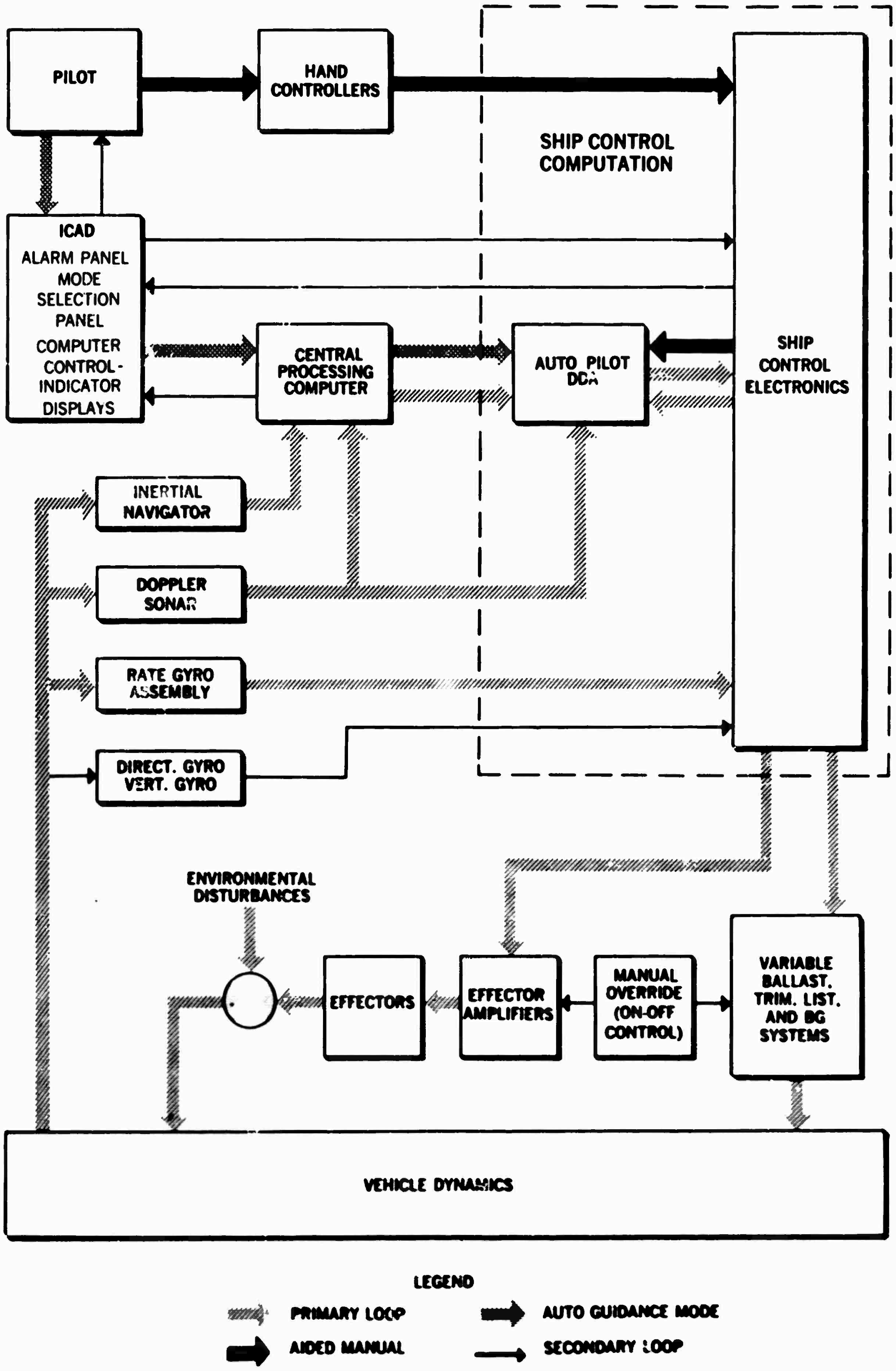


Figure No. 5.1 Ship Control Functional Block Diagram

b. To compare the measured attitude and position with the commanded attitude and position. This is accomplished in the Auto Pilot DDA.

c. To drive the effectors with signals proportional to the difference between the commanded and measured attitude and position. The Auto Pilot DDA generates vehicle command signals. The Ship Control Electronics receives the vehicle command signals and converts them to vehicle effector, ballast, trim and list drive signals.

5.1.1 Vehicle Modes

The distinction between the DSRV modes of operation is based upon the source of vehicle control. Hence, there are two modes of operation:

a. The Aided Manual mode, corresponding to hydronaut control of the vehicle by means of hand controllers.

b. The Auto Guidance mode, in which the CPC guides the vehicle in preprogrammed maneuvers.

The Aided Manual mode is the basic vehicle Control mode.

The DSRV will remain in the Aided Manual mode until explicit action is taken by the pilot to activate another mode. The term "Manual" does not mean a heavy man-machine interface. The human operator is not providing the inherent DSRV stability, but only incremental input commands when needed. All inner, and all or some of the outer loops are always closed. In addition, a distinction in vehicle operation is made with regard to the magnitude of the vehicle speed with respect to the water. The two regimes of operation are as follows:

a. The Hover Regime, employing the ducted thrusters and operating at speeds less than two knots.

b. The Cruise Regime, using the shroud and operating at speeds greater than two knots.

Mode activiation and Display, is provided by the Hand Controllers (see Figure No. 5.2) and the various ship control panels (see Figure No. 5.5). The display signals are routed as part of the secondary ship control loop.

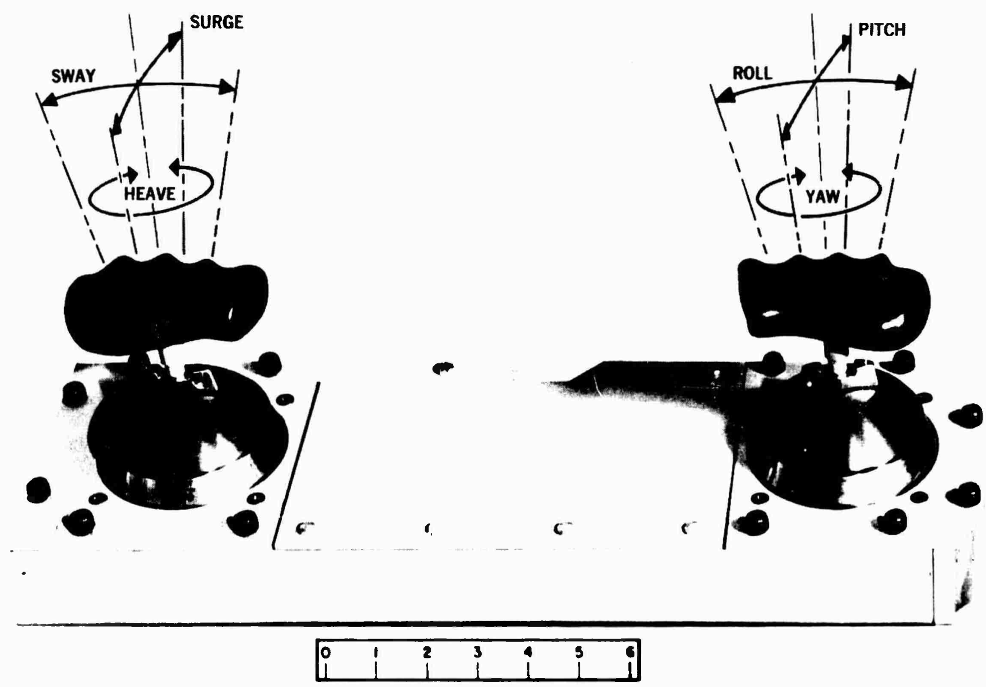


Figure No. 5.2 Hand Controllers

5.1.1.1 The Aided Manual Mode in the Hover Regime

The pilot has independent control over the six degrees of freedom through the use of the two hand controllers. With the hand controllers in neutral, the automatic attitude and position loops are closed through the prime Auto Pilot.

5.1.1.2 The Aided Manual Mode in the Cruise Regime

Through this means of control the pilot does not have independent control of the six degrees of freedom. He basically controls the surge velocity through the left-hand controller, which acts as a throttle. Attitude changes are made with the right-hand controller. By this means, maneuvering in the vertical or horizontal plane is possible. Roll is normally zero, and sway and heave degrees of freedom on the left-hand controller are not used.

5.1.1.3 Auto Guidance Modes

The CPC guides the vehicle in preprogrammed maneuvers. Course and depth keeping as well as course and depth seeking, at constant forward speed, is provided. Exit from the Computer Guidance mode to the Aided Manual mode can be achieved by the pilot at any time by activating either Hand Controller.

a. Automatic Homing Guidance: Vehicle is operated in the cruise regime until the target is nearly reached, when the regime changes to hover.

b. Automatic Search Guidance: Regime is hover or cruise depending upon the desired forward speed. This mode provides automatic guidance along a predetermined horizontal path. Sharp turns may be executed.

c. Bottom Following Guidance: Regime is either hover or cruise depending upon the desired forward speed. Ocean bottom profile is followed at constant altitude and heading. Roll is maintained at zero. This mode can be combined with a search guidance mode.

d. Automatic Attitude Guidance: Regime is hover. The vehicle can acquire any attitude, and then maintain both its attitude and position.

Note: The Automatic Guidance modes will not be mechanized for DSRV-1.

5.1.2 Mode Degradation

To ensure an acceptable level of controllability and stability for each DSRV operating mode under assumed failures of sensors and/or ship control elements, the following are required:

a. Failure detection ability.

b. A degree of subsystem redundancy coupled with the ability to reconfigure undamaged sensors and/or ship control elements.

5.1.2.1 Failure Detection Ability

Two methods of failure detection are employed:

a. Automatic failure detection achieved by the Central Processing Computer according to the following criteria: failure of master clock; sudden signal surge beyond assigned scale; power blackout; critical testing; and comparison testing. Upon such detection, the pilot is alerted by the display of the failure on the Alarm Panel.

b. Failure detection by the pilot is also possible, but requires time and training. In case of serious ship controllability difficulties, the pilot would switch to backup and detect a failure not identifiable by the CPC by trial and error.

5.1.2.2 Subsystem Reconfiguration

Reconfiguration of Ship Control and Sensor Subsystems can be accomplished either automatically or manually. The initial step is the detection of the failure by the Central Processing Computer. The components of the Ship Control subsystem and their related prime sensors that are continuously monitored by the Central Processing Computer are:

a. Auto Pilot, Digital Differential Analyzer (AP/DDA)

b. Ship Control Electronics

c. Central Processing Computer

d. Inertial Navigator

e. Rate Gyro Assembly

In the automatic reconfiguration, the failed component is replaced by its backup automatically by the Central Processing Computer. The substitution is displayed on the Ship Control Mode Panel. The pilot has the option of overriding the reconfiguration at any time. Automatic reconfiguration is not mechanized in DSRV-1. In manual reconfiguration, the pilot switches to the backup, when a failure is detected. The following table summarizes the subsystem redundancy, reconfiguration and degradation:

Failure	Substitute	Degradation
Major Components		
a. Ship Control Electronics	None	Mission Abort
b. CPC	None	No automatic control
c. AP/DDA	Various Configurations	Various Levels
Sensors		
a. Rate Gyro Assembly	Second Rate Gyro Assembly	None
b. Inertial Navigator	Vertical Gyro and Directional Gyro	Automatic Attitude -disallowed Automatic Search -disallowed Automatic Cruise -allowed (heading must be introduced manually)
c. Doppler Sonar	Accelerometer data from Inertial Navigator and data from Altitude/Depth Sonar, signal processed and converted to body coordinates. (Not mechanized in DSRV-1)	None

In the event of AP/DDA failure, the following levels of backup are provided:

a. Analog autopilot system - provides closed loop attitude rate control, and manually aided translation control through proportional drive signals to the effectors.

b. "Disconnect" configuration - provides control through the application of proportional drive signals from the hand controllers to the effectors.

c. Emergency manual override configuration - provides direct on-off ("bang-bang") control of the effectors, as shown in Figure 5.1 as part of the secondary ship control loop.

5.1.3 Hardware Implementation

The hardware comprising the Ship Control Subsystem is as follows:

a. Ship Control Electronics
b. Auto Pilot/Digital Differential Analyzer
c. Rate Gyroscope Assembly
d. Inertial Navigator Set
e. Doppler Sonar Set
f. Vertical Gyroscope
g. Directional Gyroscope
h. Controls and Displays

The Subsystem configuration is shown in Figure No. 5.3.

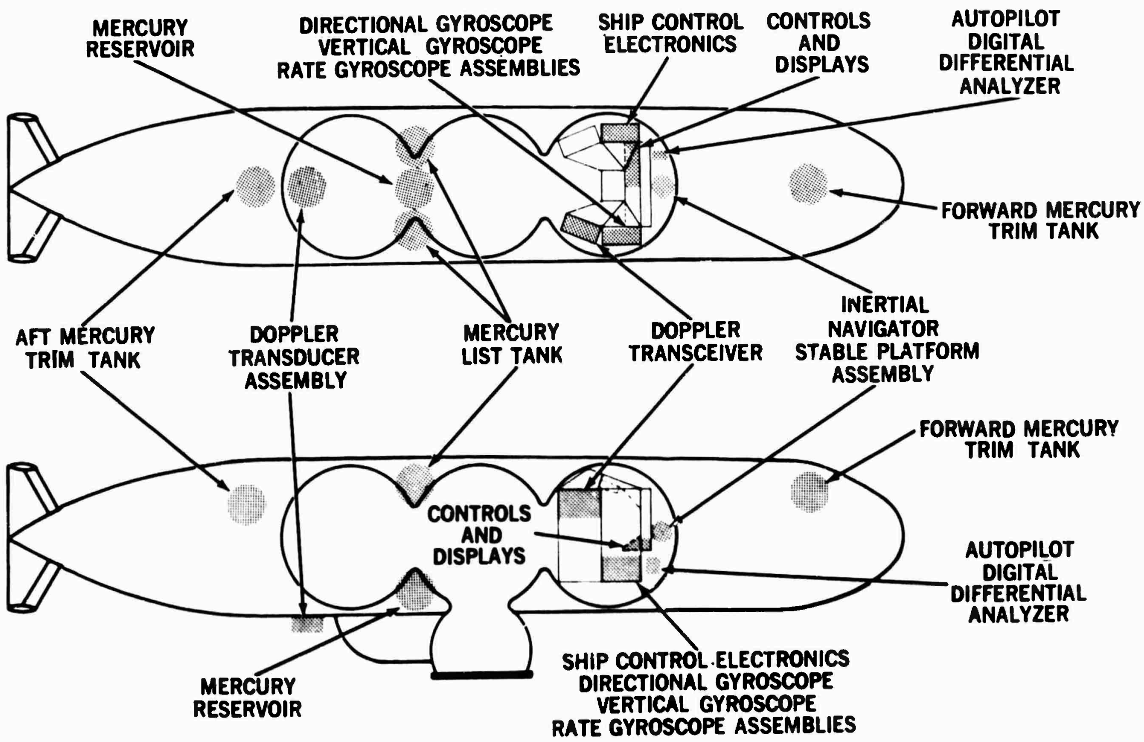


Figure No. 5.3 Ship Control Group Configuration

5.2 SHIP CONTROL ELECTRONICS

The Ship Control Electronics (SCE) performs two major functions. When operating in the aided manual mode with the Auto Pilot/Digital Differential Analyzer (AP/DDA), the SCE performs the necessary signal conditioning of the operator and vehicle inputs for the AP/DDA and the AP/DDA outputs to the effectors, and also the required external logic functions. In the event of a AP/DDA failure, the SCE assumes the additional task of providing a backup control system. In addition to the circuitry required to perform the necessary signal conditioning, backup processing, and logic functions, the SCE also includes the following:

a. a high regulation 400 Hz power supply for Directional and Vertical Gyros, Rate Gyro Assembly, and Hand Controller pickoff excitation.

b. diagnostic circuitry for the monitoring of SCE status by the CPC and the Alarm Panel.

c. outputs to operator displays (rotational rates, mode indication lights, and special effects video).

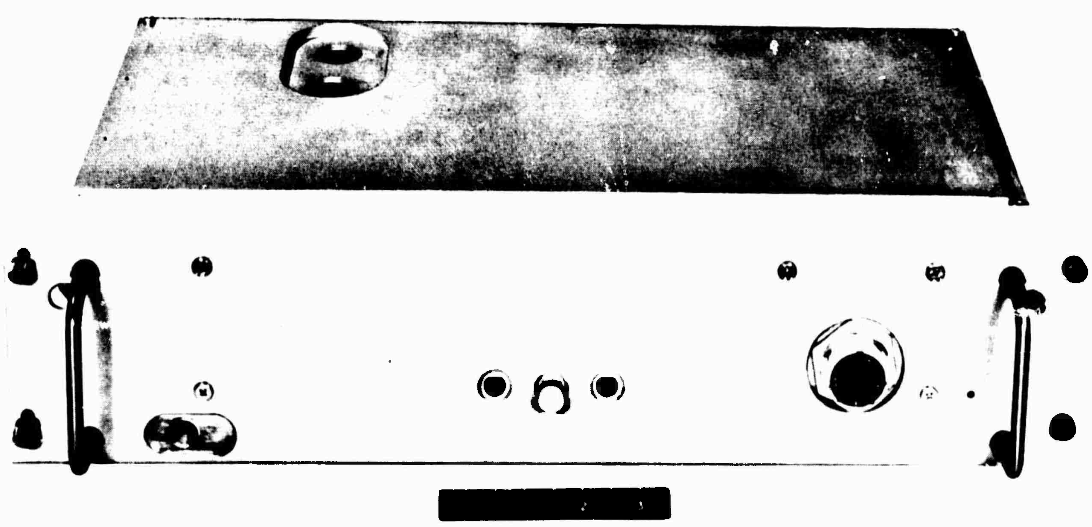


Figure No. 5.4 Ship Control Electronics

d. A DC to DC converter for providing the necessary regulated DC power for the SCE.

The ship control hardware incorporates both analog and digital circuitry in the form of monolithic integrated circuits, hybrid thin-film circuits, and discrete semiconductors and components. The Ship Control Electronics is shown in Figure No. 5.4. The unit is located in the port forward rack of the control sphere.

The Ship Control Electronics has the following characteristics:

Dimensions:	19" wide x 4.7" high x 9.5" deep
Volume:	0.5 cu. ft.
Weight:	28 lbs.
Power:	See Appendix B
Input Signals:	Process and demodulate input signals from the Directional and Vertical Gyros, Rate Gyro Assembly and Hand Controllers to an accuracy of ±1% with a DC amplitude of -7v to +7v full scale.
Output Signals:	Analog output signals to the effector amplifiers will be processed modulated to an initial accuracy of ±3% and a stability for mission duration of ±1%. The maximum AC signal will be 10 Vrms at 0° or 180° corresponding to positive or negative command polarity. Phase shift error shall be ±5° maximum and distortion shall be less than 3%.
	Discretes to and from the AP/DDA, CPC and Alarm Panel will be binary signals to 0 V and 3.2 V nominal corresponding to logic levels "0" and "1", respectively.

Analog signals to and from the AP/DDA and CPC will be -10 VDC to +10 VDC. Ground isolation will be provided by the SCE for the signals coming from the AP/DDA and CPC.

Relay drivers will switch a coil excitation current of 100 ma at 26 VDC.

Lamp drivers will switch 5.5 V rms (full wave rectified) at 400 ma per annunciator lamp.

The 400 Hz power supply will provide for 115 VAC for the Directional and Vertical Gyros, and Rate Gyro Assembly pickoff excitation and 3.2 VAC for Hand Controller microsyn excitation. Specifications for these are as follows:

	115 VAC	3.2 VAC
Initial Voltage Tolerance:	±3% max.	±5% max.
Stability: (for mission duration)	±1% max.	±2% max.
Frequency:	Synchronized to DSRV's 400 Hz	
Phase Shift:	±3° max.	±5° max.
Distortion:	1% max.	1% max.
Output Power:	12 W nom.	1.1 W nom.
Power Requirements:	Ship's ±28 VDC and 115 V 400 Hz reference.	

In the event of failure of the precision power supply, switchover to the ship's 400 Hz will be accomplished automatically.

The DC to DC converter will provide regulated DC power for the SCE at the following voltages:

+28 V, 150 ma nominal, 500 ma maximum
+15 V, 450 ma nominal, 1.3 amp maximum
-15 V, 450 ma nominal, 1.3 amp maximum
+ 5 V, 400 ma nominal, 2.0 amp maximum

Initial tolerance for each voltage will be ±1%. It will operate from ship's +28 VDC, and provide isolation between the input and the outputs. Line regulation at constant load will be 1%, and load regulation for constant input will be 1%. Ripple and noise at the outputs will be less than 20 mv peak to peak.

DC analog outputs to operator displays will be processed to an accuracy of ±1% for the rate displays and ±2% for the special effects video. Maximum amplitudes will be ±5 V for the rate displays and ±8 V for the special effects video.

5.3 AUTO PILOT/DIGITAL DIFFERENTIAL ANALYZER

The Auto Pilot/Digital Differential Analyzer (AP/DDA) is used to provide prime autopilot computation for DSRV ship control. The AP/DDA has a variable program capability to solve iterative continuous real-time programs. The program to be used aboard the DSRV, enables independent control of each of the six degrees of freedom, by decoupling of the vehicle dynamics. The program is loaded into the AP/DDA through the CPC. The Auto Pilot/Digital Differential Analyzer design incorporates 14 major integrated circuit elements. Semi-conductors and discrete components are used only where integrated circuits were not available. The AP/DDA is mounted behind the control desk and is shown in Figure No. 5.5.

The AP/DDA has the following characteristics:

Weight:	56 lbs.
Size:	10.1" wide x 11.5" high x 12.4" deep
Power:	See Appendix B
Number System:	2's complement; trinary increments
Word Length:	16 bits including sign
Memory:	500 integrator/decision operations using ultrasonic delay lines; memory parity check

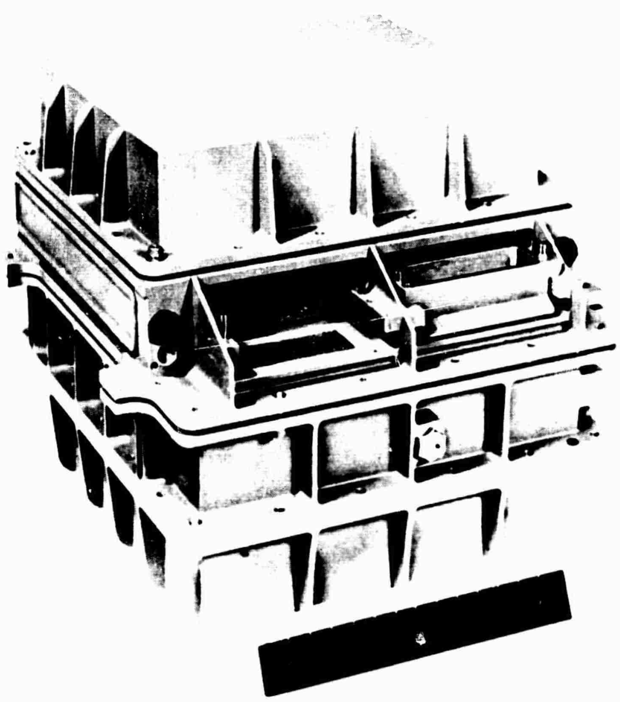


Figure No. 5.5 Auto Pilot/DDA

Instructions:	Rectangular rule integration decision-servo adder; reset functions and compare functions
Computation Speed:	Complete 500 integrator/decision computations every 1.0 ms.
Interrupts:	45 externally-controlled program mode changes
Input-Output Channels:	31 analog multiplexed input channels. 15 analog multiplexed output channels. 15 trinary incremental input channels, each at 1,000 inputs per sec. max. 15 trinary incremental output channels, each at 1,000 outputs per sec. max. 1 serial input-output channel for loading and monitoring any memory line of any integrator and 1 resolver to digital multiplexed input channel.

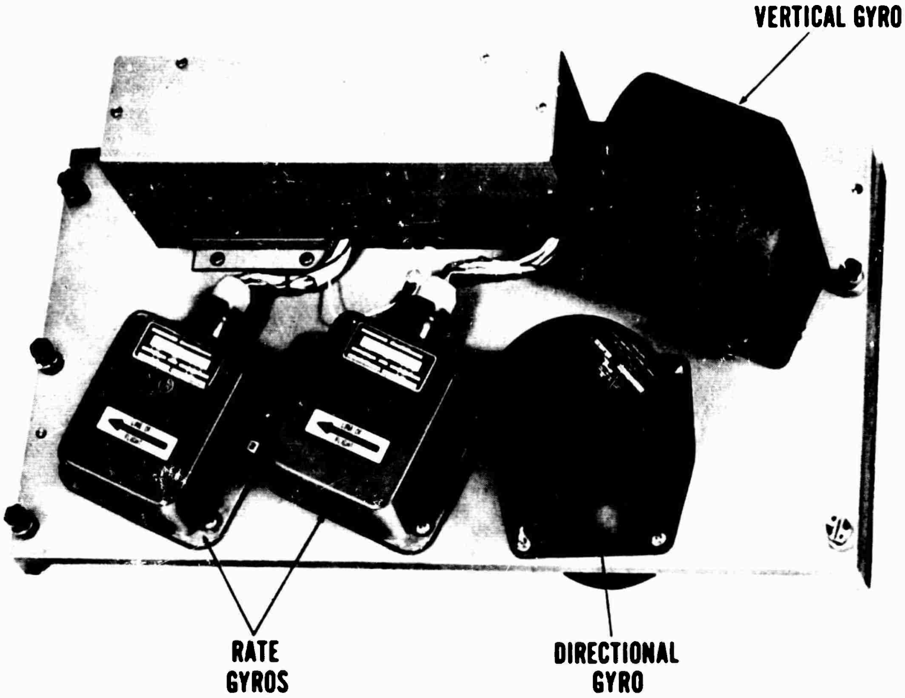


Figure No. 5.6 Gyro Shelf Assembly

5.4 GYRO SHELF ASSEMBLY

The Gyro Shelf Assembly consists of a Vertical Gyro, a Directional Gyro, two Rate Gyro Assemblies, an electronics connector box and a harness assembly mechanically aligned to and mounted on a base mounting plate. The unit is located in the starboard forward rack of the control sphere. Figure No. 5.6 shows the Gyro Shelf Assembly.

5.4.1 Rate Gyro Assembly

The Rate Gyro Assembly (RG) measures the attitude rate of the vehicle. Each of the two RG consists of three individual miniature, spring restrained, hermetically sealed rate gyros, their necessary null phase shift and sensitivity trim components, and a single external connector assembled to a rugged center-of-gravity mounting flange fitted with formed protective covers. An RG is shown in Figure No. 5.6. They operate from an AC power source, and supply AC output signals.

The Rate Gyro Assemblies have the following characteristics:

Dimensions:	3.18" x 4.05" x 3.75"
Weights	2.7 lbs.
Power:	See Appendix B
Excitation:	26.0 ± 1.3 volts, 400 ± 4 Hz single phase power source with total harmonic distortion of less than 5%.
Run Up Time:	0.5 minutes maximum

<u>Input Characteristics:</u>

Full Scale Rate:	40°/sec, with individual gyro gimbal stops set between 40 and 50°/sec.
Maximum Rate:	400°/sec for a maximum of 5 minutes
Threshold:	0.01°/sec for each axis
Resolution:	0.01°/sec for each axis

<u>Output Characteristics:</u>

Output Signal Characteristics:	The three outputs are sinusoidal 400 Hz, phase reversing, suppressed carrier signals.
Sensitivity:	0.145 volts rms/°/sec ± 10%
Phase:	With positive inputs the outputs are in-phase with excitation voltage.
Linear Acceleration Sensitivity:	Errors due to linear acceleration along any of the gyro axes shall not exceed 0.10°/sec/g
Linearity: (Independent)	The output shall be linear within ±1% FSD for outputs up to 1/2 FSD and within ±2% FSD for outputs from 1/2 FSD to FSD, in all three axis

Natural Frequency:	Minimum undamped natural frequency (90° phase lag point) of 18 Hz
Damping Ratio:	0.45 to 1.15 over temperature range of +32°F to 165°F

5.4.2 Vertical Gyro

The Vertical Gyro (VG) is a two degree of freedom displacement gyroscope with a vertical reference. Signal output is proportional to displacement about either horizontal axis. It consists of a high speed hysteresis type synchronous rotor supported by two gimbals. The spin axis is normally vertical. The inner and outer gimbal axes are normally horizontal and perpendicular to each other. The outer axis has full 360° of freedom and the inner gimbal has ±85° of freedom. Stops are provided to limit the freedom of the inner gimbal to prevent gimbal lock. The Vertical Gyro is shown in Figure No. 5.6 and has the following characteristics:

Dimensions	4.36" x 3.95" x 4.09"
Weight:	4.5 lbs.
Power:	See Appendix B
Spinmotor Data Type:	Hysteresis (synchronous)
Angular Momentum:	2×10^6 gm - cm ^{2}/sec
Synchronous Speed:	24,000 rpm
Run Up Time:	3.0 minutes maximum
Run Down Time:	6 to 15 minimum
Excitation:	115 ±10% volts, 400 ±10% Hz, 1 phase
<u>Gimbal Freedom</u>	
Outer Axis:	±360° (full freedom)
Inner Axis:	±85° (with mechanical stops)

Output Characteristics

Type:	Synchro Transmitter, Pancake, size 21 (2 of)
Excitation:	26 volts, 400 Hz, 1 phase
Maximum Output:	11.8 ± .6 volts (no load)
Output Gradient:	206 mv/deg
Static Error:	12 min. peak to peak
Null Voltage:	30 mv rms
Phase Shift:	12 degrees (lagging)

Erection Torque Motor Data

Erection Rate:	4.0 - 7.0 deg/minute for each axis
Excitation:	115 volts, 400 Hz, 1 phase
Drift Rate:	0.5 deg/minute maximum for each axis
Erection Error:	±0.15° maximum

5.4.3 Directional Gyro

The Directional Gyro (DG) is a two degree of freedom instrument indicating vehicle motion in azimuth. The heading reference is established by the gyro spin axis which is maintained level in a plane parallel to a tangent to the earth's surface. In normal operation, the DG is slaved to the Inertial Navigator. Upon an Inertial Navigator failure, azimuth discontinuities are thereby minimized. The Direction Gyro is shown in Figure No. 5.6 and has the following characteristics:

Dimensions:	5.12" x 5.12" x 6"
Weight:	5 lbs.
Power:	See Appendix B

Spinmotor Data

Type:	Hysteresis (synchronous)

Angular Momentum:	4.5 X 10^6 gm - cm ^{2}/sec
Synchronous Speed:	24,000 rpm
Run Up Time:	7 minutes maximum
Run Down Time:	15 minutes maximum
Excitation:	115 ± 5 volts, 400 ± 10 Hz, 1 phase

<u>Gimbal Freedom</u>

Outer (Azimuth) Axes:	±360° (full freedom)
Inner Axis:	±68°

<u>Output Characteristics</u>

Type:	Synchro Transmitter, Pancake, Size 21
Excitation:	115 volts, 400 Hz, 1 phase
Maximum Output:	11.8 volts (no load)
Output Gradient:	206 mv/deg
Static Error:	0.8° peak to peak
Null Voltage:	50 mv rms
Phase Shift:	41° maximum

<u>Erection Torque Motor Data</u>

Erection Rate:	0.206°/min/volt
Excitation:	26 volts, 400 Hz
Drift Rate:	5°/hr

5.5 CONTROLS AND DISPLAYS

All primary controls and displays for the ship control group are located on the pilot's (port) side of the forward sloping control desk of ICAD. The Ship Control Group control and display panels are:

a. Ship Control Mode Panel

b. Ship Control Panel

c. Emergency Ship Control Panel

d. Translational Hand Controller

e. Rotational Hand Controller

f. State Display Panel

g. Shroud Angle Meter Panel

5.5.1 Ship Control Mode Panel

The Ship Control Mode Panel, shown in Figure No. 5.7 is located immediately in front of the pilot. The panel contains the following sets of indications and switches:

a. Cruise and Hover Switch and Indicators

In the "Auto" position the hover or cruise regime is selected by the autopilot. With increasing velocity, the regime changes from hover to cruise at 2-1/4 knots surge. With decreasing velocity the mode changes from cruise to hover at 2 knots surge. The manual selection of "hover" or "cruise" is an overrride feature and also is used in conjunction with the backup ship control modes, "backup" and "disconnect".

b. Sensors Reconfiguration Switches and Indicators

These are used for manual or automatic replacement of faulty sensors by their backups. Appropriate displays show present status. As discussed in section 5.1.2.2, alternate sensors for the Inertial Navigator, Rate Gyro Assembly and Doppler Sonar may be introduced either manually, or automatically, depending upon the position of the appropriate switch.

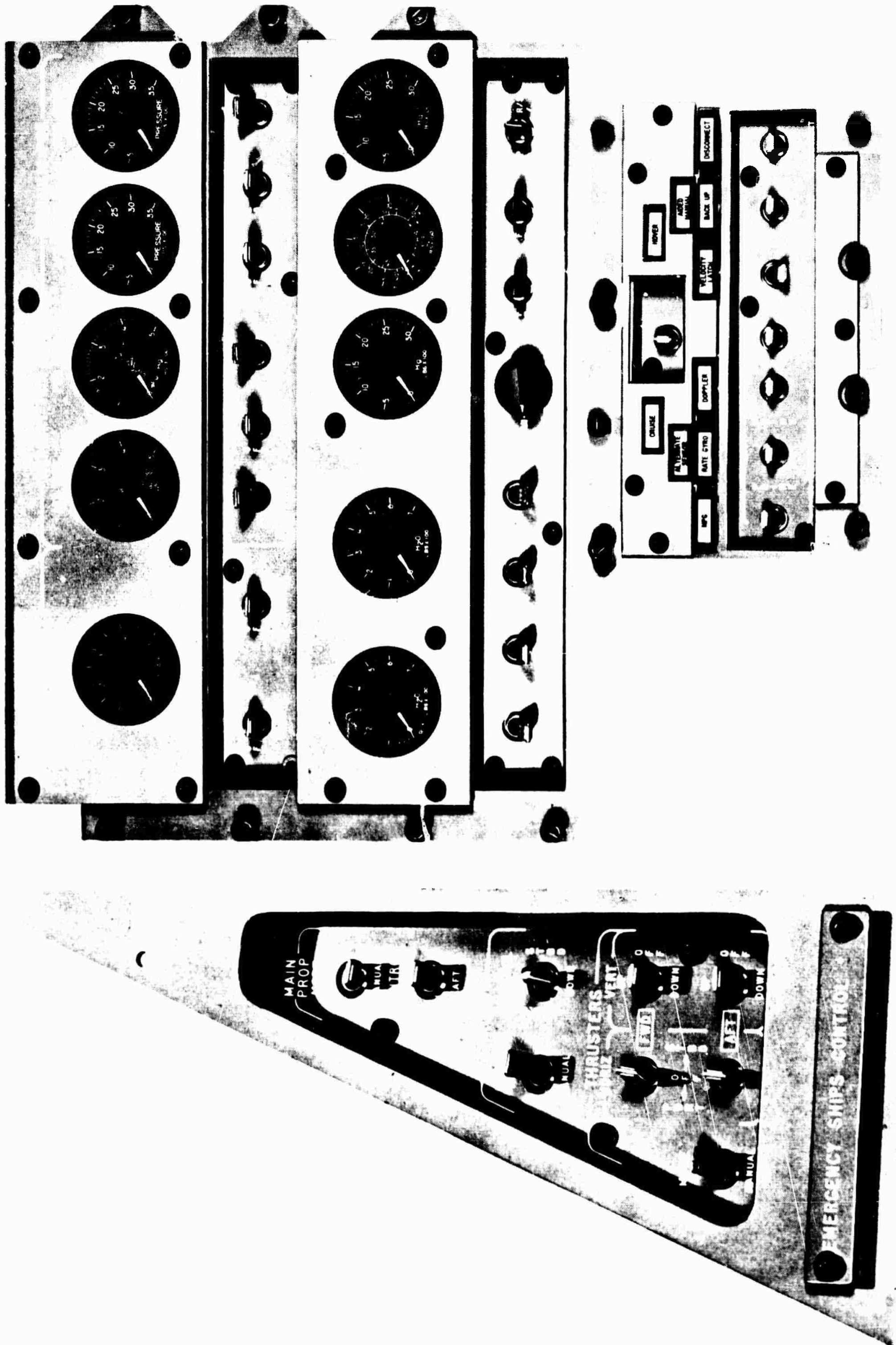


Figure No. 5.7 Ship Control Panels

c. Aided Manual Mode Reconfiguration Switches and Indicators

These switches allow for manual ship control mode changing or computer control of backup moding dependent upon failure indications.

d. Interconnection Switch

This switch controls the interconnection of the AP/DDA and the CPC for program loading and diagnostic checkout, navigation guidance inputs or isolated operation.

e. Velocity Latch

This switch, in the "ON" position, maintains the ship's velocity during cruise in conjunction with the AP/DDA.

The Ship Control Mode Panel weighs 3.5 lbs.

5.5.2 Ship Control Panel

Directly above the Ship Control Mode Panel is the Ship Control Panel, Figure No. 5.7. This panel contains controls and displays for the:

a. Main Ballast System

b. Variable Ballast System

c. Mercury Trim System

d. Mercury List and BG System

e. Hydraulics Power System

The Ship Control Panel weighs 21 lbs.

5.5.3 Emergency Ship Control Panel

The Emergency Ship Control Panel Contains three mode selector switches and six control switches for the control of Main Propulsion, Thrusters and Shroud. The Panel is located to the left of the Ship Control Panel,

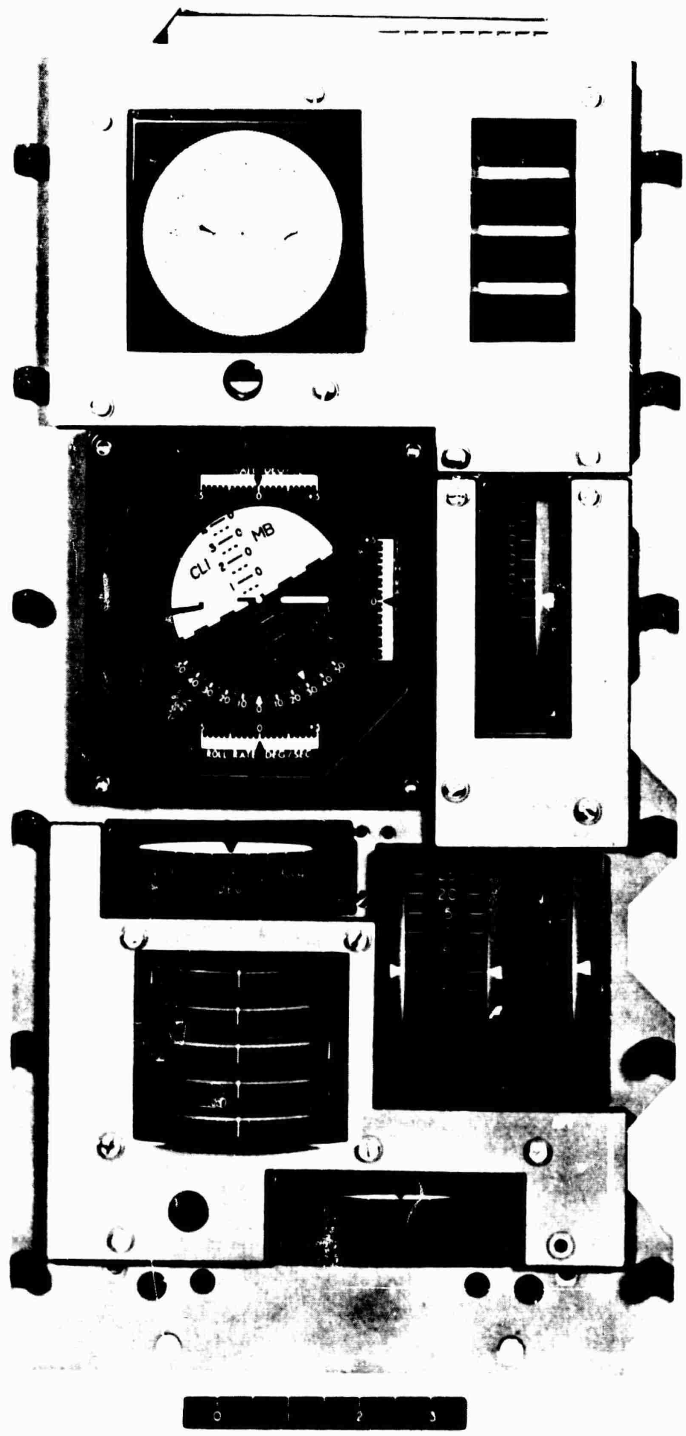


Figure No. 5.8 State Display Panel

Figure No. 5.7. With the selector switches in the "AUTO" mode, proportional signals processed by the Sensors and Controls Subsystem Electronics control the Main Propulsion, Thrusters and Shroud. With the selector switches in the "MANUAL" mode, on-off signals from the six control switches bypass the Sensors and Controls Subsystem Electronics to control the Main Propulsion, Thrusters and Shroud directly.

The Emergency Ship Control Panel weighs 5 lbs.

5.5.4 Hand Controllers

The Hand Controllers are a three degree-of-freedom device which converts torques applied to the hand grip into angular displacements around the torque axis, which in turn generates electrical signals proportional to the displacements. Angular displacement about each axis is restricted to ±15° from the neutral position. The Translational and Rotational Hand Controllers are shown in Figure No. 5.2. A spring restraint is provided for each axis which will return the Hand Controller to its neutral position when torque is removed. In addition to the spring restraint, a preload and detent is provided in the neutral position so that a definite torque is required to cause a displacement. A lock mechanism is also provided which is capable of locking the Hand Controller in any position within its operating limits.

The Hand Controllers weigh 11.5 lbs. each.

5.5.5 State Display Panel

The State Display Panel shown in Figure No. 5.8 is located directly above the Ships Control Panel. This panel contains information about the variables defining the state of the vehicle. The displayed information is summarized in the following table:

STATE DISPLAYS

Information Displayed	Displayed Range	Displayed Accuracy	Source of Input Data	Scale of Graduations
Coarse Vehicle Attitude Rates				
Roll	±50°	±1°	Vertical Gyro	
Pitch	±50°	+1°	Vertical Gyro	
Roll Rate	±5°/sec	±5% full scale	Rate Gyro Assembly	
Pitch Rate	±5°/sec	±5% full scale	Rate Gyro Assembly	
Yaw Rate	±5°/sec	±5% full scale	Rate Gyro Assembly	
Fine Vehicle Attitude & Attitude Commands				
Indicated Roll	±50°	±2% full scale	Inertial Navigator	2°
Indicated Pitch	±50°	±2% full scale	Inertial Navigator	2°
Velocity (Body Axes)				
Fore-Aft	±8 Kts	±2% full scale	Doppler Sonar	0.2 Kt
Port-Starboard	±3 Kts	±2% full scale	Doppler Sonar	0.2 Kt
Range to Target	4 decimal digits	1 unit	CPC	

STATE DISPLAYS (Continued)

Information Displayed	Displayed Range	Displayed Accuracy	Source of Input Data	Scale of Graduations
Azimuth				
Indicated Azimuth	0°-360° continuous	±1°	IN or Slaved Directional Gyro	
Command Azimuth	±170°	±1°	CPC	
Vertical Rate	Course scale = ±250 ft/min	±2% full scale	CPC or	10 ft/min
	Fine scale: ±25 ft/min	±2° full scale	Doppler Sonar	1 ft/min
Sonar Altitude	4 decimal digits	1 unit digit	Altitude/ Depth Sonar	
Sonar Depth	4 decimal digits	1 unit digit	Altitude/ Depth Sonar	
Pressure Depth	4 decimal digits	1 unit digit	CPC	
Engine Speeds				
Main Engine	±700 rpm	±2% full scale	Speed	50 rpm
Fwd Hor	±100 rpm	±2% full scale	Transducers, Demodulators	10 rpm
Fwd Vert	±100 rpm	±2% full scale		10 rpm
Aft Hor	±100 rpm	±2% full scale		10 rpm
Aft Hor	±100 rpm	±2% full scale		10 rpm

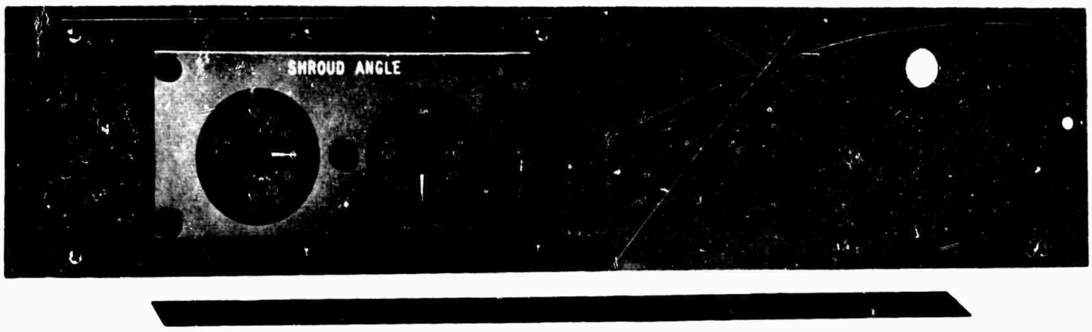


Figure No. 5.9 Shroud Angle Meter Panel

The State Display Panel weighs 50 lbs.

5.5.6 Shroud Angle Meter Panel

The Shroud Angle Meter Panel contains two meters which indicate the pitch and azimuth angles of the shroud. The panel is located in the port forward rack and weighs 3.5 lbs. The Shroud Angle Meter Panel is shown in Figure No. 5.9.

6.0 OBSTACLE AVOIDANCE

6.1 GENERAL

A crucial aspect of the DSRV mission is the vehicle's avoidance of any and all obstacles in its path. In order to insure such an obstacle avoidance capability, the following equipments are part of the DSRV sensor equipments:

a. Horizontal Obstacle Sonar

b. Vertical Obstacle Sonar

c. Topside Television Cameras

The locations of these equipments are shown in Figure No. 6.1.

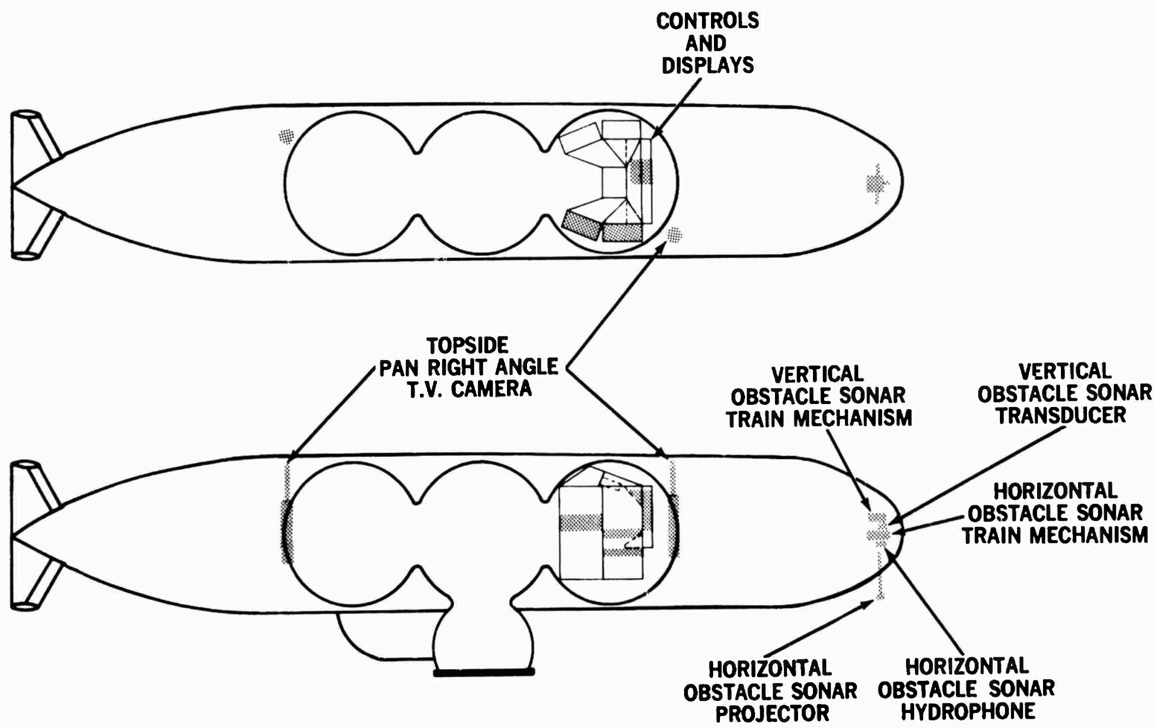


Figure No. 6.1 Obstacle Avoidance Group Configuration

6.2 HORIZONTAL OBSTACLE SONAR

6.2.1 The Horizontal Obstacle Sonar (HOS) indicates objects which lie in the path of the DSRV in the horizontal plane. The HOS is also useful for limited search in the sector directly ahead of the DSRV. The HOS transmits a continuous frequency modulated (CTFM) signal whose frequency varies linearly with time. It has the ability to continuously track and present multiple targets. A hydrophone of narrow beamwidth is utilized to scan the area for sonar returns. Knowledge of the frequency of the return signal indicates the range of the target. The azimuth position of the scanning transducer provides target bearing information. A functional block diagram is shown in Figure No. 6.2.

6.2.2 The HOS external equipment consists of a Horizontal Obstacle Sonar Projector and a Horizontal Obstacle Sonar Hydrophone, both mounted on the Horizontal Obstacle Sonar Train Mechanism, located in the DSRV bow. The HOS internal equipment is comprised of two electronics packages; the Horizontal Obstacle Sonar Transceiver and the Horizontal Obstacle Sonar Analyzer, located in the starboard aft and forward racks, respectively. The electronics will provide a continuous-transmission signal to the

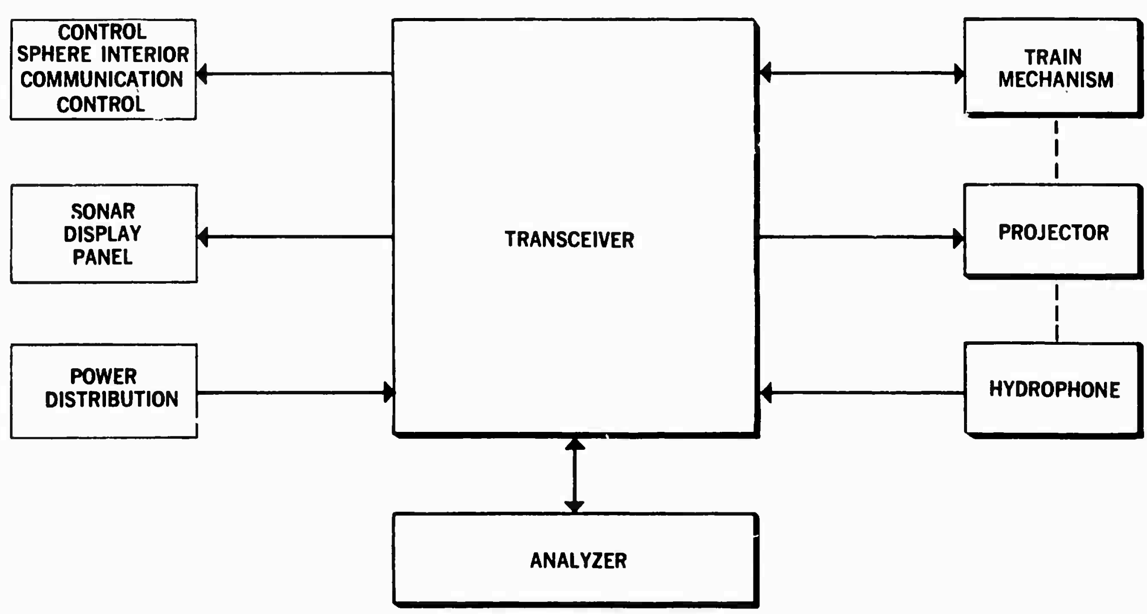


Figure No. 6.2 Horizontal Obstacle Sonar Functional Block Diagram projector, process return signals and provide range and bearing information to a display and to the Data Recorder Reproducer (for post-mission analysis). The transceiver will also contain test circuitry which can activate a test transducer for checking the hydrophone-electronics combination or simulate a hydrophone signal for checking the electronics separately. The Horizontal Obstacle Sonar is shown in Figure No. 6.3. The display is a PPI-type display of range and bearing. The display panel is described in section 6.5.1. Figure No. 6.4 contains a pictorial representation of an HOS display.

6.2.3 The projector ensonifies a volume in front of the submersible that is 60 degrees in the horizontal plane and 15 degrees in the vertical plane. The hydrophone has a beamwidth of 2 degrees in the horizontal plane and 15 degrees in the vertical plane. This is shown in Figure No. 6.5. In normal operation, these transducers are rotated at a speed of about 25° per second to a maximum of 90° to port and starboard. The transducers can also be rotated manually or the automatic scan can be limited to a sector 60° wide, centered about any azimuth position.

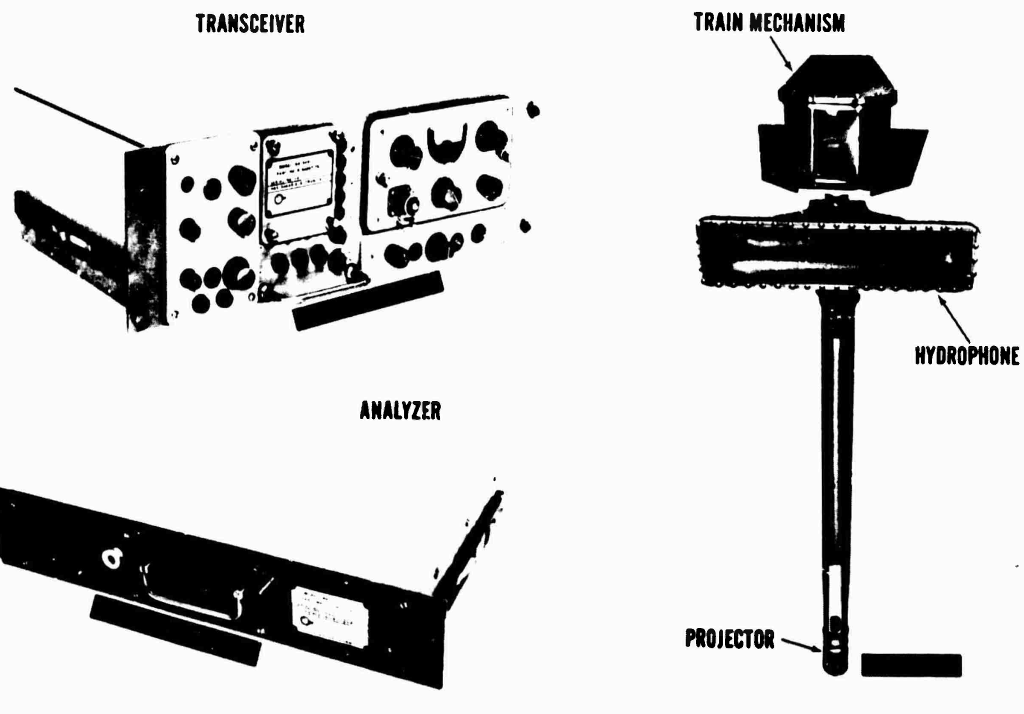


Figure No. 6.3 Horizontal Obstacle Sonar

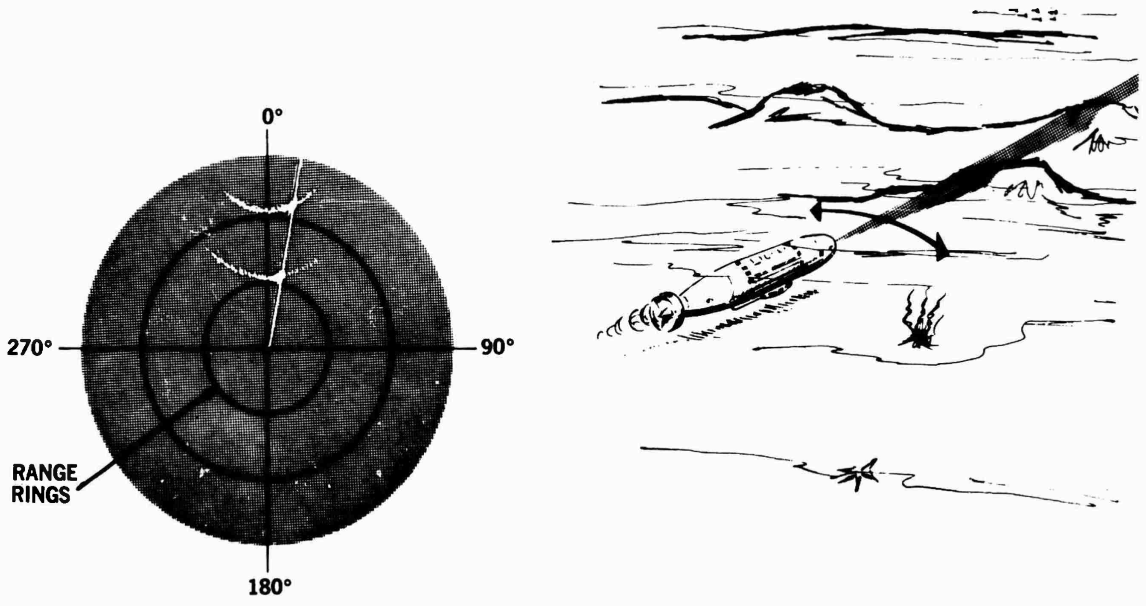


Figure No. 6.4 Horizontal Obstacle Sonar Display

RANGE 1500 YDS
RESOLUTION = 2% OF RANGE AND
2° IN BEARING

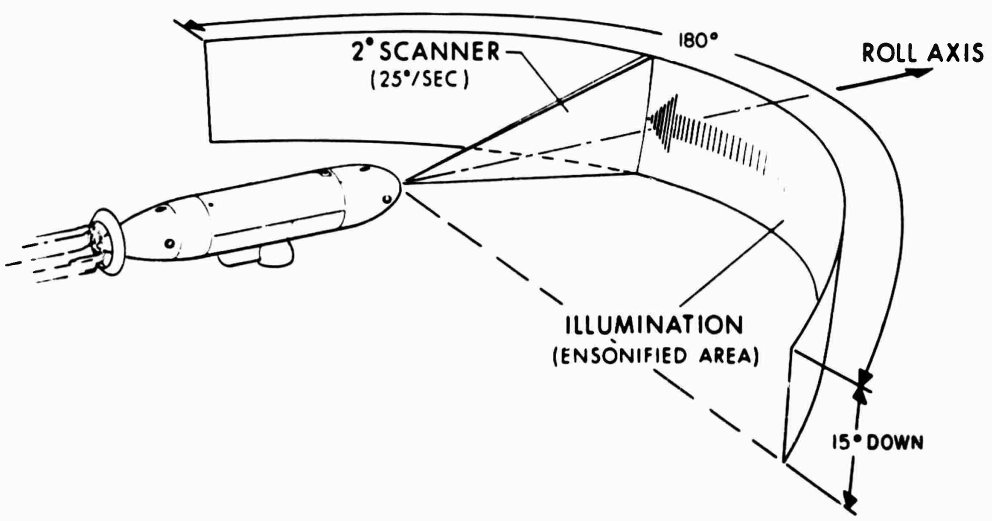


Figure No. 6.5 Horizontal Obstacle Sonar Beam Pattern

6.2.4 The Horizontal Obstacle Sonar has the following characteristics:

Dimensions, Transceiver	17" wide x 6.4" high x 11" deep
Dimensions, Analyzer	17" wide x 3.6" high x 9.5" deep
Dimensions, Projector	3" in diameter x 6" long
Dimensions, Hydrophone	28" wide x 6" high x 5" deep
Dimensions, Train Mechanism	13.5" wide x 6.3" high x 13.5" wide
Volume, Transceiver	0.8 cu. ft
Volume, Analyzer	0.4 cu. ft
Volume, Projector	0.1 cu. ft
Volume, Hydrophone	0.4 cu. ft
Volume, Train Mechanism	2.8 cu. ft
Weight, Transceiver	38 lbs
Weight, Analyzer	15 lbs
Weight, Projector:	5.5 lbs (in air) 4.0 lbs (in water)
Weight, Hydrophone	32.5 lbs (in air) 23.5 lbs (in water)
Weight, Train Mechanism	10.0 lbs (in air) 8.5 lbs (in water)
Power:	See Appendix B
Ranges:	10 yards to 50 yards 30 yards to 150 yards 100 yards to 500 yards 300 yards to 1500 yards
Transmitting Source Level:	+90db re 1 ubar at 1 yard

Duty Cycle:	Continuous
Frequency:	72.5 KHz to 87.5 KHz
Wavelength:	0.8 inches to 0.64 inches
Beam Pattern:	Projector 60° in horizontal plane 15° in vertical plane
	Front-to-Back Ratio: 15 db
	Hydrophone: 2° in horizontal plane 15° in vertical plane
	Front-to-Back Ratio: 25db
	Maximum sidelobes for projector and hydrophone 15db down
Sensitivity:	-40db re 1 ubar at 1 yard
	minimum detectable target
	0db at 500 yards 25db at 1000 yards
Accuracy:	Range: ±2% of full scale
	Bearing: ±2 degrees
Resolution:	2% of full scale in range; 2 degrees in bearing
Scan Rate:	25 deg/sec (nominal)

Provisions have been made to supply the HOS audio signal to the intercommunication system to assist the DSRV operator in target detection. The HOS is essentially an existing equipment requiring (a) repackaging to the dimensions above, (b) conversion from AC to DC powered operation and (c) incorporation of a new high-resolution analyzer.

6.3 VERTICAL OBSTACLE SONAR

The Vertical Obstacle Sonar (VOS) is designed to give an indication of height, from a bottom reference plane of any object in the path of the DSRV. The VOS complements the Horizontal Obstacle Sonar for the obstacle-avoidance function. Figure No. 6.6 is a functional block diagram of the VOS. The internal equipment, located in the control sphere, is comprised of the Vertical Obstacle Sonar Transceiver and Train Control Panel mounted in the starboard forward rack. The Transceiver Front Panel is shown in Figure No. 6.7. The Transceiver provides output

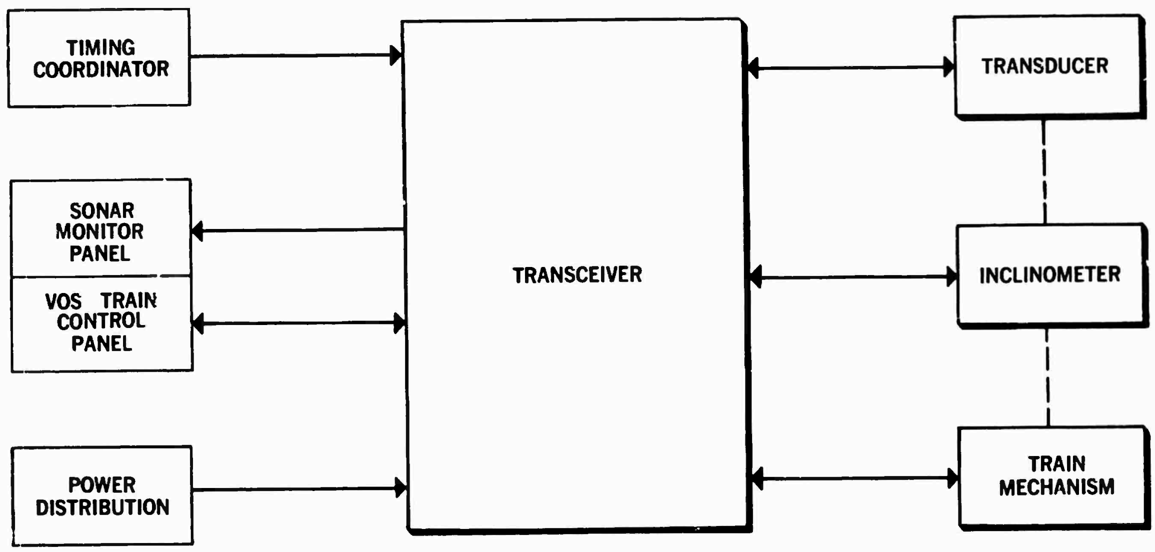


Figure No. 6.6 Vertical Obstacle Sonar Functional Block Diagram

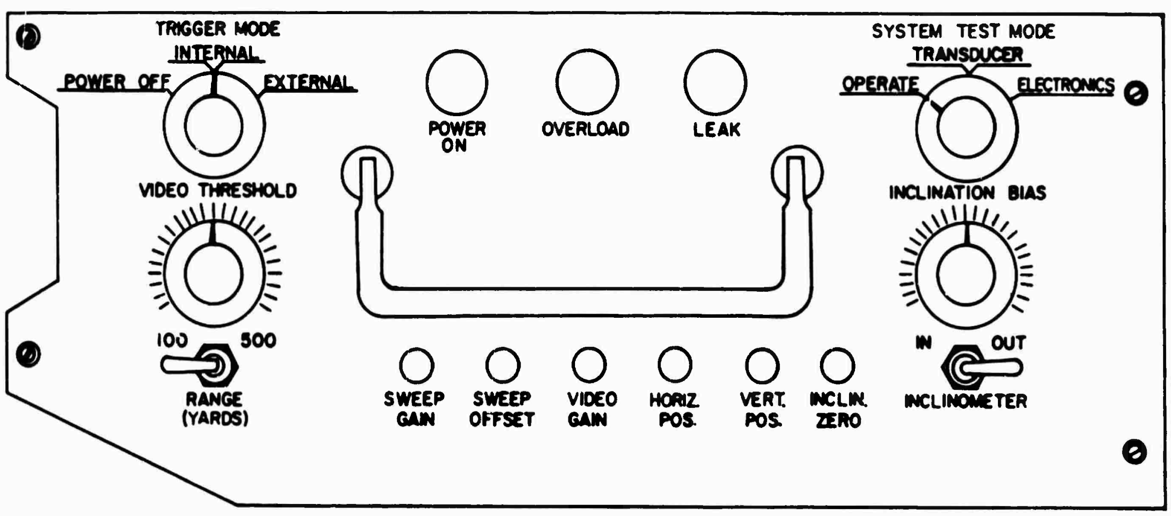


Figure No. 6.7 Vertical Obstacle Sonar Transceiver Front Panel pulses to the transducer, and timing, range, elevation and intensity information to a Sonar Display for a range-vs-height presentation. The VOS external equipment consists of the Vertical Obstacle Sonar Train Mechanism located in the bow of the DSRV. A transmitted acoustic pulse ensonifies a volume in front of the submersible that is 5° wide in the horizontal plane and 60° wide in the vertical plane. The total time required for a reflected signal to return is converted to range data. Phase differences in the signals received by the dual hydrophone configuration ("split transducer") indicate angle of depression (or elevation), with respect to the DSRV, of an object in its path. A pictorial representation of the VOS display on the Sonar Display Panel is shown in Figure No. 6.8. The train mechanism enables the DSRV pilots to aim the VOS transducers (in 5° $\pm$ 0.5° steps to a maximum of $\pm$45°) along the vehicle's velocity vector. When this is accomplished the VOS is allowed to remain in this position until the operator decides to move it. (The VOS does not automatically train, or rotate, back and forth.) One half of the split transducer is supplied with the transmit signal which it projects into the water. Both halves of the transducer are used to detect the return.

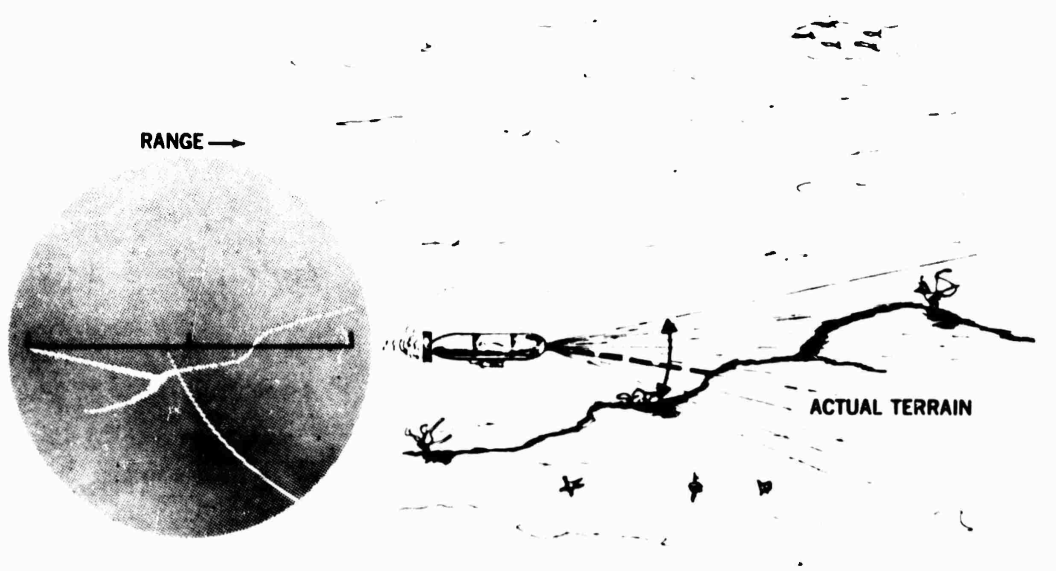


Figure No. 6.8 Vertical Obstacle Sonar Display

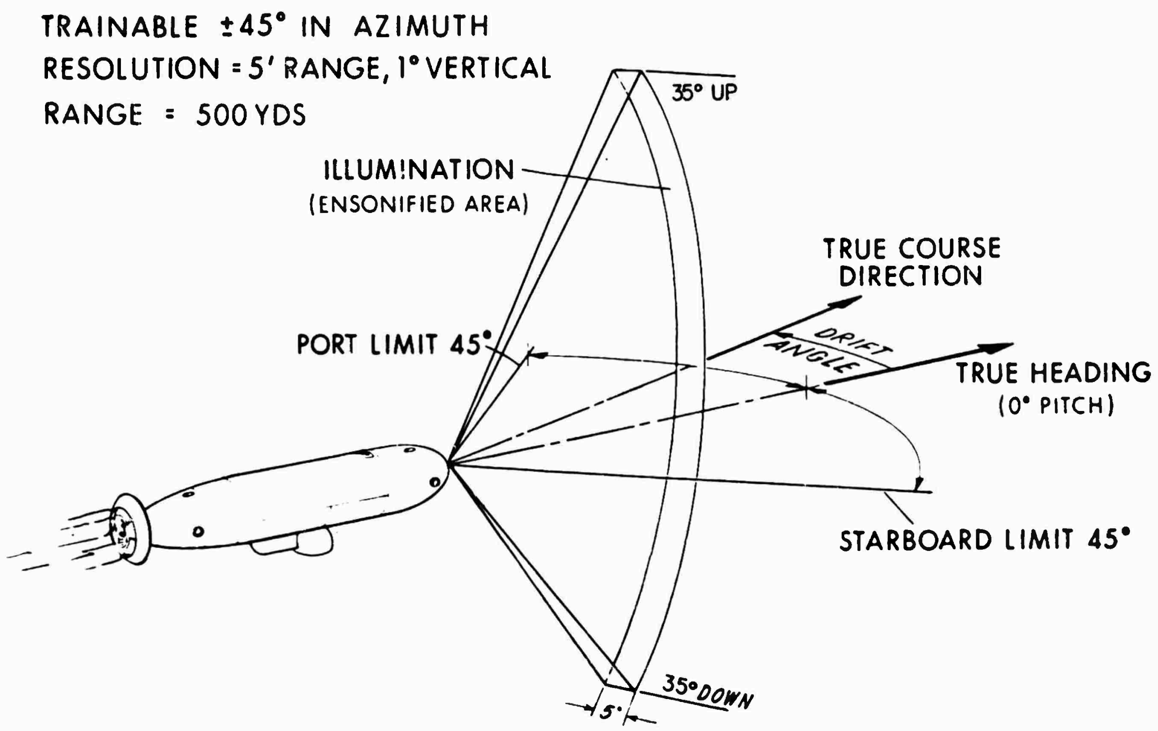


Figure No. 6.9 Vertical Obstacle Sonar Beam Pattern

An inclinometer, built onto the transducer, provides a signal to the electronics which indicates the amount of inclination of the sonar beam to the horizontal plane. This minimizes the amount of apparent target motion caused by pitching of the DSRV. The VOS beam pattern is shown in Figure No. 6.9.

The VOS is a devlopmental sonar with the following characteristics:

Dimensions, Transceiver:	10" wide x 4.1" high x 3.4" deep
Dimensions, Transducer:	12" wide x 3" high x 3" deep
Dimensions, Train Mechanism:	4" in diameter x 10" long
Volume, Transceiver:	0.2 cu. ft
Volume, Transducer:	0.1 cu. ft

Volume, Train Mechanism:	0.3 cu. ft
Weight, Transceiver:	16.0 lbs
Weight, Train Control Panel:	2 lbs
Weight, Transducer:	18.0 lbs (in air) 11.0 lbs. (in water)
Weight, Train Mechanism:	18.0 lbs (in air 13.0 lbs (in water)
Power:	See Appendix B
Accuracy:	±10 feet
Resolution:	Range: 5 feet Bearing: ±1°
Range:	500 yards, 100 yards
Display Range Resolution:	3 yards
Transmitting Source Level:	110db re 1 ubar at 1 yard
Transmit Duty Cycle:	less than 1%
Frequency:	60 KHz ±0.6 KHz
Wavelength:	1.0 inch ±.01 inch
Pulse Length:	2 millisecond (9.6 feet)
Cycles per pulse:	120
Pulse Repetition Rate:	1 pulse/sec (maximum)
Beam Pattern:	5° in horizontal plane (-3db points) 60° in vertical plane (-3db points)

6.4 TOPSIDE TELEVISION CAMERA GROUP

6.4.1 Right Angle Television Camera

The two Right Angle Television Cameras are located externally on the forward and aft Topside Retractable Pan Units. The primary functions of the Topside Television Camera Group are:

a. Continuous surfaced viewing when the topside hatch cannot be opened due to either high sea state high ambient pressure level within the Mid Sphere (both units).

b. Viewing of the sail of the distressed and/or mother submarine during mating and disembarking operations (both units).

c. Viewing of the DSRV shroud area (aft unit).

d. Viewing of the port and starboard pickups to facilitate engaging ASR cable during recovery by the ASR (forward unit).

The characteristics of both Right Angle Television Cameras are as follows:

<u>Mechanical</u>

Dimensions:	4.5" x 3.9" x 26.4" long (with connectors)
Volume:	0.3 cu. ft
Weight:	15.5 lbs (in air) 8.0 lbs (in water)
Material:	6061 - T6 Al (hard anodized)

<u>Electrical</u>

Power:	See Appendix B
Video Bandwidth:	8 MHz
Scanning Standard:	U.S. (EIA) Standard, Double Interlace

Horizontal Resolution:	600 TV Lines
Automatic Target Control Light Level Compensation Range:	10,000 to 1
Video Output:	1.5v composite video negative Sync.
Frequency Control:	Crystal Controlled Oscillator
Focus:	Remote-controlled from TV Monitor Panels

Optical

Focus Range:	3' to infinity
Vidicon Spectral Response:	Peaks at 4500 Angstroms
View Angle in Water:	44° horizontal 33.6° vertical

The Topside Pan Right Angle Television Cameras are equipped with lens heaters. The heaters are required to keep the lens mechanism operable under all surface weather conditions, including sub-freezing temperatures.

6.4.2 Topside Retractable Pan Units

The DSRV employs two topside pan units. The forward unit supports the forward Topside Pan Right Angle Television Camera and Mercury Vapor Lamp #8 (The Mercury Vapor Lighting System is discussed in Section 7.4.5). The aft unit supports the aft Topside Pan Right Angle Television Camera and Mercury Vapor Lamp #12. The forward and aft units both have one operational degree of freedom, 355° rotation about a deck to keel axis. In addition to this degree of freedom both forward and aft heads can be extended/retracted although the equipment will be used only when it is fully extended. The Topside Retractable Pan Unit Extender controls are located on the Pan and Tilt Extender Control Panel. The pan controls are located on the TV Monitor Panels. The lens heater controls for the Topside Pan Right Angle Television Cameras are found on the Optics Override Switching Panel. These controls and displays are shown in Figure No. 6.13.

6.5 DISPLAYS

6.5.1 Sonar Control and Display Group

The DSRV utilizes three identical, interchangeable Sonar Monitors, as well as a Special Effects Unit. The Sonar Monitors are located in a vertical line, in the center of the ICAD panel on both the vertical and upper instrument panels. The Special Effects Unit (SEU) is located on the lower right area of the vertical panel of ICAD.

The purposes of the display units are, under operator control, to:

a. selectively display the outputs of the Horizontal Obstacle, Vertical Obstacle, and Short Range Sonars. (See Figure Nos. 6.4, 6.8 and 7.5)

b. provide range and bearing information about sonar targets being displayed

c. provide SEU-generated visual aids to interpret the Short Range Sonar during the final phases of the search and mating sequences of the mission.

6.5.1.1 The Sonar Monitors are 7 inch "X-Y" oscilloscopes with a medium persistence (P7) phosphor typical of sonar displays. The monitors accept sweep deflection, video (sonar returns), and range signals from the various sonar systems. The output signals from the sonars and the SEU are hard wired to each of the monitors, and switch-selected within the displays, as shown in Figure No. 6.10. This feature provides redundancy in the system. In the event of failure of any one Sonar Monitor, any two of the sonar presentations can still be displayed. Each unit has display controls and a sonar selector switch. For ease in interpreting the display, a three-layered selectively lighted graticule is provided to superimpose an azimuth and reference lines on the display. The graticule pattern appropriate to the sonar being displayed is automatically lighted via the sonar selector. The Sonar Monitors weigh 21 lbs.

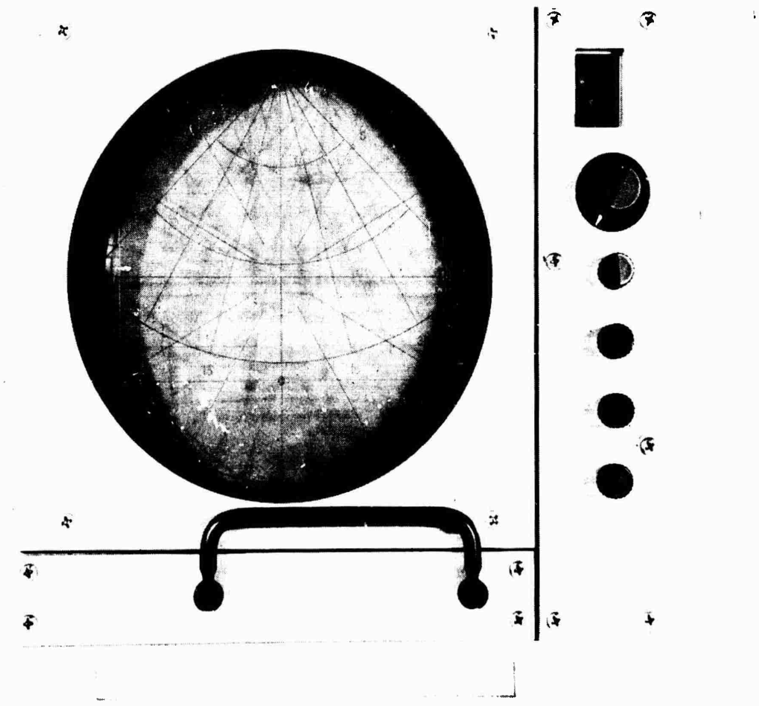


Figure No. 6.10 Sonar Monitor

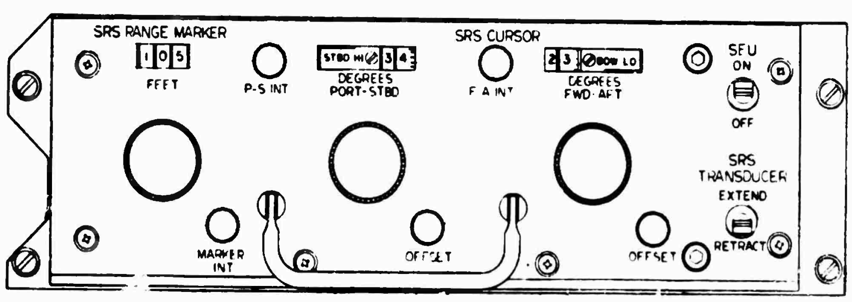


Figure No. 6.11 Special Effects Unit Front Panel

6.5.1.2 The purpose of the Special Effects Unit is to provide a means of introducing necessary controls and displays which are not provided on either the sonar electronics or the Sonar Monitors. Moreover, some of these controls permit the three monitors to be identical. At present, the SEU controls are limited to items to be used in conjunction with the Short Range Sonar. In addition,

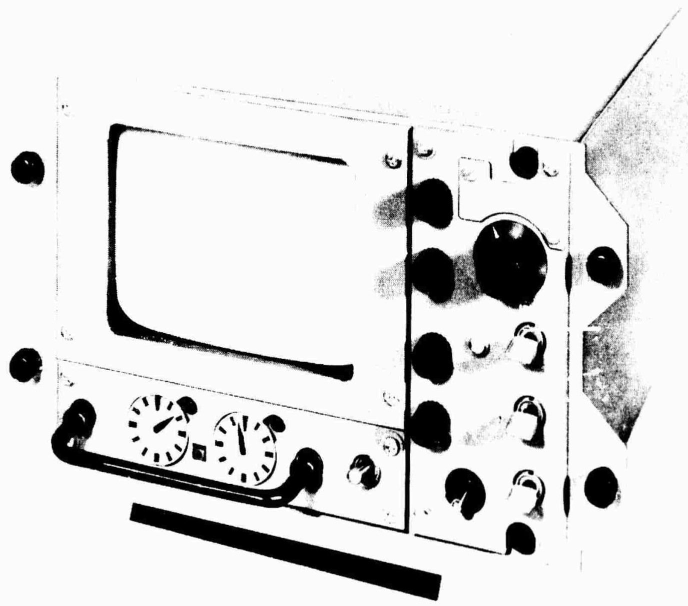


Figure No. 6.12 TV Monitor

the unit provides range markings for the TV monitors. The front panel arrangement is shown in Figure No. 6.11. The Special Effects Unit wights 17 lbs.

6.5.2 Television Camera Controls and Displays

Associated with the six television cameras (the four Bottomside Television Cameras are discussed in section 7.4) are four 5 inch TV monitors for pictorial display. The monitors are time shared, at the discretion of the operator, and are located on the Vertical and Upper Instrument Panels of ICAD. Three televisions are wired to each monitor, thereby allowing each of the TV Camera images to be viewed on either of two monitors. Provision is made for the transmission of video and sync information, via cable, to these monitors. The TV controls are located on the TV Monitors. These controls are shown in Figure No. 6.12. In addition, the Optics

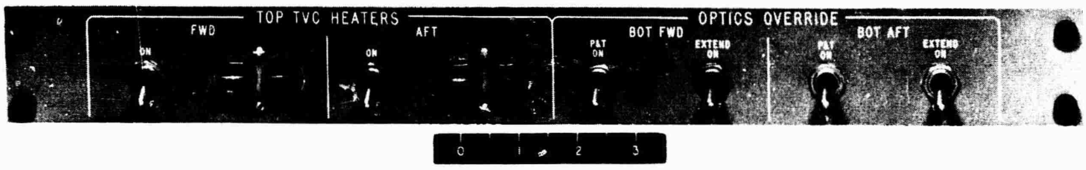


Figure No. 6.13 Optics Override Switching Panel

Override Switching Panel contains pan and tilt on/off switches, as well as extend on/off switches for each of the bottomside Pan and Tilt Heads. Immediately adjacent to these controls are on/off switches, as well as fuses, for both the forward and aft Topside Pan Right Angle TV Camera heaters. The Optics Override Switching Panel is also shown in Figure No. 6.13.

7.0 RENDEZVOUS AND MATING

7.1 GENERAL

The Rescue mission begins when a submarine is bottomed at less than collapse depth. Upon notification of a submarine mishap, the Localization phase commences and the DSRV is dispatched to the vicinity of the bottomed submarine. The DSRV is transported by a surface support ship (ASR), or a suitably configured nuclear submarine. Upon location of the disabled submarine (DISSUB), the DSRV departs from the support ship and descends toward the disabled submarine. The DSRV will use its sensors for obstacle avoidance, during descent, until it is within a few hundred feet of the submarine. At this point the initial Rendezvous and Mating phase commences. The operation begins with a cautious approach toward the DISSUB hatch by the DSRV. The DSRV, while hovering, uses it optical and sonar sensors as guides, to orient and lower itself over the submarine hatch. The manipulator arm is used to clear away any debris or cables that may interfere with the Mating operation. Following such clearance, the DSRV skirt mates to the submarine hatch, and secures a pressure seal. Upon verification of a pressure seal the Mating operation is completed, and the Rescue phase commences.

In order to accomplish the Rendezvous and Mating operations, the following equipments are used:

a. Short Range Sonar
b. Control Sphere Forward Viewport Optics
c. Bottomside Television Camera Group
d. External Floodlighting Set
e. 35mm Still Picture Camera Set
f. Directional Listening Hydrophone Set
g. Skirt Pressure Transducer
h. Hatch Marker
i. Radiacmeter (included but used during rescue phase)
j. Homing Transponder Set

The locations of these equipments are shown in Figure No. 7.1.

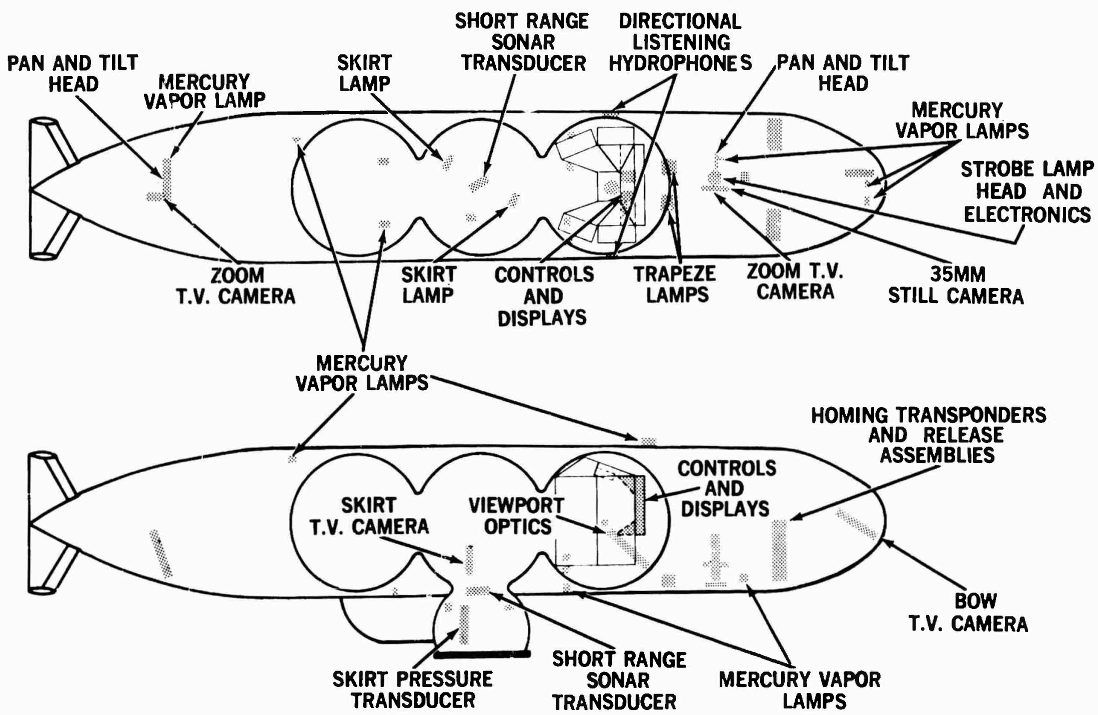


Figure No. 7.1 Rendezvous and Mating Group Configuration

7.2 DIRECTIONAL LISTENING HYDROPHONE SET

This equipment is designed to give the DSRV a capability of general purpose underwater listening. It permits the DSRV, through biaural detection of acoustic signals (particularly those signals generated by hull hammer blows), to home in on such an acoustic source. These signals will be received by two hydrophones mounted on opposite sides of the DSRV and acoustically isolated from one another by the DSRV's forward pressure sphere. The detection assembly will have separate channels for each hydrophone signal with the necessary amplification and filtering. The operator, by listening to the time delay and intensity difference between the two signals, will be able to determine the direction of the signal source. The internal equipment consists of a Directional Listening Hydrophone Electronics and a Directional Listening Hydrophone Remote unit. The receiver contains the bulk of the electronic circuitry concerned with amplifying and filtering the signals received from the hydrophones.

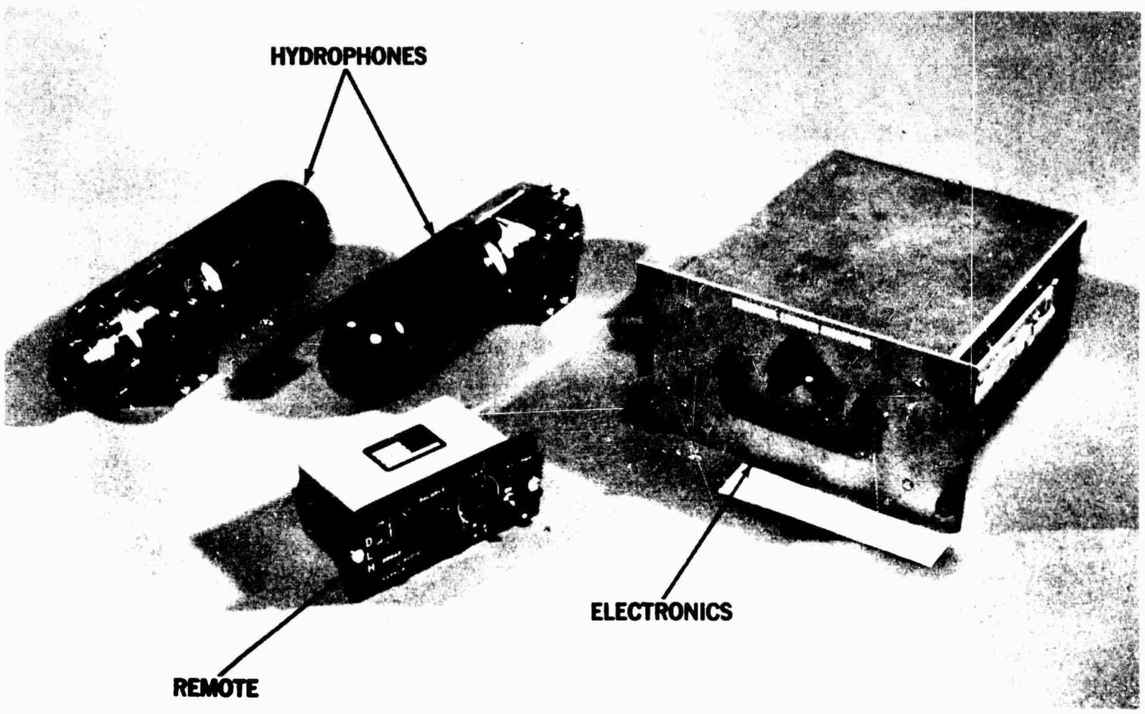


Figure No. 7.2 Directional Listening Hydrophone

The control unit is integrated with the Interior Communication Group (see Figure No. 8.3). The external equipment consists of the two hydrophones which contain a low-noise preamplifier. The Directional Listening Hydrophone Set characteristics are as follows:

Directional Listening Hydrophone

Dimensions:	3" diameter x 10.4" long
Volume:	0.1 cu ft
Weight:	9.0 lbs (in air) 7.0 lbs (in water)
Power:	See Appendix B
Bandpass:	300-12,00 Hz

Directional Listening Hydrophone Electronics

Dimensions:	8.0" wide x 4.6" high x 10.3" deep

Volume:	0.2 cu ft.
Weight:	10 lbs
Power:	See Appendix B
Filter Bandpass:	300-4,500 Hz

Directional Listening Hydrophone Remote

Size:	5.8" wide x 4.3" high x 4" deep
Weight:	1.5 lbs

The Directional Listening Hydrophone Set is a developmental item and is shown in Figure No. 7.2.

7.3 SHORT RANGE SONAR

The Short Range Sonar (SRS) is an active sonar used to provide information to a display which will depict the DSRV skirt and the Distressed Submarine hatch area. The pilot will use this displayed information in conjunction with optical sensor displays to effect a hatch mate. A medium range (150 feet) mode is used to initially detect the attitude of the Distressed Submarine. When the DSRV has descended to 15 feet above the deck, the Short Range Mode is used during the actual mating operation. The SRS will provide definition of the angle between the DISSUB deck and the DSRV Mating Skirt. This information will enable the DSRV to align itself at the proper attitude for approaching the DISSUB hatch. The SRS external equipment consists of a Short Range Sonar Transducer comprised of two transducer pairs and an associated scan mechanism mounted in the DSRV mating skirt. The internal equipment consists of a Transceiver located in the forward starboard rack. The Short Range Sonar is shown in Figure No. 7.3.

7.3.1 The display information is obtained by transmitting acoustic pulses toward the distressed submarine hatch and measuring the total time required for the reflected signal to return. This transmit to receive time is converted to range data which is presented on a cathode ray tube display. Angular information is obtained by synchronizing the sweep of the display trace with the transducer scanning motion. Acoustic returns from different targets appear as intensity variations on the display. A functional block diagram of the Short Range Sonar is shown in Figure No. 7.4. The transducer

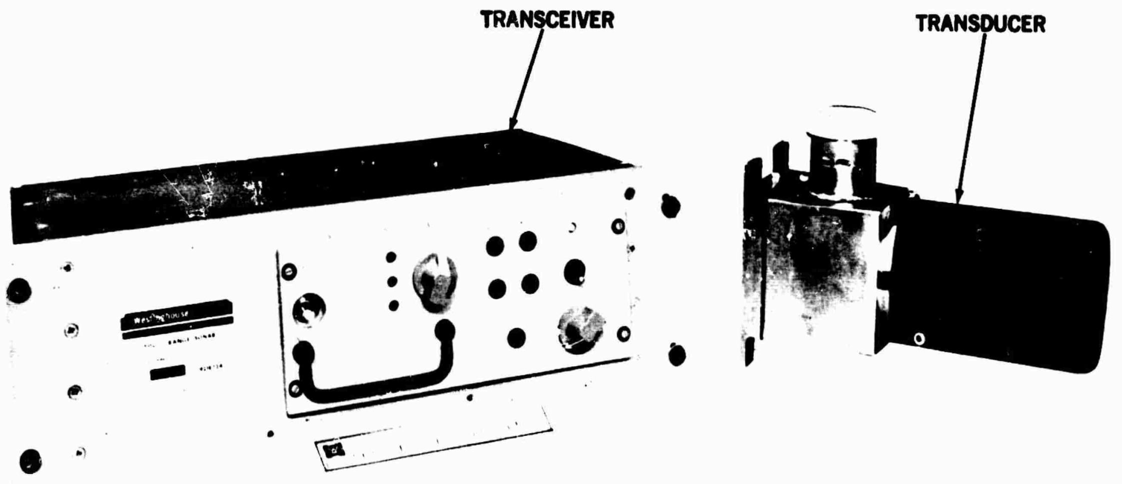


Figure No. 7.3 Short Range Sonar

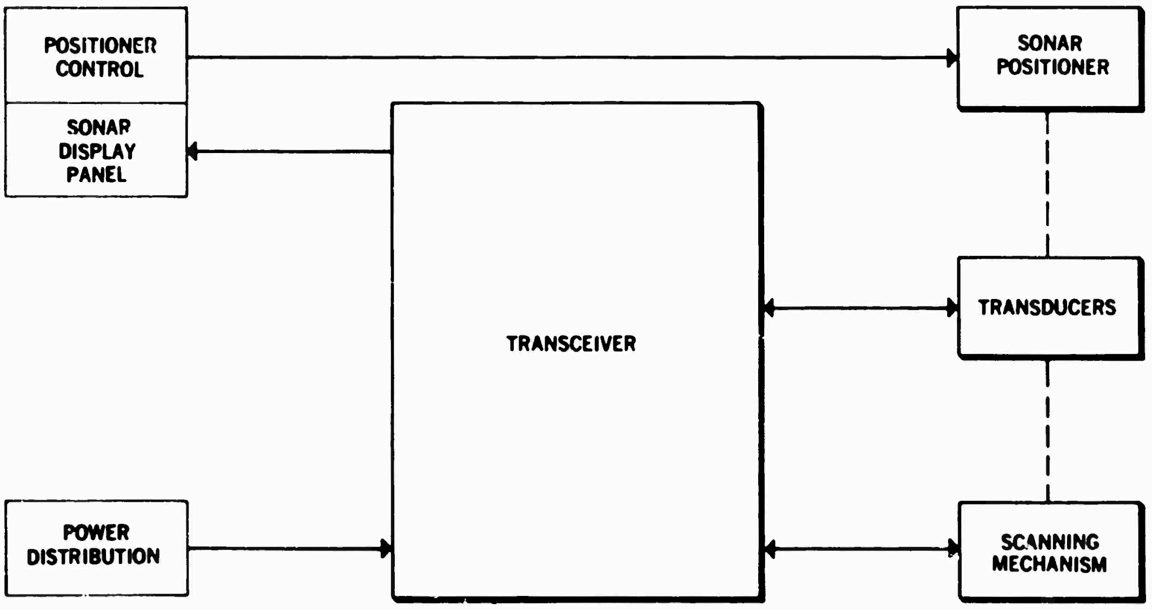


Figure No. 7.4 Short Range Sonar Functional Block Diagram

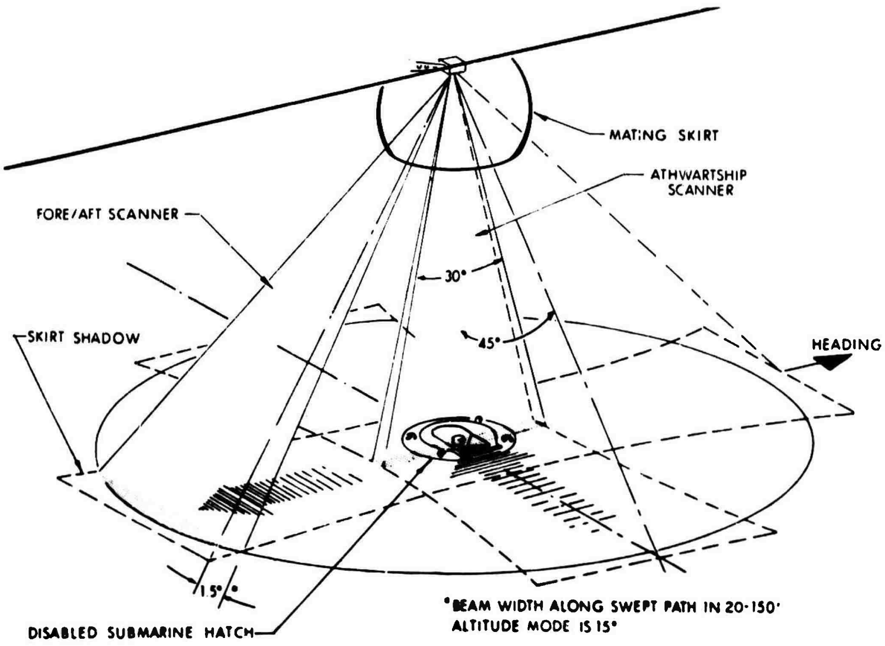


Figure No. 7.5 Short Range Sonar Beam Pattern

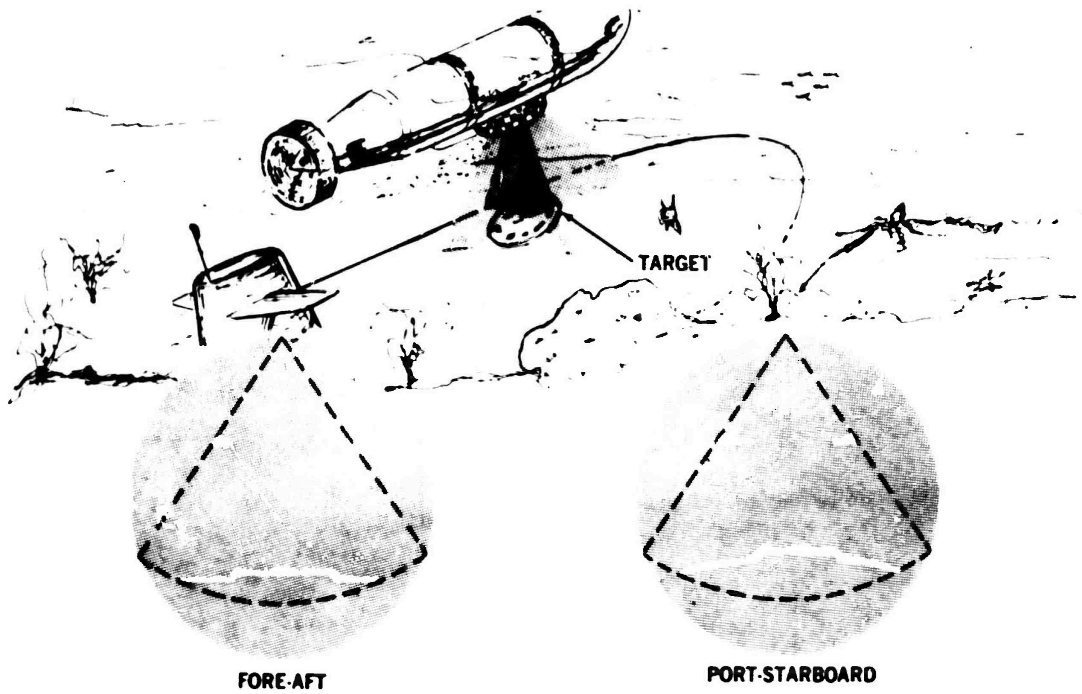


Figure No. 7.6 Short Range Sonar Display assembly radiates the acoustic energy in two orthogonal fan-shaped beams for each mode. Each beam sweeps through a 90° sector along the longitudinal and athwartships axes of the ship. Each beam is scanned alternately in a one second period and while one beam is scanning, the other returns to its starting position. This beam pattern is shown in Figure No. 7.5. The Transceiver provides the output pulses, echo timing and processes the signals for presentation on the Sonar Monitors. Each of the two sweeping beams will be displayed on separate monitors as shown in Figure No. 7.6.

7.3.2 The Short Range Sonar has the following characteristics:

Dimensions, Transceiver:	17" wide x 5.9" high x 11" deep
Dimensions, Transducer:	4" x 4" x 10" long
Volume, Transceiver:	0.7 cu. ft
Volume, Transducer:	0.1 cu. ft
Weight, Transceiver:	42.0 lbs
Weight, Transducer:	18.0 lbs (in air) 6.0 lbs (in water)
Power:	See Appendix B

	Short Range Mode	Medium Range Mode
Range:	15 feet	150 feet
Transmitting Source Level:	+100 db re 1 ubar at 1 yard	+100 db re 1 ubar at 1 yard
Frequency:	1.0 MHz ±20 KHz	116 KHz ±4 KHz
Wavelength:	0.06 inches	0.5 inches
Pulse Length:	20 sec ±2 sec (1.2 inches)	1 msec ±0.1 msec (5 feet ±6 inches)
Cycles per pulse:	20	116

	Short Range Mode	Medium Range Mode
Pulse Repetition Rate:	166 pulses/sec	16 pulses/sec
Beam Pattern:	1.5° along swept path	15° along swept path
	30° across swept path	30° across swept path
	12.5 db down for first side lobe	12.5 db down for first side lobe
	17.5 db down for all others	17.5 down for all others
	25 db down in rear hemisphere	25 db down in rear hemisphere
Sensitivity:	-50 db target at 15 feet	-30 db target at 150 feet
Accuracy:	0.6 inches	2.4 feet
Display Range Resolution:	1-1/4 inches	1 foot
Scanning Rate:	96 deg/sec	96 deg/sec
Length of arc per step:	36 arc minutes	6 degrees
Transmit Duty Cycle:	Less than 10%	Less than 5%

Both modes incorporate a time varied gain to compensate to within $\pm$3db for transmission losses. Under conditions of good visibility, television cameras and viewports are the prime sensors for locating and centering the rescue skirt on the submarine hatch. The SRS is a developmental item.

7 4 CONTROL SPHERE FORWARD VIEWPORT OPTICS

The Forward Control Sphere Viewport Optics is located internally between the pilot and co-pilot. The primary functions of the Forward Control Sphere Viewport Optics are:

a. Viewing of the distressed and/or mother submarine during mating and disembarking maneuvers.

b. Viewing for the purpose of identifying and classifying obstacles.

c. Viewing in order to determine the location, orientation and identity of the distressed submarine.

d. Viewing of the mother submarine's trapeze to assist in engaging during mating operations.

The Viewport Optics has a detachable turret head with two tubular eyepieces that are pivoted, allowing for either simultaneous monocular viewing by the pilot and co-pilot or individual binocular viewing. The eyepieces can be individually focused and adjusted. The Viewport Optics column is hinged below the ICAD shelf so that the turret head can be swung down between the pilot and co-pilot seats for stowage.

7.5 BOTTOMSIDE TELEVISION CAMERA GROUP

7.5.1 Bow Television Camera

The primary functions of the Bow (Wide Angle) Television Camera are:

a. Viewing of the distressed and/or mother submarine during mating and disembarking maneuvers.

b. Viewing in order to determine the location, orientation and identity of the distressed submarine.

The Bow Television Camera is located externally in the bow. Its viewing axis is approximately twenty degrees below the horizontal plane. The characteristics of the Bow Wide Angle Television Camera are:

<u>Mechanical</u>

Dimensions:	7.5" diameter x 24.5" long (with connector)
Volume:	2.5 cu. ft
Weight:	20.0 lbs (in air) 10.0 lbs (in water)

Case Material:	6061 - T6 Al (Hard anodized)

<u>Electrical</u>

Power:	See Appendix B
Video Bandwidth:	8.0 MHz
Scanning Standard:	U.S. (EIA) Standard, Double Interlace
Video Output:	1.5V composite video negative sync
Sync Frequency Control:	Crystal controlled oscillator
Horizontal Resolution:	600 TV lines (minimum)
Automatic Target Control Light Level Compensation Range:	10,000 to 1
Focus:	Remote-controlled from TV monitor

<u>Optical</u>

Focus Range:	9" to infinity
Vidicon Spectral Response:	Peaks to 4500 Angstroms
View Angle in Water:	75° horizontal, 60° vertical
View Axis:	20° below horizontal

The Bow Television Camera is shown in Figure No. 7.7.

7.5.2 Zoom Television Camera

The primary functions of the two pan and tilt Zoom Television Cameras are:

a. Viewing of the distressed and/or mother submarine during the mating and disembarking maneuvers (both units).

b. Viewing in order to determine the location, orientation and identity of the distressed submarine (both units).

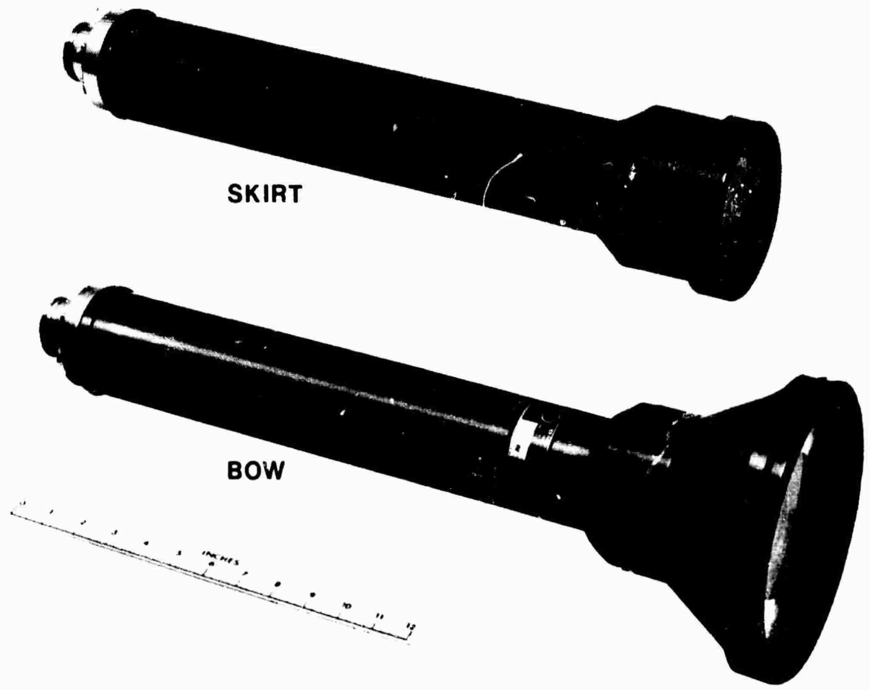


Figure No. 7.7 Television Camera Group

c. Viewing for the purpose of identifying and classifying obstacles (both units).

d. Viewing in order to provide the operator with a picture of the shroud area (aft unit).

e. Viewing in order to facilitate deployment and positioning of port and starboard anchors (forward unit).

f. Viewing in order to insure proper placement of Homing Transponders (forward unit).

g. Viewing in order to insure efficient manipulator operation (forward unit).

One Zoom Television Camera is located externally on the bottomside forward retractable pan and tilt head, the other is located on the bottomside aft head. The characteristics of the Zoom Television Cameras are:

Mechanical

Dimensions:	4.50" diameter x 24.6" long (with connector)
Volume:	0.9 cu. ft.
Weight:	17.0 lbs (in air) 8.0 lbs (in water)
Case Material:	6061 - T6 Al (Hard anodized)

Electrical

Power:	See Appendix B

All other electronics characteristics are identical to the Bow Wide Angle Television Camera with the exception of the addition of zoom and iris controls and their corresponding power requirements.

Optical

Focus Range:	3' to infinity	
Focal Length:	13 - 52 mm	
View Angle in Water:	Horizontal:	36° at minimum focal length (13 mm) 10° at maximum focal length (52 mm)
View Angle in Water:	Vertical:	27.4° at minimum focal length (13 mm) 7.4° at maximum focal length (52 mm)

7.5.3 Skirt Television Camera

The primary functions of the Mating Skirt Wide Angle Television Camera are:

a. Viewing of hatches and mating areas for obstacles.

b. Viewing in order to facilitate precision maneuvering near hatches and final approach/alignment.

c. Viewing in order to facilitate hual-down winch operation.

The Skirt Television Camera is located internally, in a fixed orientation, in the Mid Sphere, and is directed down at the skirt area. The characteristics of the Skirt Television Camera are:

Mechanical

Dimensions:	4.5" diameter x 22.5" long (with connector)
Volume:	0.8 cu. ft.
Weight:	14.0 lbs (in air)
Case Material:	6061 - T6 Al (Hard anodized)

Electrical

Power:	See Appendix B
Video Bandwidth:	8.0 MHz
Scanning Standard:	U.S. (EIA) Standard, Double Interlace
Horizontal Resolution:	600 TV lines
Automatic Light Level Compensation Range:	10,000 to 1
Video Output:	1.5V composite video negative sync
Sync Frequency Control:	Crystal controlled oscillator
Focus:	Remote-controlled from TV Monitor panels

Optical

Focus Range:	3" to infinity
Vidicon Spectral Response:	Peaks at 4500 Angstroms

Assuming TV viewing up to 50', the Skirt Television Camera is functionally duplicated by the Short Range Sonar (for ranges of 2' to 50'). The Camera is shown in Figure No. 7.7.

7.5.4 Bottomside Retractable Pan and Tilt Heads

The DSRV employs two bottomside retractable pan and tilt heads, both located on the vehicle's fore-aft axis. The forward unit supports the forward Zoom Television Camera, the Still Picture Camera, the Strobe Lamp Head and Mercury Vapor Lamp #3. The aft unit carries the aft Zoom Television Camera and Mercury Vapor Lamp #11. (The Mercury Vapor Lighting System is discussed in Sec. 7.5.1.) The forward and aft heads both have two operational degrees of freedom, 350° rotation about a deck to keel axis and 210° about an axis in the deck plane. In addition to these degrees of freedom both forward and aft head can be extended/retracted, although the equipment will be used only when it is fully extended. It is estimated that the head can situate the camera equipment 18 inches from the hull when fully extended. The retractable section on which the pan and tilt heads are mounted, is part of the vehicle subsystem. The controls and displays for the Bottomside Retractable Pan and Tilt Heads each consist of 3 position extend/off/retract switches and fully extended-retracted indicators, all located on the Pan and Tilt Extender Control Panel. (See Figure No. 7.8.) Meters displaying angles of pan

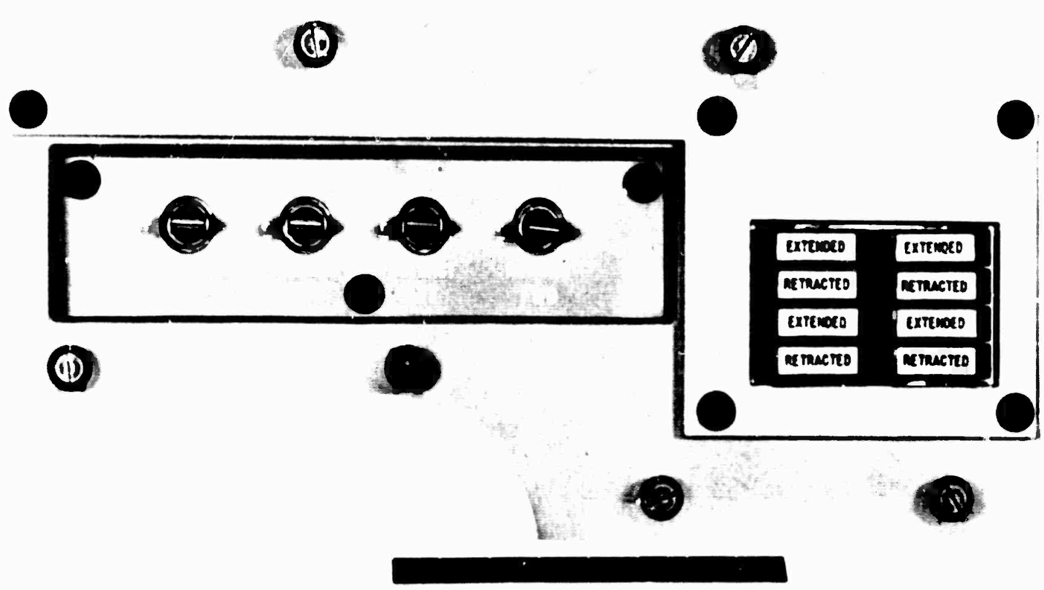


Figure No. 7.8 Pan and Tilt Extender Control Panel and tilt are located on the TV Monitor Panel. The Optics Override Switching Panel (see Figure No. 6.13), has backup on/off power switches for the Pan and Tilt Heads and the extend/retract mechanisms. In case of emergency the Pan and Tilt Heads are equipped with a jettisoning mechanism. These controls are located on the Emergency Jettison Panel (see Section 9.2). The characteristics of the Pan and Tilt Heads are:

Mechanical

Dimensions:	12.5" diameter x 18.0" long
Volume:	1.2 cu. ft.
Weight:	83.5 lbs (in air) 63.5 lbs (in water)

Electrical

Power:	See Appendix B

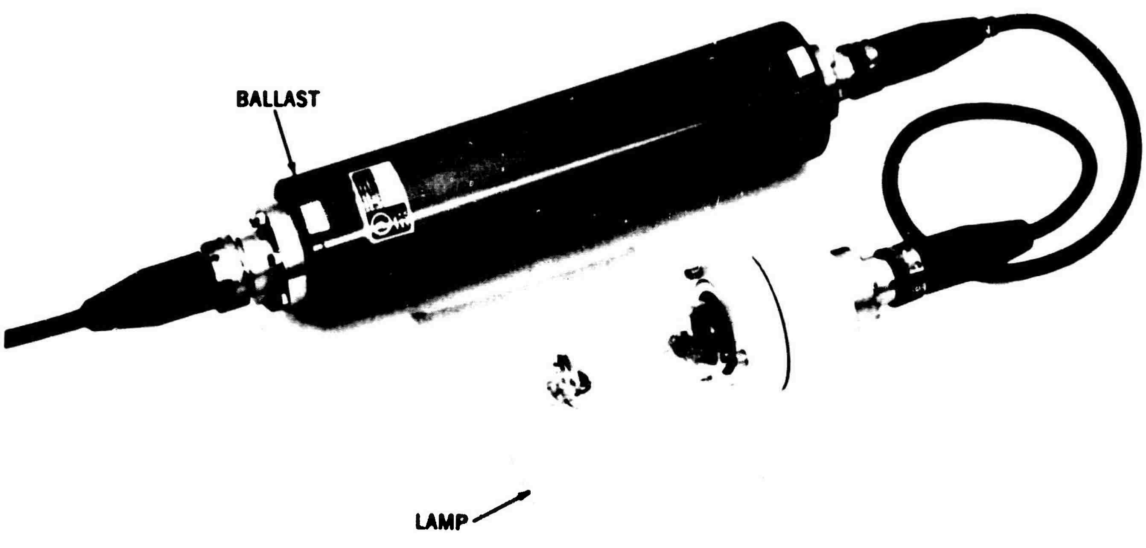


Figure No. 7.9 Mercury Vapor Lighting System

7.6 EXTERNAL FLOODLIGHTING SET

7.6.1 Mercury Vapor Lighting System

The Mercury Vapor Lamps are the primary source of illumination for the Television Camera Group. The associated Mercury Vapor Ballast Converters provides the minimum voltage necessary to excite the mercury vapor ions. The Mercury Vapor Lighting System is shown in Figure No. 7.9. The control switches are located on the External Floodlights Control Panel. The system characteristics are as follows:

<u>Mercury Vapor Lamps</u>

Dimensions:	5.9" x 4.1" x 10.2" long (with connector)
Volume:	0.1 cu. ft.
Weight:	4.5 lbs (in air) 3.0 lbs (in water)
Power:	See Appendix B
Case Material:	6061 - T6 Al (hard anodized)
Light Output: (112 VDC input to ballast converter)	2500 centerbeam candlepower minimum, with a peak radiation at 435 millimicrons, to match the transmission characteristics of sea water and the spectral sensitivity of the TV Camera vidicons.
Beam Width: (water)	±53° vertical to 1/2 centerbeam intensity ±53° horizontal to 1/2 centerbeam intensity.
Lamp Life:	2,000 hours minimum
Warm-Up Time:	10-12 minutes in water

<u>Mercury Vapor Ballast Converters</u>

Dimensions:	3.5" diameter x 17.4" long (with connector)
Volume:	0.1 cu. ft.

Weight:	13.5 lbs (in air) 8.0 lbs (in water)
Power:	See Appendix B
Case Material:	6061 - T6 Al (hard anodized)

The location of the Mercury Vapor Lamps is shown in Figure No. 7.1. The associated ballast unit is located in adjacent areas. The 13 Mercury Vapor Lamps are used to provide the following:

Lamps #1 & #2	Illumination for the Bow Television Camera.
Lamp #3	Illumination for the forward Zoom Television Camera.
Lamps #4, #5, #6 & #7	Illumination of the skirt area, to allow viewing from the control and mid sphere viewports and additional illumination for the forward Zoom Television Camera.
Lamp #8	Illumination for the forward Pan Right Angle Television Camera.
Lamps #9 & #10	Additional illumination of the skirt area for viewing with the aft Zoom Television Camera.
Lamp #11	Illumination for the aft Zoom Television Camera.
Lamp #12	Illumination for the aft Right Angle Television Camera.
Lamp #13	Additional illumination for forward viewing with the forward Zoom Television Camera.

7.6.2 Skirt Lamps

There are two Mating Skirt Quartz Iodide Lamps which are the primary light sources for the Skirt Television Camera. They are located in the skirt and direct their light towards the skirt opening. The lamps have modified reflectors, because of limited skirt space. These two lamps also have a guard around the bulb. One of them is provided with additional cable length so that it may be unmounted and brought into the Mid Sphere to provide additional illumination. Both Mating Skirt Quartz Iodide Lamps are capable of operating in air as well as water. In view of the importance of their function, both lamps have high reliability and provision will be made for quick and simple replacement. The Mating Skirt Quartz Iodide Lamp characteristics are:

Mechanical

Dimensions:	3.5" diameter x 10.3" long
Volume:	0.1 cu. ft.
Weight:	3.5 lbs (in air) 2.5 lbs (in water)
Case Material:	6061 - T6 Al (hard anodized)

Electrical

Power:	See Appendix B

Optical

Light Output: (23 VDC)	450 centerbeam candlepower minimum
Beam Width (water):	±53° horizontal to 1/2 centerbeam intensity ±53° vertical to 1/2 centerbeam intensity.
Lamp Life:	1500 hours minimum
Warm Up Time:	Negligible

A Skirt Lamp is shown in Figure No. 7.10.

7.6.3 Trapeze Lamps

There are two Trapeze Quartz Iodide Lamps which provide illumination for the DSRV trapeze hook area. The lighting from these lamps facilitates engagement of the DSRV trapeze hook and the mother submarine's trapeze during mating. The Trapeze Lamp is shown in Figure No. 7.10. The two Trapeze Quartz Iodide Lamps are capable, as are the Skirt

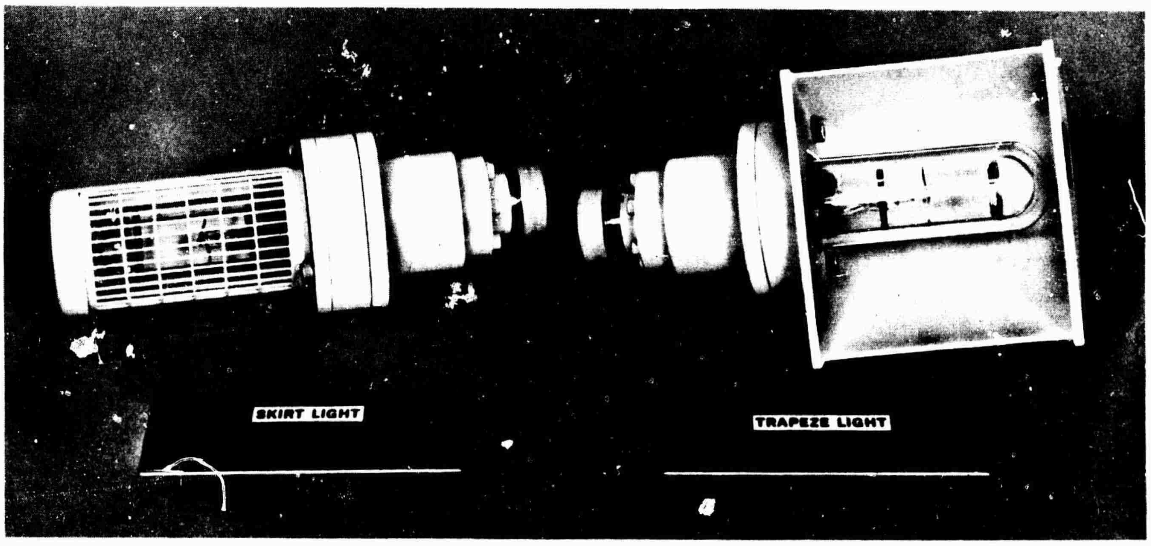


Figure No. 7.10 Quartz Iodide Lamps

Lamps, of operating in air as well as in water. The Trapeze Lamps have high reliability and provision is to be made for quick and simple replacement. The Trapeze Quartz Iodide Lamp characteristics are:

Mechanical

Dimensions:	4.1" x 5.9" x 10.2" long (with connector)
Volume:	0.1 cu. ft.
Weight:	4.5 lbs (in air) 3.0 lbs (in water)
Material:	6061 - T6 Al (hard anodized)

Electrical

Power:	See Appendix B

Optical

Light Output: (28 VDC)	450 centerbeam candlepower minimum

Lamp Life: 1500 hrs. minimum

Warm Up Time: Negligible

7.6.4 Controls

The controls for the External Floodlighting Set are contained on the External Floodlights Control Panel which is shown in Figure No. 7.11. The panel weighs 10.5 lbs.

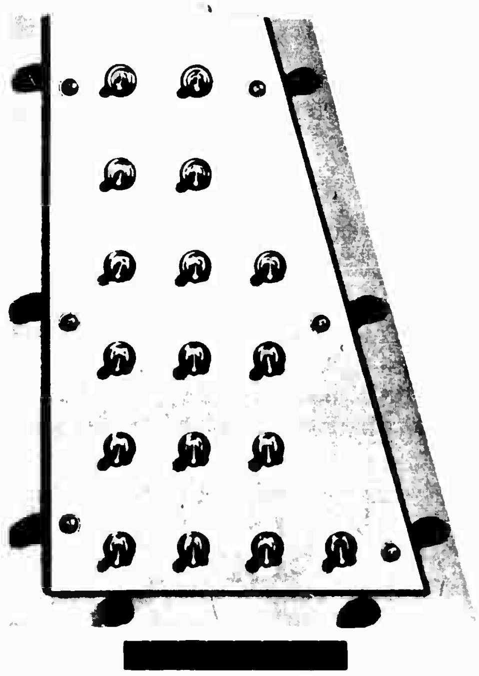


Figure No. 7.11 External Floodlights Control Panel

7.7 SKIRT PRESSURE TRANSDUCER

The Skirt Pressure Transducer measures absolute skirt pressure. The transducer has a voltage regulator so that variations in the excitation voltage do not affect the output. The internal equipment is located in the Control Sphere, and consists of a display. The transducer is housed in a protective case, and is an off-the-shelf item.

The Skirt Pressure Transducer supplies pressure information for use when equalizing skirt pressure and Mid-Sphere pressure during the Mating operation. The transducer measures absolute pressure from 0 to 150 psia to an accuracy of ±0.5% of full scale output. The skirt pressure will be monitored on an analog voltmeter, located on the Mating Controls Panel of ICAD (see Figure No. 9.6). The Skirt Pressure Transducer is located in the mating skirt. The Skirt Pressure Transducer characteristics are as follows:

Dimensions:	3.4" diameter x 9.3" long
Volume:	0.2 cu. ft.
Weight:	13.5 lbs (in air) 12.0 lbs (in water)
Power:	See Appendix B
External Case Material:	CRES 316L protected by anti-corrosion and anti-fouling coatings
Case Sacrificial Anode:	Aluminum QQ-A-250/1b
Pressure Range:	0-150 psia
Input Power:	23 ±4 VDC, 50 ma maximum
Resonant Frequency:	Greater than 7 KHz
Noise Level:	Output ripple voltage or wide band noise shall not exceed 50 mv peak-to-peak
Output Impedance:	Less than 300 ohms
Insulation Resistance:	Greater than 50 megohms at 50 VDC
Isolation Resistance:	Isolation between input and output greater than 50 megohms at 50 VDC
Full Scale Sensitivity:	5.0 + 0, - 0.20 VDC into 125K minimum load

Regulation:	The transducer output shall not change more than ±0.20% FSO for input voltage variations from 24 to 32 VDC
Output Limiting:	Output shall never exceed +6.5 VDC or drop below -1.0 VDC.
Compensated Temperature Range:	+30°F to +90°F
Operating Temperature Range:	-40°F to +200°F
Thermal Sensitivity Shift:	0.005% FSO°F (+30°F to +90°F)
Thermal Zero Shift:	0.005% FSO°F (+30°F to +90°F)
Vibration Acceleration Error:	Within 0.01% FSO/g (0-2000 Hz)
Static Error Band:	The combined effects of linearity, hysteresis and repeatability shall be within ±0.50% FSO
Linearity (Endpoint):	Within ±0.35% FSD
Hysteresis:	Within 0.1% FSD
Repeatability:	Within 0.1% FSD
Zero Balance:	Within 0 to +2% FSD
Resolution:	Infinite
Overload:	30 times rated range
Burst Pressure Rating:	40 times rated range

7.8 HOMING TRANSPONDER SET

The Homing Transponder Set (HT) consists of:

a. Homing Transponder

b. Homing Transponder Release Assembly

Two Homing Transponders will be carried by the DSRV during the rescue mission. They are carried in recessed release tubes (Homing Transponder Release Assembly) external to the pressure hull. A transponder will be placed on the ocean bottom near the distressed submarine during the initial descent. The HT serves as a homing device for all subsequent descents and will be used in conjunction with the Transponder Interrogation Sonar. Each transponder is released by throwing a switch located on the Clock and Transponder Release Panel (see Figure No. 4.17). The Transponder is a compact, battery powered unit, able to transmit a sonic reply pulse when interrogated by the proper sonic pulse. It will receive continuously, and transmit 10^5 replies, or operate for 30 days, whichever occurs first. The HT consists of five assemblies: a battery/anchor assembly, an electronics assembly, a cable assembly, a transducer assembly, and a buoyant element. The battery/anchor will anchor the transponder in a one knot current, and provide power for the electronics. The electronics consists of a receiver and a transmitter. Upon impact with the ocean bottom the release assembly will cause the cylindrical buoyant element to separate from the battery/anchor, and "float" vertically at the end of a tethering cable at approximately 10 feet above the anchor on the ocean floor. The transducer assembly is located in the upper end of the buoyant element, and is configured to radiate an upward hemispherical pattern. The HT interrogation signal is 7 KHz $\pm$50 Hz with a pulse width envelope of 4 ms $\pm$0.5 ms, and a maximum pulse repetition rate of 1 per 2 seconds. The receiver bandwidth between 3 db points is 250 Hz, and operates with a signal-to-noise ratio of 10 db in a noise ambient equivalent to a State 2 Sea. The receiver incorporates signal verification circuitry to reduce the probability of false replies. To prevent the transponder from being retriggered during a receive-transmit cycle by reverberations, or other signals, the receiver incorporates a 0.5 $\pm$0.05 sec. inhibit circuit. The time delay from start of interrogation to start of reply is within $\pm$1 ms of the nominal value set by the manufacturer. The transmitted reply signal is of a pre-selected frequency, with a pulse width envelope of 4 ms. The frequency may be one of the following ten frequencies:

12.5 KHz	15.0 KHz
13.0	15.5
13.5	16.0
14.0	16.5
14.5	17.0

The acoustic power output is 90 ± 3db at 1 yard for all angles up to ± 90° from the acoustic axis of the transducer. The HT is a developmental item and has the following physical characteristics:

Homing Transponder

Dimensions:	9.8" diameter x 33" long
Volume:	1.5 cu. ft.
Weight:	80.0 lbs (in air) 27.0 lbs (in water)

Homing Transponder Release Assembly

Dimensions:	10" diameter x 45" long
Volume:	2 cu. ft.
Weight:	26.0 lbs (in air) 17.0 lbs (in water)

7.9 SONAR HATCH MARKER

Sonar Hatch Marker will be used to assist in relocating the hatch of the distressed submarine by providing a strong acoustic target for the Short Range Sonar. They will be mounted to the hatch in some specific arrangement after the first group of survivors have been taken aboard the DSRV. These Sonar Hatch Markers consist of an acoustic corner reflector designed to operate with the high frequency (1 MHz) mode of the Short Range Sonar. Having an irregular shape, they occupy a volume less than that of a 2" cube. The Hatch Markers are constructed of aluminum and weigh less than 0.5 pound. A magnet attached to the base of the corner reflector assures a positive mounting to the hatch of the distressed submarine. The Sonar Hatch Marker is a developmental item.

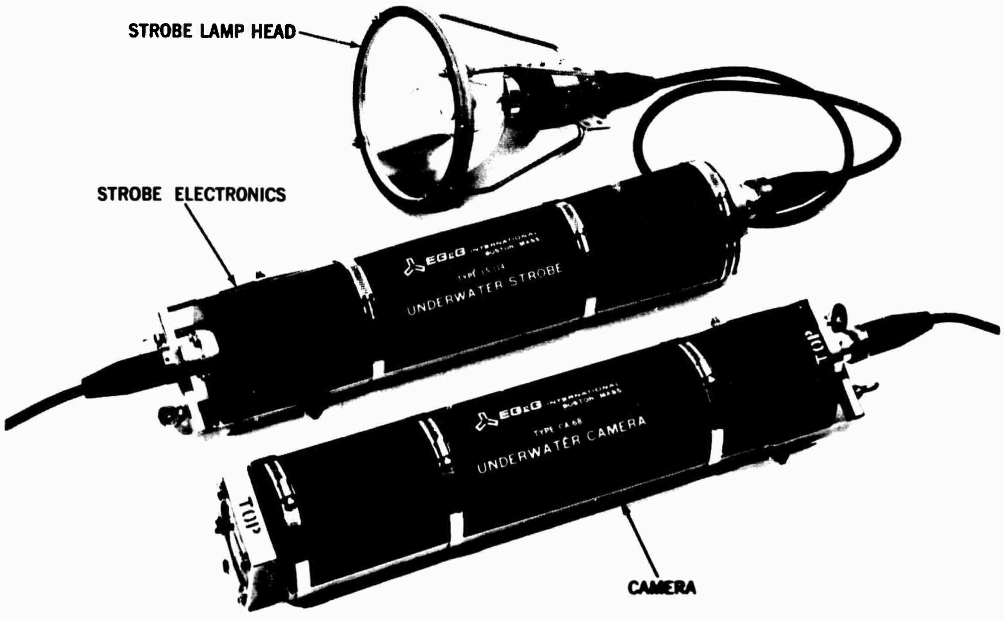


Figure No. 7.12 35mm Still Camera Set

7.10 35mm STILL CAMERA SET

7.10.1 Still Camera

The function of this camera is to provide a permanent record of obstacles, articles and activities in the area of the forward pan and tilt unit. The camera will be located on the forward bottomside retractable Pan and Tilt Head for the primary mission. It may also be mounted on the aft bottomside retractable Pan and Tilt Head to meet secondary mission requirements. A control unit is provided for the camera in order to activate the camera and strobe light. The Still Picture Camera Set is shown in Figure No. 7.12. The 35mm Still Picture Camera controls and displays are located on the Film Camera Control Panel of ICAD. The 35mm Still Picture Camera characteristics are:

<u>Mechanical</u>

Dimensions:	5.0" diameter x 27.5" long
Volume:	0.3 cu. ft.

Weight:	25.0 lbs (in air) 9.5 lbs (in water)
Case Material:	6061 - T6 Al (hard anodized)
<u>Electrical</u>	
Power:	See Appendix B
<u>Optical</u>	
Lens:	f/4.5 Hopkins (corrected for underwater use)
Focal Length:	35mm (in air) 50mm (in water)
Viewing Angle:	33° vertical x 51° horizontal
Focus Range:	Adjustable 3 feet to infinity
Shutter:	Wollensak #0 Alpax, single action x sync
Film Size:	35mm
Number of Exposures:	500 (for 100 foot film roll)
Data Chamber Lens:	f 2.5 Wollensak-Cine Raptar, focal length - 13mm

It should be noted that the 35mm Still Picture Camera also photographs an internal data chamber mounted on the rear end cap. The data chamber contains a depth gage (0 - 3000 meters), an accutron clock and a frame counter. The camera system is commercially available and will require no modifications to meet the present requirements.

7.10.2 Strobe Lamp Head and Electronics

The Strobe Lamp Head and Strobe Electronics provide illumination for the Still Camera. The Strobe Lamphead is located on the forward bottomside retractable Pan and Tilt Head, for the DSRV primary mission. The Converter Electronics is located in the near vicinity of the Strobe Lamp Head. A switch closure between the external sync lead and the 28 volt common is needed to activate the trigger circuit that fires the flash tube. This closure will be provided by the external sync shutter controls of the 35mm Still Picture Camera. The Strobe Lamp Head controls are located on the Film Camera Control Panel. The characteristics of the Strobe Lamp Head and Converter Electronics are:

<u>Strobe Electronics</u>

<u>Mechanical</u>

Dimensions:	6.3" diameter x 27.4" long (with connector)
Volume:	0.4 cu. ft.
Weight:	28.0 lbs (in air) 12.0 lbs (in water)
Case Material:	6061 - T6 Al (hard anodized)

<u>Electrical</u>

Power:	See Appendix B

<u>Strobe Lamp Head</u>

<u>Mechanical</u>

Dimensions:	8.5" diameter x 12.4" long (with connector)
Volume:	0.4 cu. ft.
Weight:	5.5 lbs (in air) 3.5 lbs (in water)
Material:	6061 - T6 Al (hard anodized)

<u>Optical</u>

Light Output:	11,000 Lumen-sec (nominal)

This unit is a commercially available off the shelf item.

7.10.3 Controls

The controls for the 35mm Still Camera Set are located on the Film Camera Control Panel. The Panel weighs 9.5 lbs.

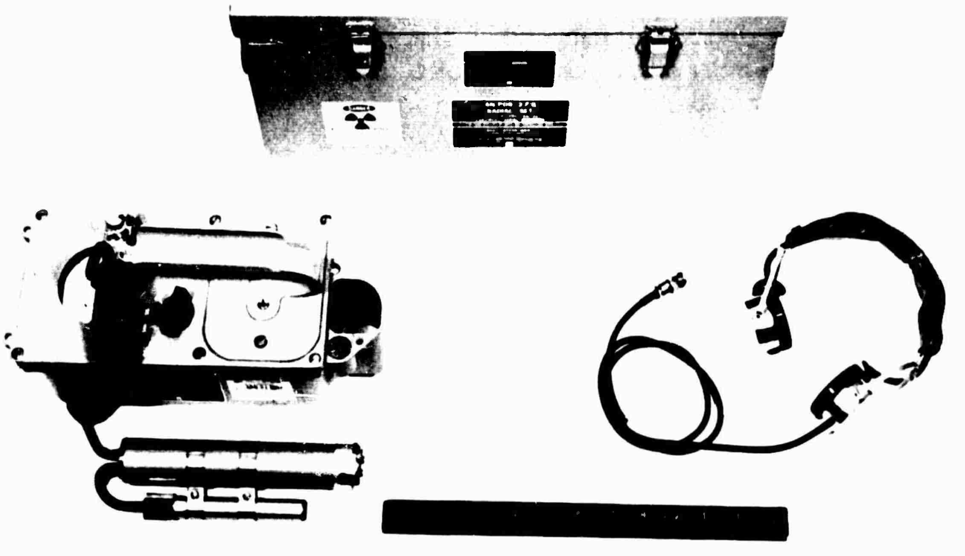


Figure No. 7.13 Radiacmeter

7.11 RADIACMETER

The Radiacmeter (AN/PDR-27Q) is used to monitor the clothing of rescued survivors. The Radiacmeter contains Geiger-Mueller (G-M) tubes to detect gamma and beta radiations. When the G-M tubes are exposed to such radiations, they produce short-duration d-c voltage pulses at an average repetition rate proportional to the average radiation field intensity in the vicinity of the tubes. These pulses, which are of random duration and random amplitude, are converted to pulses of equal duration and constant amplitude by electronic circuits, and are used to energize a meter whose reading is proportional to the pulse repetition rate. The pulses can also be heard as clicks by connecting a headset to the jack on the Radiacmeter panel.

The Radiacmeter detects, and displays dose rates of 0.5 to 500 milliroentgens/hrs to an accuracy of +20%. The unit measures 7.6" x 11.6" x 5", and weighs 7.7 lbs. (batteries included). This equipment is portable and will be located in the mid or aft sphere. The Radiacmeter is an existing military off-the-shelf equipment and is shown in Figure No. 7.13.

8.0 COMMUNICATIONS

8.1 GENERAL

The Communications Group provides the DSRV crew with a means of communicating on the surface, or underwater, between:

a. The members of the crew within the DSRV.

b. The DSRV and the Distressed Submarine.

c. The DSRV and the Support Ships.

d. The DSRV and an attending personnel during launch and/or recovery.

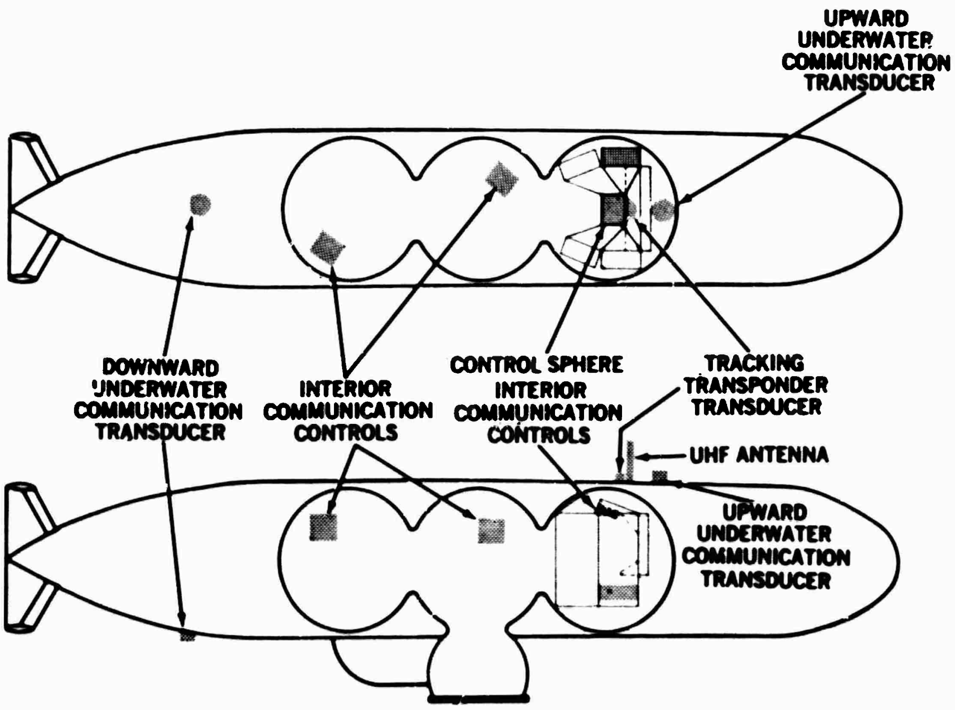


Figure No. 8.1 Communication Group Configuration

These capabilities are accomplished by utilizing the:

a. Interior Communication Set.

b. Underwater Telephone.

c. UHF Radio

d. Tracking Transponder Set.

The configuration is shown in Figure No. 8.1.

8.2 UNDERWATER TELEPHONE

The Underwater Telephone provides voice and continuous wave communication capability between the DSRV and its Support Ship, and between the DSRV and a Distressed Submarine. Communication capability is adequate at all depths down to 20,000 feet, with a lateral separation of up to three miles between the two vessels, for Sea State 3 surface conditions and a reasonably uniform sound-velocity profile. The external equipment of the Underwater Telephone consists of a Top Underwater Telephone Transducer and a Bottom Underwater Telephone Transducer. The top transducer, which transmits in an upward direction, provides subsurface communication, when the DSRV is submerged. The bottom transducer, which transmits in a downward direction, provides bottom communication. The internal equipment consists of an Underwater Telephone Remote Unit and an Underwater Telephone Electronics Unit. The Underwater Telephone Remote has a switch which selects for use, either the top or bottom transducer. In addition, this control has switches which select the type of communication (normal or CW) and the range for transmission (near, med. or far). The normal voice communications will be transmitted in the form of an amplitude-modulated, single-sideband, suppressed carrier, sound wave. Continuous Wave (CW) communications will be in the form of a constant amplitude, manually-keyed sound wave. The Underwater Telephone Electronics contains the bulk of the electronics necessary for transmitting and receiving these voice and CW signals. The entire Underwater Telephone is shown in Figure No. 8.2. The characteristics of this sonar set are:

Dimensions, Top Transducer:	5.4" diameter x 11.3" long

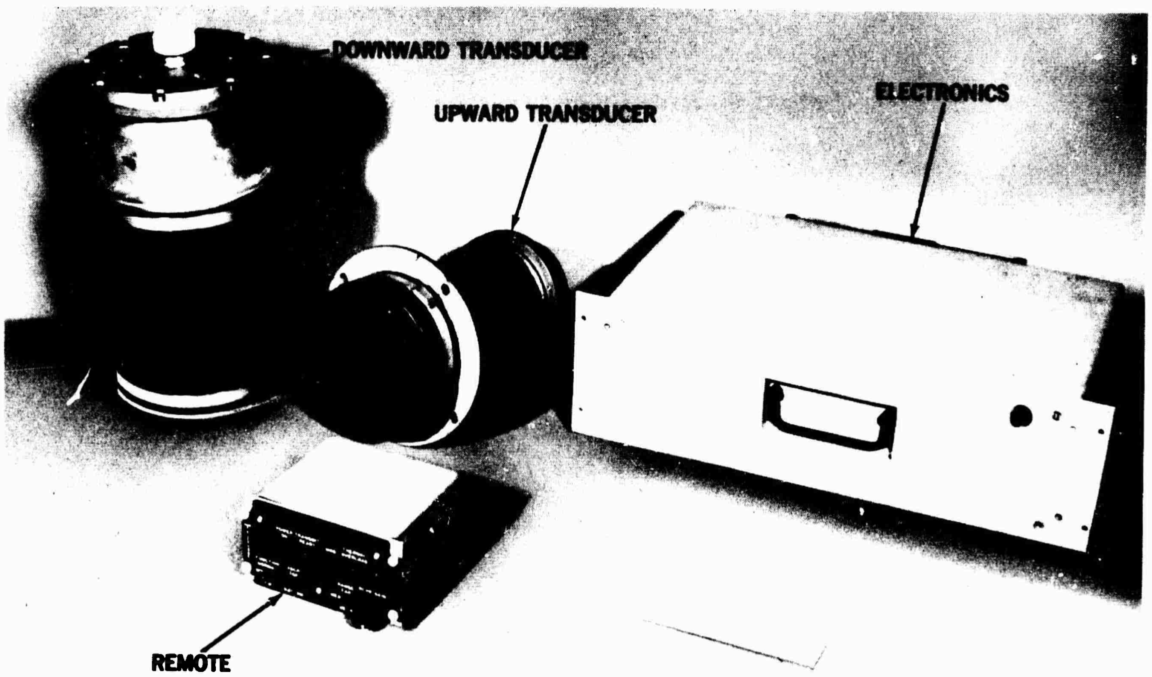


Figure No. 8.2 Underwater Telephone

Dimensions, Bottom Transducer:	6.9" diameter x 12.6" long
Dimensions, Transceiver:	19" wide x 5.3" high x 11.8" deep
Dimensions, Underwater Telephone Remote:	5.75" wide x 3" high x 5" deep
Weight, Top Transducer:	31.5 lbs. (in air) 27.5 lbs. (in water)
Weight, Bottom Transducer:	49.5 lbs. (in air) 33.5 lbs. (in water)
Weight, Transceiver:	35.0 lbs. (in air)
Weight, Underwater Telephone Remote:	3 lbs. (in air)

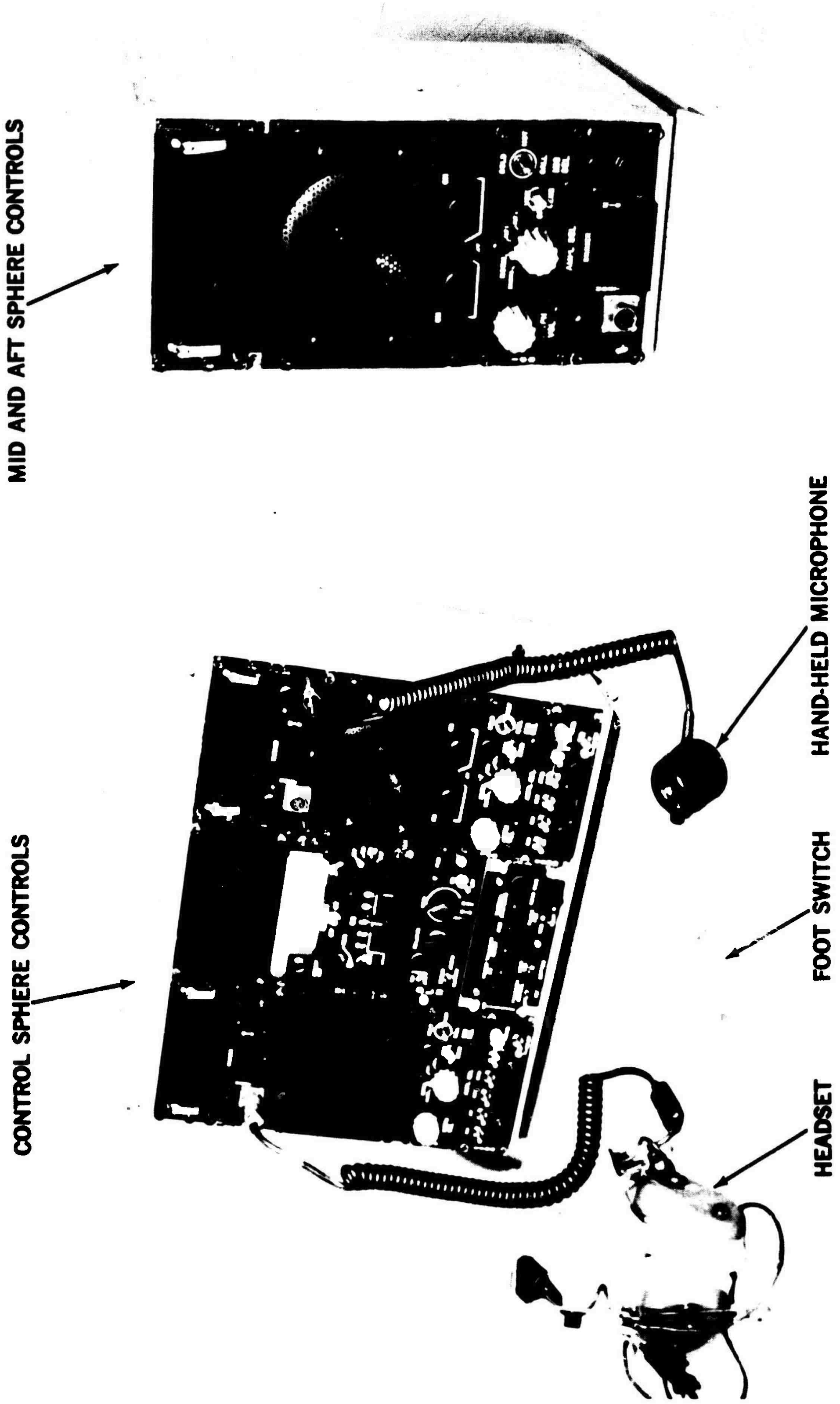
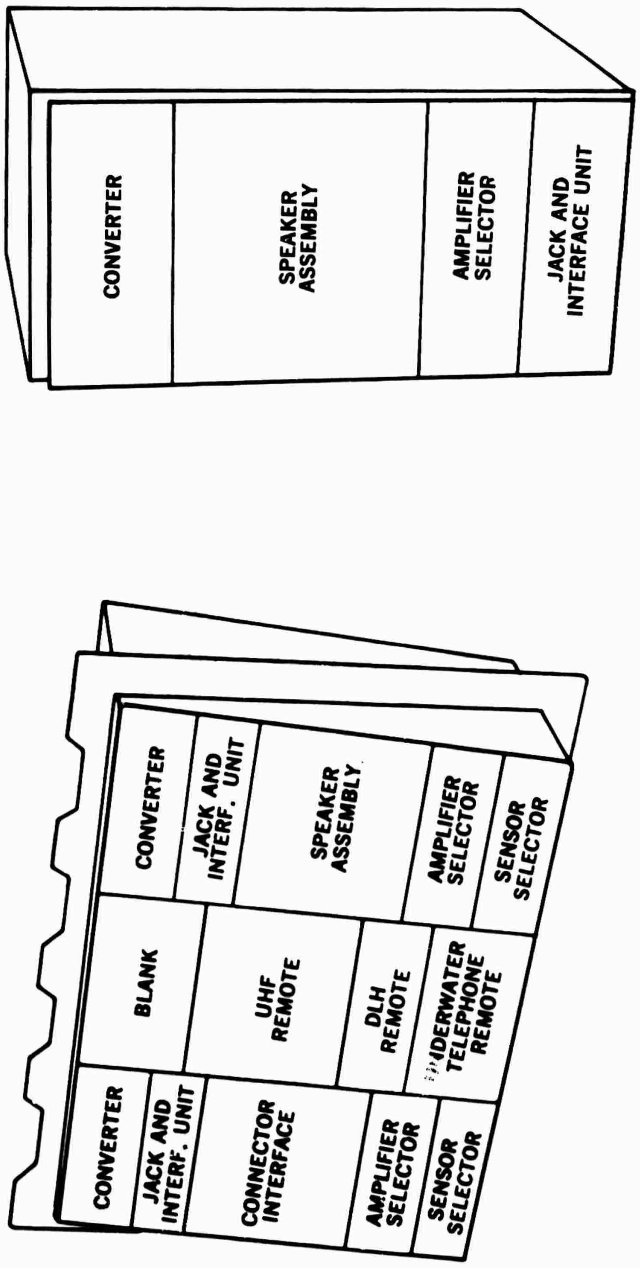


Figure No. 8.3 Interior Communications Set



Key to Figure No. 8.3

Volume, Top Transducer:	260 in^3
Volume, Bottom Transducer:	475 in^3
Volume, Transceiver:	1190 in^3
Volume, Underwater Telephone Remote:	86 in^3
Power:	See Appendix B
Carrier Frequency (Voice Communications):	8.0875 KHz
Carrier Frequency (CW):	8.8 KHz
Frequency Range For Single Side-band:	8-11 KHz

The Underwater Telephone is the only underwater communications equipment on the DSRV, and is a backup to the UHF Radio Set when the DSRV is at the surface. This set is integrated with the Interior Communications Set (Section 8.3) through the Underwater Telephone Remote, thus providing the DSRV Pilot and/or Copilot operational control of the Underwater Telephone. The Underwater Telephone is an off the shelf item which has been repackaged.

8.3 INTERIOR COMMUNICATIONS SET

The function of the Interior Communications Set (IC SET) is to provide hardwire communication between the three DSRV pressure spheres and between the DSRV and a Surface Support Ship, a Mother Submarine, a Distressed Submarine, or an attending personnel during launch and/or recovery. The IC SET is integrated with all audio inputs to, and outputs from, the various DSRV communications equipments. The forward sphere IC equipment is packaged as part of the Control Sphere Interior Communication Controls. The Control Sphere Interior Communications Controls also contains the Underwater Telephone Remote and the UHF Remote. The Control Sphere Interior Communication Controls are mounted overhead, between the Pilot and

Copilot, to provide convenient, complete control of operational modes for the entire Communications Suite. The center and aft spheres are each equipped with an interior communication station which provides amplification of IC signals delivered to, or received from other IC stations. The IC SET allows an operator at one station to communicate simultaneously with all of the other stations, including the topside and skirt external jacks. In addition, the Pilot and Copilot have access to any and all combinations of the following: UHF Radio, Underwater Telephone and audio from the Horizontal Obstacle Sonar Set. Each IC station is provided with a Headset-Microphone, which can be used for automatic communication by means of voice operated relays. A speaker assembly and a Hand-Held Microphone may be selected, for press to talk communication instead of the Headset-Microphone. The Interior Communication Set is shown in Figure No. 8.3. The skirt and the topside jack are provided in the mating skirt and on the topside, respectively, to permit communication with the Distressed Submarine, Support Submarine (while mated) and with external support personnel. The characteristics of the Interior Communication Set are:

Dimensions, Control Sphere Interior Communications Controls:	17.25" wide x 14.25" high x 9.0" deep
Dimensions, Mid and Aft Spheres Interior Communications Controls:	6.0" wide and 12.75" high x 9.0" deep
Volume, Control Sphere Interior Communications Controls:	12.5 ft^3
Volume, Mid and Aft Spheres Interior Communications Controls:	690 in^3
Weight, Control Sphere Interior Communications Controls:	61.5 lbs (in air)
Weight, Mid and Aft Spheres Interior Communications Controls:	21.5 lbs (in air)
Power:	See Appendix B

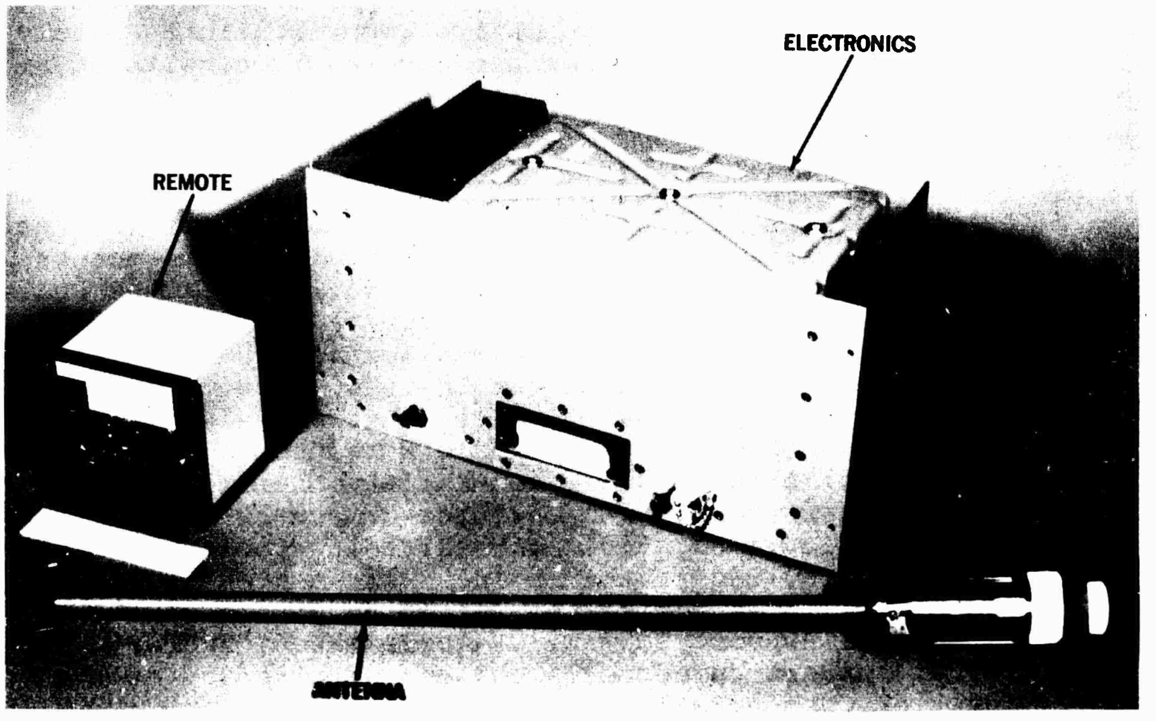


Figure No. 8.4 UHF Radio

The Interior Communication Set is an adaptation of a naval aircraft integrated interconnection system AN/AIC-14A.

8.4 UHF Radio

The UHF Radio provides the DSRV with two-way radio communication with the Support Vessel when the DSRV is on the surface. This will be accomplished by an amplitude modulated radio signal in the frequency range of 225-400 MHz. The transceiver can also transmit a tone modulated frequency for homing in and locating the DSRV after surfacing. The UHF Antenna is externally mounted on the topmost part of the fairing of the DSRV. The UHF Remote provides all controls necessary for the operation and frequency selection of the UHF Radio. The UHF Electronics and the UHF Remote are located in the control sphere. The UHF Remote is integrated with the Interior Communication Set. The UHF Radio is shown in Figure No. 8.4. The UHF Radio characteristics are as follows:

Dimensions, UHF Electronics:	8.72" wide x 17" high x 10" deep
Dimensions, UHF Remote:	4.8" wide x 5.75 high x 5.53" deep
Dimensions, UHF Antenna:	.75" diameter x 30.7" long
Volume, UHF Electronics:	1480 in^3
Volume, UHF Remote:	156 in^3
Volume, UHF Antenna:	13.5 in^3
Weight, UHF Electronics:	46 lbs (in air)
Weight, UHF Remote:	3.8 lbs (in air)
Weight, UHF Antenna:	5.5 lbs (in air) 4.5 lbs (in water)
Power, UHF Radio:	See Appendix B

The UHF Radio will act as the prime equipment for communications on the surface. The Underwater Telephone will serve as a backup for surface communications. The unit is a modified RT-780/ARC-51AX UHF Radio Receiver-Transmitter. The modifications include the homing signal transmission feature and repackaging.

8.5 TRACKING TRANSPONDER SET

The Tracking Transponder Set (TT) consists of:

a. Tracking Transponder Transceiver

b. Tracking Transponder Transducer

The transceiver is a compact unit mounted in the port forward rack in the control sphere. It contains the transmitting and receiving electronics. The transducer will be configured to radiate in an upward hemispherical pattern, while its receiving pattern will also be hemispherical. The TT permits tracking of the DSRV by the Support Ship. It is mounted at the top of the DSRV,

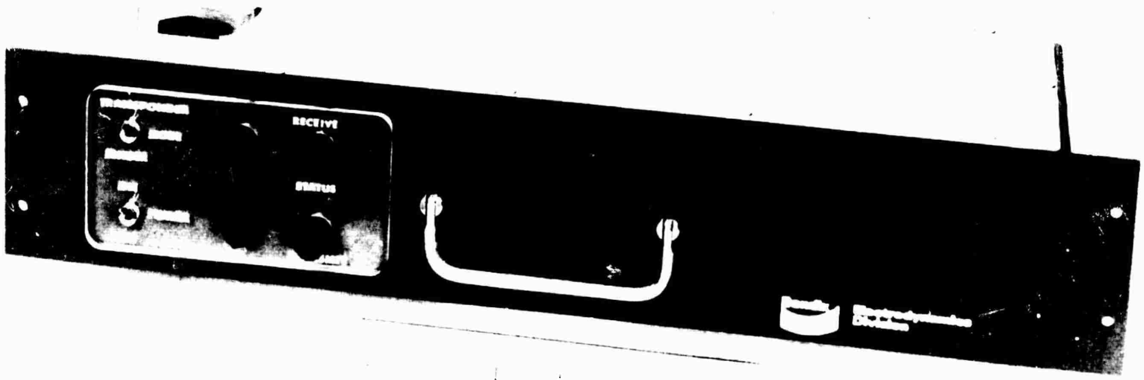


Figure No. 8.5 Tracking Transponder Transceiver

approximately amidships. The TT operates in either a transponder or a pinger mode. In the transponder mode, the TT will transmit a sonic reply pulse when interrogated by a sonic pulse from a support ship. In the pinger mode, the TT will transmit a sonic pulse repetitively at a rate of 1 pulse per 2 seconds. The transponder mode presents fewer interference problems than the pinger mode. The pilot or co-pilot of the DSRV will be able to select the operating mode, as well as turn the TT off. The receiver incorporates signal verification circuitry to reduce the probability of false replies. The receiver also incorporates a 0.5 $\pm$ 0.05 sec inhibit circuit, to prevent the transponder from being retriggered during a receive-transmit cycle by reverberations or other signals. The true delay from start of interrogation to start of reply is within $\pm$1 ms of the nominal value set by the manufacturer. The transmitted reply signal will be at any one of ten frequencies. The Tracking Transponder Transceiver is shown in Figure No. 8.5. The Tracking Transponder Set has the following characteristics:

Dimensions, Transceiver:	17" wide x 3.5" high x 6" deep

Dimensions, Transducer:	4" diameter x 4.375" long
Volume, Transceiver:	375 in^3
Volume, Transducer:	55 in^3
Weight, Transceiver:	10.0 lbs (in air)
Weight, Transducer:	8.0 lbs (in air)
Power:	See Appendix B
Frequency (Interrogation Signal):	7 KHz $\pm$ 50 Hz
Frequencies (Reply Signals):	12.5 KHz, 13.0, 13.5, 14.0 14.5, 15.0, 1515, 16.0, 16.5, 17.0 KHz
Pulse Width (Reply & Interrogation):	4 ms
Pulse Repetition (Pinger Mode):	Less than 1 pulse per 2 seconds
Receiver Bandwidth: (between 3 db points)	250 Hz
Signal to Noise Ratio: (Noise ambient equivalent to a State 2 Sea)	10 db

The Tracking Transponder is a developmental item.

9.0 VEHICLE/LIFE SUPPORT CONTROLS AND DISPLAYS

9.1 POWER DISTRIBUTION

9.1.1 Main Power Monitor Panel

The primary power displays consist of DC voltmeters located on the Main Power Monitor Panel as shown in Figure No. 9.1. This panel provides illuminated meters which display: voltage of forward and aft batteries; state of charge of forward and aft batteries; bus voltage of the essential and utility inverters (buses); bus voltage of the two converters; and emergency battery voltage. The Main Power Monitor Panel also provides leakage resistance to ground checks for each bus. The Main Power Monitor Panel weighs 11.5 lbs.

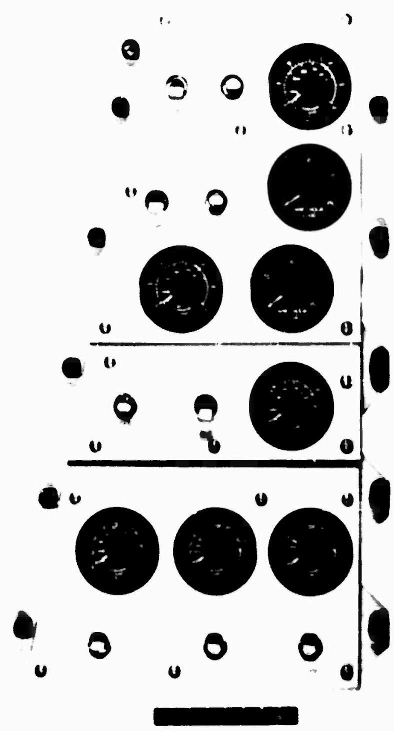
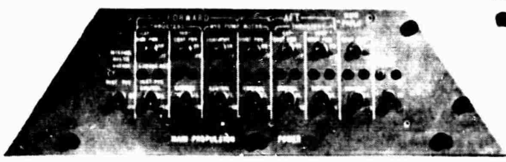


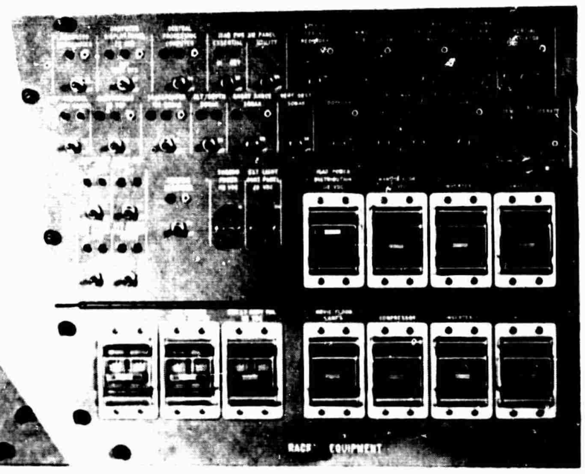
Figure No. 9.1 Main Power Monitor Panel

9.1.2 Power Switching Panels

All primary and secondary power circuit breakers and switches for both the Vehicles and S&C subsystems are



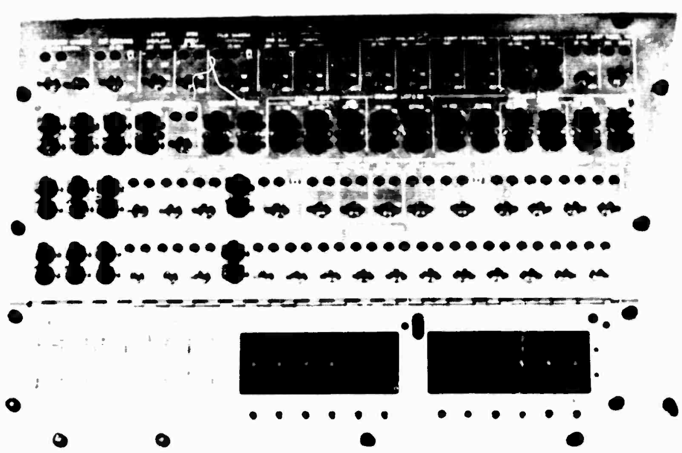
MAIN PROPULSION POWER PANEL



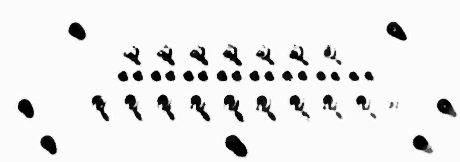
RACK EQUIPMENT POWER SWITCHING PANEL

STARBOARD

[redacted]



CONTROL AND DISPLAY POWER SWITCHING PANEL



PRIMARY POWER PANEL

PORT

Figure No. 9.2 Power Switching Panels

located on the four Power Switching Control panels above each of the side racks. The panels are shown in Figure No. 9.2 and are as follows:

a. Vehicle Primary Power Panel (mounted above the port forward rack) primary power switches and test points. The Vehicle Power Panel weighs 8.0 lbs.

b. Main Propulsion Power Panel (mounted above the starboard forward rack): main propulsion power switches and test points. The Main Propulsion Power Panel weighs 8.5 lbs.

c. Rack Equipment Power Switching Panel (mounted above the starboard aft rack): primary power circuit breakers (all but three), power on switches for the equipments in the side racks, the Sound Velocimeter, the Ship Control Electronics and the Inertial Navigator Set. Primary Inertial Navigator moding is also accomplished by a panel switch. The Rack Equipment Power Switch Panel weighs 63.0 lbs.

d. Control and Display Power Switching Panel (mounted above port aft rack): additional primary power circuit breakers, power on switches, fuses and test points for ICAD front panel. The Control and Display Power Switching Panel weighs 74.5 lbs.

The emergency bus transfer control is located on the Control and Display Power Switching Panel. In the event of an emergency, the Alarm Power Supply, the UHF Radio Set and the Interior Communication Group are all transferred to emergency power by the emergency bus transfer switch.

9.2 EMERGENCY JETTISON

The emergency jettison controls are located on the forward sloping control desk, as shown in Figure No. 9.3, and consist of switches to:

a. Cut haul down cable by pyrotechnic means

b. Cut anchor cables by pyrotechnic means.

c. Activate mercury jettison and mercury jettison pump by pyrotechnic or gravitational means.

d. Jettison the pan and tilt heads by pyrotechnic means.

e. Disengage a locking mechanism, disengage fluid or electrical passages; forcibly eject the manipulator arm or terminal end device for a distance which completely clears it from the vehicle. The Emergency Jettison Panel weighs 9.0 lbs.

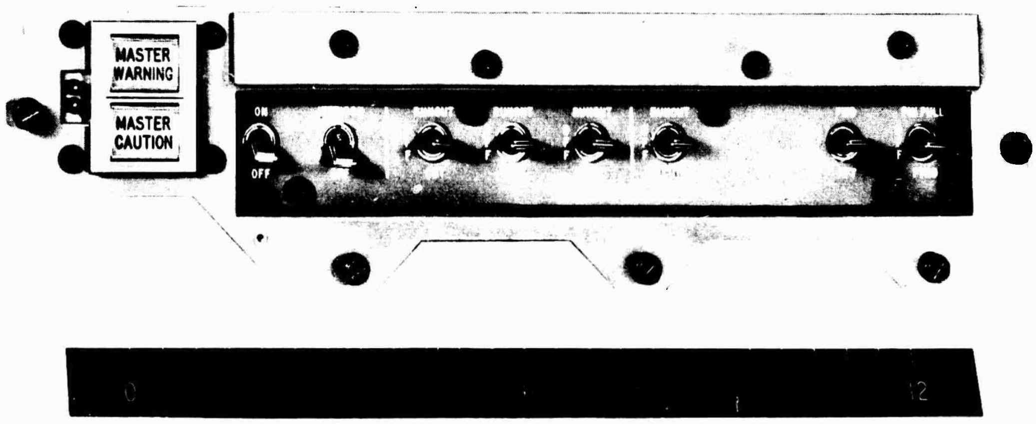


Figure No. 9.3 Emergency Jettison Panel

9.3 LIFE SUPPORT

The Life Support System displays consist of meters monitoring control, mid and aft sphere cabin pressures, O_2 partial pressures, and CO_2 partial pressures. Controls are provided to select the desired sphere information to be displayed. The Life Support System displays and controls are located on the Life Support Panel and are shown in Figure No. 9.4. The Control Sphere temperature controls consist of a cabin blower selector switch and a heater ON-OFF switch. These controls are also located on the Life Support Panel.

9.4 EQUIPMENT COOLING

The Equipment Cooling controls and display are located on the top left portion of the Life Support Panel, as

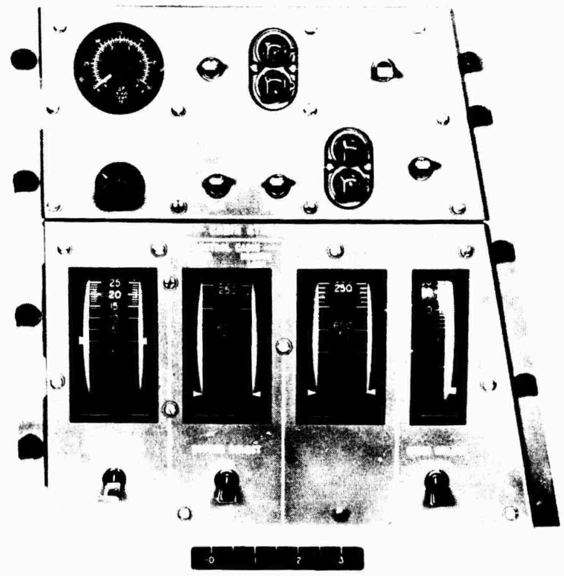


Figure No. 9.4 Life Support Panel

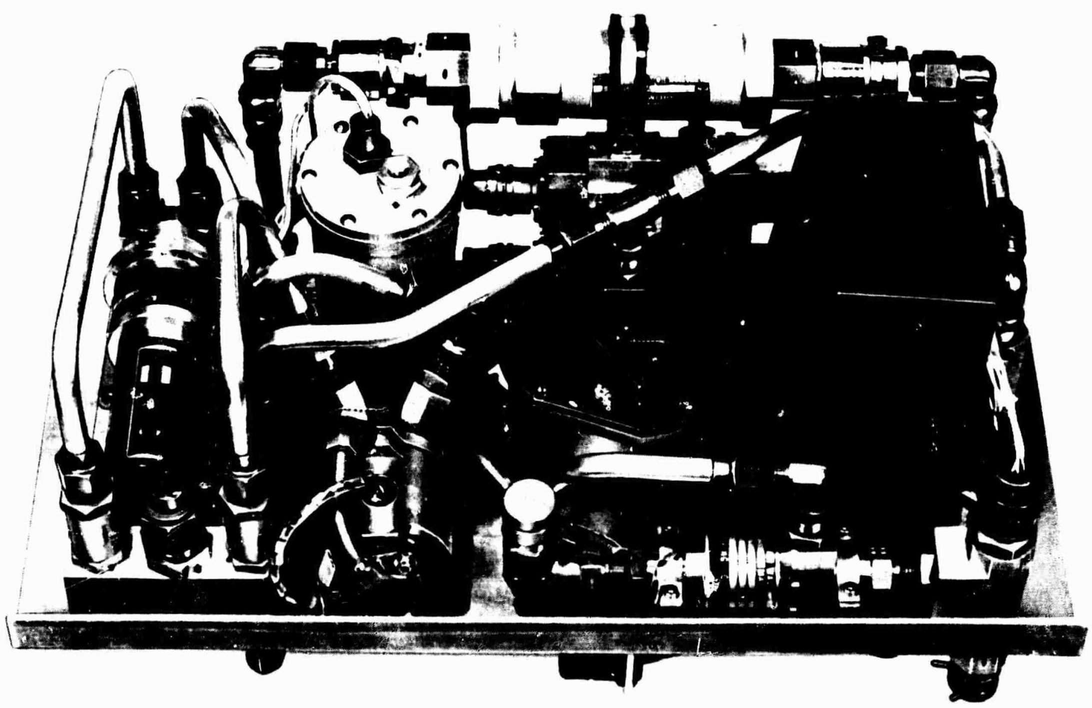


Figure No. 9.5 Liquid Coolant Unit

shown in Figure No. 9.4. The display on this panel consists of a double scale meter showing pressure differential and temperature. The pressure differential or temperature displayed on this panel is controlled by a 5-position Temperature/ P selector switch located directly beneath the display. Two of the five switch positions select pressure differentials for display; one of these positions selects the pressure drop across the STBD blower, the other selects the drop across the PORT blower. The remaining three positions select temperature for display. The temperatures displayed are; the temperature of the cooling air at input duct of the PORT rack, the air temperature at the input duct of the STBD rack, and the temperature of the exhaust air after having cooled the equipment. The rest of the panel consists of controls for the liquid cooling. These controls consist of an EMER-GLYCOL PUMP ON-OFF switch, a PUMP MODE selector switch and a LOOP MODE selector switch. The Liquid Coolant unit is shown in Figure No. 9.5. The Liquid Coolant Group, which includes, in addition to the unit pictured, various temperature sensors, heat exchangers and tubing, weighs 78.5 lbs.

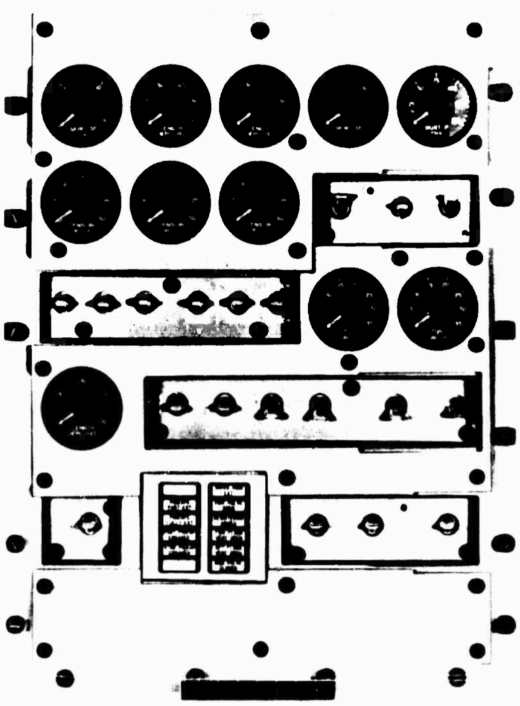


Figure No. 9.6 Hating Controls Panel

9.5 MATING

The Mating Controls Panel is shown in Figure No. 9.6 and contains the following function controls and displays:

a. Shock Mitigation: the position of the skirt shock mitigation system is controlled by a switch and monitored by a status light on the panel.

b. Anchor: The cable length deployed, as well as the tension in the cable, are displayed on meters. The controls consist of switches to operate winches and energize anchor magnets. The status of the magnets is monitored by lights.

c. Haul Down Winch: The haul down winch is controlled by switches which operate the winch and hook release. The length of the deployed cable is displayed on a meter.

d. Skirt De-watering: DC voltmeters monitor the Forward and Aft Tank water weights, the Skirt P (pressure differential between the skirt and the ambient sea), and the absolute Skirt Pressure. This information is also available from the computer Numeric display for greater resoltuion. Lights monitor uncontrolled flood conditions, tank shut-off, pump, and hydraulic valve status. The pumps and hydraulic valves are controlled by switches.

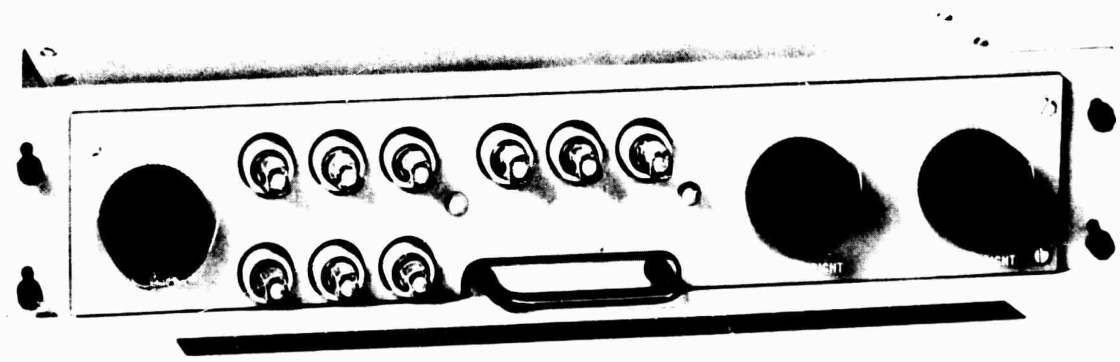


Figure No. 9.7 Control and Display Lighting Control Panel

e. ASR Recovery: The ASR Recovery System controls consist of a switch to extend, retract, or turn off the pickups. The displays consist of alarm lights indicating the position of the pickups. The Mating Controls Panel weighs 21.5 lbs.

9.6 ICAD LIGHTING

The Control and Display Lighting Control Panel controls the illumination level of the ICAD panels. This panel is shown in Figure No. 9.7. The ICAD Lighting Controls Panel weighs 9.0 lbs.

9.7 SENSOR PROTECTION PANEL

The Sensor Protection Panel provides individual fuse protection for the external sensors, which require grounding. This panel is shown in Figure No. 9.8. The Sensor Protection Panel weighs 10.0 lbs.

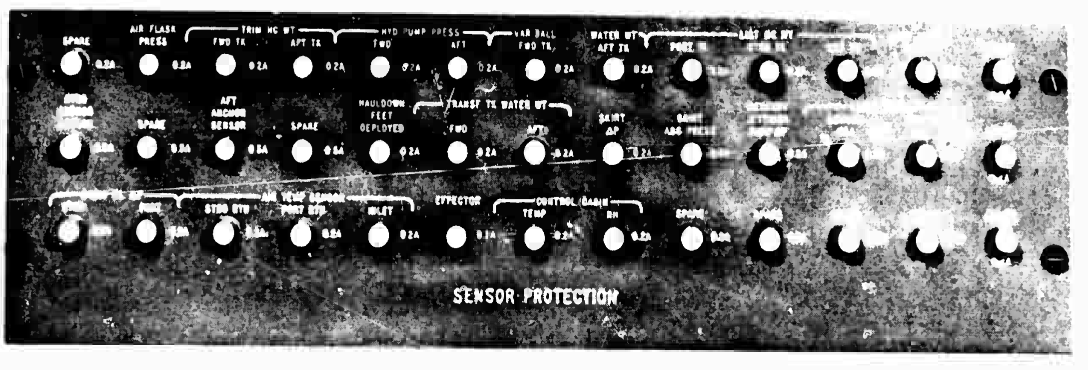


Figure No. 9.8 Sensor Protection Panel

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE

FORMAL	INFORMAL	ABBREVIATION
OPTICS EQUIPMENT		
Television Set	Television Set	TV SET
Camera, Television, Wide Angle, Bow	Bow Television Camera	BOW TV
Camera, Television, Wide Angle, Mating Skirt	Skirt Television Camera	SKT TV
Camera, Television, Zoom, Pan & Tilt	Zoom Television Camera	ZM TV
Camera, Television, Right Angle, Topside Pan	Right Angle Television Camera	RA TV
Monitor, Television Set & Control-Indicator, Pan (& Tilt)	TV Monitor	TV MON
Generator, Electronic Marker	Special Effects Unit	SEU
Relay Assembly, Television Camera	TV Camera Select Unit	TV SEL
Panel, Power Distribution, Heaters, Pan TV Camera and Control-Indicator, Pan & Tilt Group	Optics Override Switching Panel	OPT OVRD PNL
Camera Set, Still Picture, 35mm	35mm Still Camera Set	35mm STILL CAMR SET
Camera, Still Picture	Still Camera	STILL CAMR
Lamp, Flash Tube	Strobe Lamp Head	STROBE LMPHD
Power Supply, Flash Tube	Strobe Electronics	STROBE ELEX
Control-Indicator, Cameras, Still & Motion Picture	Film Camera Control Panel	FILM CAMR CONT
Optics Set, Viewport, Control Sphere, Forward	Control Sphere Forward Viewport Optics	CS FWD VPO
Floodlight Set, Electric	External Floodlighting Set	EXT FLDLTG SET
Lamp, Mercury Vapor	Mercury Vapor Lamp	HG VPR LMP
Lamp, Incandescent, QI, Skirt	Skirt Lamp	SKT LMP
Lamp, Incandescent, QI, Trapeze	Trapeze Lamp	TRAP LMP
Ballast, Lamp, Mercury Vapor	Mercury Vapor Ballast	HG VPR BALL
Switch Assembly, Floodlight Set	External Floodlights Control Panel	LXT FLDLTS CONT PNL

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
OPTICS EQUIPMENT (CONT'D)		
Pan and Tilt Group	Pan & Tilt Group	P&T GR
Head, Pan and Tilt, Forward	Forward Pan & Tilt Head	FWD P&T HD
Head, Pan and Tilt, Aft	Aft Pan & Tilt Head	AFT P&T HD
Panel, Power Distribution, Heaters, Pan TV Camera and Control-Indicator, Pan & Tilt Group	Optics Override Switching Panel	OPT OVRD PNL
Control-Indicator, Extender, Pan (& Tilt) Heads	Pan & Tilt Extender Control Panel	P&T EXTNDR CONT
Monitor, Television Set & Control-Indicator, Pan (& Tilt)	TV Monitor	TV MON
SONAR EQUIPMENT		
Detecting-Ranging Set, Sonar, Vertical Obstacle (AN/BQS-16)	Vertical Obstacle Sonar	VOS
Transducer, Sonar, Vertical Obstacle	Vertical Obstacle Sonar Transducer	VOS XDCR
Receiver-Transmitter, Sonar, Vertical Obstacle	Vertical Obstacle Sonar Transceiver	VOS XCVR
Train Mechanism, Sonar, Vertical Obstacle	Vertical Obstacle Sonar Train Mechanism	VOS TN MECH
Monitor, Sonar	Sonar Monitor	SNR MON
Control-Indicator, Sonar, Train Mechanism, Vertical Obstacle	Vertical Obstacle Sonar Train Control Panel	VOS TN CONT PNL
Detecting-Ranging Set, Sonar, Horizontal Obstacle (AN/BQS-18)	Horizontal Obstacle Sonar	HOS
Converter Group, Signal Data, Horizontal Obstacle (OU-52/BQS-18)	Horizontal Obstacle Sonar Analyzer	HOS ANAL

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
SONAR EQUIPMENT (CONT'D)		
Receiver-Transmitter, Sonar, Horizontal Obstacle (RT-952/BQS-18)	Horizontal Obstacle Sonar Transceiver	HOS XCVR
Projector, Sonar, Horizontal Obstacle (TR-246/BQS-18)	Horizontal Obstacle Sonar Projector	HOS PROJ
Hydrophone, Sonar, Horizontal Obstacle (DT-366/BQS-18)	Horizontal Obstacle Sonar Hydrophone	HOS HYD
Train Mechanism, Sonar, Horizontal Obstacle	Horizontal Obstacle Sonar Train Mechanism	HOS TN MECH
Monitor, Sonar	Sonar Monitor	SNR MON
Transducer, Sonar, Horizontal Obstacle (TR-247/BQS-18))	Horizontal Obstacle Sonar Transducer	HOS XDCR
<u>Sounding Set, Sonar, Altitude/Depth</u> (AN/BQN-10)	<u>Altitude/Depth Sonar</u>	<u>ADS</u>
Receiver-Transmitter, Sonar, Altitude/Depth	Altitude/Depth Transceiver	AD XCVR
Transducer, Sonar, Altitude/Depth	Altitude/Depth Transducer	AD XDCR
Control, Recorder Altitude/Depth	Graphic Recorder Electronics	GR ELEX
Recorder, Range Altitude/Depth	Graphic Recorder	GR
<u>Detecting-Ranging Set, Sonar, Short Range</u> (AN/BQS-17)	<u>Short Range Sonar</u>	<u>SRS</u>
Receiver-Transmitter, Sonar, Short Range	Short Range Sonar Transceiver	SRS XCVR
Transducer, Sonar, Short Range	Short Range Sonar Transducer	SRS XDCR
Monitor, Sonar	Sonar Monitor	SNR MON
<u>Interrogator Set, Sonar</u> (AN/BQN-9)	<u>Transponder Interrogation Sonar</u>	<u>TIS</u>
Receiver-Transmitter, Sonar, Interrogator (RT-936/BQN-9)	Transponder Interrogation Sonar Transceiver	TIS XCVR
Transducer, Sonar, Interrogator (TR-240/BQN-9)	Transponder Interrogation Sonar Transducer	TIS XDCR

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
SONAR EQUIPMENT (CONT'D)		
Generator, Electronic Marker	Special Effects Unit	SEU
Junction Box, Sonar	Sonar Junction Box	SNR JB
Timer Sequential-Switch Assembly, Sonar	Timing Coordinator	TC
NAVIGATION EQUIPMENT		
Inertial Navigator Group	Inertial Navigator	IN
Stable Platform Assembly, Inertial Navigator	Inertial Navigator Binnacle	IN BINN
Control Electronics, Inertial Navigator	Inertial Navigator Control Electronics	IN ELEX
Gyroscope Assembly Group	Gyro Shelf Assembly	GYRO SHELF ASSY
Gyroscope, Directional	Directional Gyro	DG
Gyroscope, Vertical	Vertical Gyro	VG
Gyroscope Assembly, Rate	Rate Gyro Assembly	RG
Transformer, Gyroscope	Gyro Transformer	GYRO XFMR
Tracer, Dead Reckoning	Navigation Data Plotter	NAV PLOTTER
Measuring Unit, Sound Velocity	Sound Velocimeter	SV
Absolute Velocity Log, Sonar, Doppler	Doppler Sonar	DOPPLER
Receiver-Transmitter, Sonar, Doppler	Doppler Transceiver	DOPPLER XCVR
Transducer Assembly, Sonar, Doppler	Doppler Transducer Assembly	DOPPLER XDCR

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
COMMUNICATION EQUIPMENT		
Receiving Set, Sonar, Directional Listening (AN/BQR-18)	Directional Listening Hydrophone Set	DLH SET
Receiver, Sonar	Directional Listening Hydrophone Electronics	DLH ELEX
Hydrophone, Sonar	Directional Listening Hydrophone	DLH
Control, Receiver	Directional Listening Hydrophone Remote	DLH RMTE
Communication Set, Sonar (AN/BQC-3)	Underwater Telephone	UWT
Receiver-Transmitter, Sonar, Communication	Underwater Telephone Electronics	UWT ELEX
Transducer, Sonar, Upward	Top Underwater Telephone Transducer	TOP UWT XDCR
Transducer, Sonar, Downward	Bottom Underwater Telephone Transducer	BOT UWT XDCR
Control, Communication Set	Underwater Telephone Remote	UWT RMTE
Radio Set	UHF Radio	UHF RAD
Receiver-Transmitter, Radio	UHF Electronics	UHF ELEX
Antenna	UHF Antenna	UHF ANT
Control, Radio Set	UHF Remote	UHF RMTE
Recorder-Reproducer Set, Signal Data	Speech and Data Recorder Set	SDR SET
Recorder-Reporducer, Signal Data	Speech and Data Recorder	SDR
Tape, Sound Recording, Magnetic	Magnetic Tape	MAG TAPE
Intercommunication Set	Interior Communications Set	IC SET
Intercommunication Station	Interior Communication Controls	IC
Intercommunication Station, Control Sphere	Control Sphere Interior Communication Controls	CS/IC
Switch, Foot, Communication	Foot Switch	FT SW
Microphone, Dynamic, Hand Held	Hand-Held Mike	MIKE
Holder, Microphone	Hand-Held Mike Mount	MIKE MT
Headset-Microphone	Headset	HD SET
Headset-Microphone, Control Sphere	Control Sphere Headset	CS HD SET

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
COMMUNICATION EQUIPMENT (CONT'D)		
Panel,Key, Telegraph	CW Key Panel	CW KEY PNL
Bin, Storage, Magnetic Tape	Magnetic Tape Storage Bin	MAG TAPE STOR
SPECIAL DEVICES EQUIPMENT		
Target, Sonar	Hatch Marker	HMKR
Radiacmeter (IM-195/PDR-27Q)	Radiacmeter	RADMTR
Transponder Set, Sonar, Homing (AN/BQN-8)	Homing Transponder Set	HT SET
Release Assembly, Transponder, Homing (MX-8236/BQN-8)	Homing Transponder Release Assembly	HTRA
Test Set, Transponder, Homing (TS-2754/BQN-8)	Homing Transponder Test Set	HTT SET
Transponder Set, Sonar, Tracking (AN/BQN-7)	Tracking Transponder Set	TT
Receiver-Transmitter, Sonar, Tracking (RT-935/BQN-7)	Tracking Transponder Transceiver	TT XCVR
Transducer, Sonar, Tracking (TR-239/BQN-7)	Tracking Transponder Transducer	TT XDCR
Transducer, Pressure, Skirt	Skirt Pressure Transducer	SKT PRESS XDCR
Transducer, Pressure, Depth	Depth Pressure Transducer	DEPTH PRESS XDCR

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
DATA PROCESSING EQUIPMENT		
Computer Set, Signal Data Generator	Central Processing Computer Set	CPC SET
Computer, Signal Data Generator	Central Processing Computer	CPC
Recorder-Reproducer, Signal Data	Computer Recorder-Reproducer	CRR
Tape, Electronic Data Processing, Programmed	Computer Program Tape	CPC TAPE
Control-Indicator, Computer	Central Processing Computer Control and Display Panel	CPC C&D PNL
Computer Group, Stabilization Data	Ship Control Computer Group	SC CMPTR GR
Computer, Stabilization Data, Digital	Auto Pilot/Digital Differential Analyzer	AP/DDA
Computer, Stabilization Data, Analog	Ship Control Electronics	SCE
Bin, Storage, Magnetic Tape	Magnetic Tape Storage Bin	MAG TAPE STOR
INTEGRATED CONTROL AND DISPLAY EQUIPMENT		
Ship Control Group	Ship Control Group	SC GR
Panel, Control-Indicator, Tanks, Ballast, Trim & List	Ship Control Panel	SC PNL
Panel, Emergency Ship Control	Emergency Ship Control Panel	EMERG SC PNL
Controller, Hand, Translational	Translational Hand Controller	TRANS CONTLR
Controller, Hand, Rotational	Rotational Hand Controller	ROT CONTLR
Control-Indicator, Mode, Ship Control	Ship Control Mode Panel	SC MODE PNL
Indicator, Multiple, State Display	State Display Panel	ST DSPLY PNL
Panel, Shroud Angle Meter	Shroud Angle Meter Panel	SHRD ANGLE PNL

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
INTEGRATED CONTROL AND DISPLAY EQUIPMENT (CONT'D)		
Power Distribution Group	Power Switching Group	PWR SW GR
Panel, Control-Indicator, Emergency Jettison	Emergency Jettison Panel	EMERG JTSN PNL
Panel, Monitor, Main Power	Main Power Monitor Panel	MN PWR MON PNL
Panel, Power Distribution, Control-Indicators	Control and Display Power Switching Panel	C&D PWR SW PNL
Panel, Power Distribution, Primary, Vehicle	Primary Power Panel	PRIM PWR PNL
Panel, Power Distribution, Main Propulsion	Main Propulsion Power Panel	MN PRPLN PWR PNL
Panel, Power Distribution, Racks	Rack Equipment Power Switching Panel	RK PWR PNL
Power Supply, Control-Indicators	Control and Display Power Supply	C&D PWR SUP
Junctions, Grounding	Ground Point Junctions	GRD PT JCTS
Panel, Protection, Sensor	Sensor Protection Panel	SNSR PR
Cable Assemblies, Interconnecting	Wiring Harnesses	WHARNS
Coolant Group, Liquid	Liquid Coolant Group	LIQ COOL CP
Coolant Unit, Liquid	Liquid Coolant Unit	LIQ COOL UNIT
Heat Exchanger, Hull	Hull Heat Exchanger	HULL HEAT EX
Heat Sink, Core Memory Unit	Auxilliary Memory Coldplate	AUX MEM CPLATE
Transducer, Temperature, T-1, T-2 or T-5	T-1, T-2 or T-5 Temperature Transducer	T-1,2,5 TEMP XDCR
Transducer, Temperature, T-3 or T-7	T-3 or T-7 Temperature Transducer	T-3,7 TEMP XDCR
Transducer, Temperature, T-4 or T-6	T-4 or T-6 Temperature Transducer	T-4,6 TEMP XDCR
Tube, Bent, Aluminum Alloy (13 pcs.)	Aluminum Alloy Tubing (13 pcs.)	AL TUBING (13 pcs.)
Hose assembly, Nonmetalic (21 pcs.)	Nonmetalic Hose Assembly (21 pcs.)	NONMET HOSE ASSY
Manifold, Fluid, T1	T1 Manifold	T1 MANF
Manifold, Fluid, T7	T7 Manifold	T7 MANF
Manifold, Fluid, Distribution	Distribution Manifold	DISTR MANF
Manifold, Fluid, Computer & Core Memory Unit	Computer & Auxilliary Memory Manifold	CPC & AUX MEM MANF

DSRV-1 SENSORS AND CONTROLS (S&C) SUBSYSTEM NOMENCLATURE (CONT'D)

FORMAL	INFORMAL	ABBREVIATION
INTEGRATED CONTROL AND DISPLAY EQUIPMENT (CONT'D)		
Panel, Control-Indicator, Environmental	Life Support Panel	LSPT PNL
Panel, Control-Indicator, Mating	Mating Controls Panel	MATING CONT PNL
Panel, Alarm	Alarm Panel	ALM PNL
Panel, Clock and Transponder Release	Clock and Transponder Release Panel	CLK/TR PNL
Panel, Lighting Control, Control-Indicators	Control and Display Lighting Control Panel	C&D LTG PNL
Power Supply, Lighting, AC	AC Lighting Power Supply	AC LTG PWR SUP
Power Supply, Lighting, DC	DC Lighting Power Supply	DC LTG PWR SUP
Relay Assembly, Mercury Jettison	Mercury Jettison Relay Assembly	HG JTSN RLY
Structures, Internal	Internal Structures	INT STRUCT
Panel, Fire Extinguisher & Ground Support Cooling, Port	Port Fire Extinguisher & Ground Support Cooling Panel	PT FE & GRD SPT COOL PNL
Panel, Fire Extinguisher & Ground Support Cooling, Starboard	Starboard Fire Extinguisher & Ground Support Cooling Panel	STBD FE & GRD SPT COOL PNL

DSRV-1 POWER CONTROL DATA FOR S&C EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS) MAX	RUN	MIN	NOTES
AUTO PILOT/DIGITAL DIFFERENTIAL ANALYZER	RACK	56VDC		90		
ALTITUDE/DEPTH TRANSCEIVER	RACK	+28VDC		21		
ALTITUDE/DEPTH TRANSDUCERS (2)						POWERED THROUGH TRANSCEIVER
CENTRAL GROUNDPOINT PACKAGE						NEGLIGIBLE POWER CONSUMED
CENTRAL PROCESSING COMPUTER	RACK	56VDC		300		
AUXILIARY MEMORY						POWERED THROUGH COMPUTER
CENTRAL PROCESSING COMPUTER CONTROL & DISPLAY PANEL	RACK	56VDC		133		
CONTROL & DISPLAY LIGHTING CONTROL PANEL	UTIL	115VAC	334	170	170	
LIGHTING POWER SUPPLY						POWERED THROUGH C&D LIGHTING PNL
TV MONITORS						BACKLIGHTING OF CRT SCREENS
SONAR MONITORS						BACKLIGHTING OF CRT SCREENS
RACK EQUIPMENT PANELS						EDGELIGHTING
CONTROL & DISPLAY PANELS						EDGELIGHTING
CONTROL & DISPLAY METERS						METER ILLUMINATION
CONTROL & DISPLAY POWER SUPPLY						
SENSOR EXCITATION	ICAD	56VDC		3		
SKIRT PRESSURE TRANSDUCER						S&C SENSOR EXCITATION
DEPTH PRESSURE TRANSDUCER						REQUIREMENTS ONLY
TV CONSTANT CURRENT SOURCE	ICAD	+56VDC		112		
SKIRT TV CAMERA						POWERED BY CONST CURRENT SOURCE
BOW TV CAMERA						POWERED BY CONST CURRENT SOURCE
RIGHT ANGLE TV CAMERA (FWD)						POWERED BY CONST CURRENT SOURCE
RIGHT ANGLE TV CAMERA (AFT)						POWERED BY CONST CURRENT SOURCE
ZOOM TV CAMERA (FWD)						POWERED BY CONST CURRENT SOURCE
ZOOM TV CAMERA (AFT)						POWERED BY CONST CURRENT SOURCE

DSRV-1 POWER CONTROL DATA FOR S&C EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS) MAX	RUN	MIN	NOTES
ALARM POWER SUPPLY	ICAD	+28VDC		14		
ALARM PANEL						POWERED BY ALARM POWER SUPPLY
CONTROL & DISPLAY POWER SWITCHING PANEL						CONSUMES NEGLIGIBLE POWER
CONTROL SPHERE COMMUNICATIONS CONTROLS	ICAD	+28VDC		105		
MID SPHERE INTERIOR COMMUNICATIONS CONTROLS						POWERED THROUGH C.S. COMMUN.CONT
AFT SPHERE INTERIOR COMMUNICATIONS CONTROLS						POWERED THROUGH C.S. COMMUN.CONT
FOOT SWITCHES (2)						CONSUMES NEGLIGIBLE POWER
HAND HELD MIKES (4)						CONSUMES NEGLIGIBLE POWER
HEADSETS (4)						CONSUMES NEGLIGIBLE POWER
CONTROL SPHERE FORWARD VIEWPORT OPTICS						CONSUMES NO POWER
CONTROL SPHERE AFT VIEWPORT OPTICS						CONSUMES NO POWER
MID SPHERE STARBOARD VIEWPORT OPTICS						CONSUMES NO POWER
DIRECTIONAL LISTENING HYDROPHONE ELECTRONICS	RACK	+28VDC		20		
DIRECTIONAL LISTENING HYDROPHONES (2)						CONSUMES NO POWER
DIRECTIONAL LISTENING HYDROPHONE REMOTE						POWERED THROUGH ELECTRONICS
DOPPLER TRANSCEIVER	RACK	+56VDC		85		
DOPPLER TRANSDUCER ASSEMBLY						POWERED THROUGH TRANSCEIVER
EMERGENCY JETTISON PANEL						CONSUMES NEGLIGIBLE POWER
EMERGENCY SHIP CONTROL PANEL						CONSUMES NEGLIGIBLE POWER

DSRV-1 POWER CONTROL DATA FOR S&C EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS)			NOTES
			MAX	RUN	MIN	
EXTERNAL FLOODLIGHT CONTROL PANEL						CONSUMES NEGLIGIBLE POWER
MERCURY VAPOR BALLAST (13)	FWD	+112VDC		4108		TOTAL FOR 13
MERCURY VAPOR LAMP (13)						POWERED THROUGH BALLAST
SKIRT LAMPS (2)	RACK	-28VDC		160		TOTAL FOR 2
TRAPEZE LAMPS (2)	RACK	-28VDC		160		TOTAL FOR 2
FILM CAMERA CONTROL PANEL	ICAD	+28VDC		40		
35MM STILL CAMERA	ICAD	-28VDC		20		
STROBE ELECTRONICS	ICAD	-28VDC	308	168		
STROBE LAMP HEAD						POWERED THROUGH ELECTFONICS
GRAPHIC RECORDER ELECTRONICS	RACK	+28VDC		108		
GRAPHIC RECORDER						POWERED THROUGH ELECTRONICS
HATCH MARKERS						NO POWER REQUIRED
HOMING TRANSPONDER RELEASE ASSEMBLY (PORT)	ICAD	+28VDC		75		IMPULSE
HOMING TRANSPONDER RELEASE ASSEMBLY (STBD)	ICAD	+28VDC		75		IMPULSE
HOMING TRANSPONDER (PORT)						SELF POWERED
HOMING TRANSPONDER (STBD)						SELF POWERED
HOMING TRANSPONDER TEST UNIT						SELF POWERED
CLOCK & TRANSPONDER RELEASE PANEL						NEGLIGIBLE POWER REQUIRED
HORIZONTAL OBSTACLE TRANSCEIVER	RACK	+28VDC		106		
	RACK	-28VDC		17		
HORIZONTAL OBSTACLE ANALYZER						POWERED THROUGH TRANSCEIVER
HORIZONTAL OBSTACLE HYDROPHONE						POWERED THROUGH TRANSCEIVER
HORIZONTAL OBSTACLE PROJECTOR						POWERED THROUGH TRANSCEIVER
HORIZONTAL OBSTACLE TRAIN MECHANISM	ESSEN	115VAC		162		

DSRV-I POWER CONTROL DATA FOR S&C EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS) MAX	RUN	MIN	NOTES
INERTIAL NAVIGATOR CONTROL ELECTRONICS	RACK RACK	+28VDC -28VDC		55 55		
INERTIAL NAVIGATOR BINNACLE						POWERED THROUGH ELECTRONICS
LIQUID COOLANT ASSEMBLY	ICAD ESSEN FWD	-28VDC 115VAC 112VDC		30 40 50		BACKUP
LIFE SUPPORT PANEL						NEGLIGIBLE POWER REQUIRED
MAIN POWER MONITOR PANEL						NEGLIGIBLE POWER REQUIRED
MAIN PROPULSION POWER PANEL						NEGLIGIBLE POWER REQUIRED
MATING CONTROLS PANEL						CONSUMES NEGLIGIBLE POWER
MERCURY JETTISON RELAY ASSEMBLY						CONSUMES NEGLIGIBLE POWER
NAVIGATIONAL DATA PLOTTER	UTIL	115VAC		110		
OPTICS OVERRIDE SWITCHING PANEL						CONSUMES NEGLIGIBLE POWER
PAN & TILT EXTENDER CONTROL PANEL						CONSUMES NEGLIGIBLE POWER
PAN TILT HEAD (FWD)	ESSEN	115VAC	400	350		
PAN & TILT HEAD (AFT)	UTIL	115VAC	400	350		
RACK EQUIPMENT POWER SWITCHING PANEL						CONSUMES NEGLIGIBLE POWER
RADIACMETER						SELF POWERED
SENSOR PROTECTION PANEL						CONSUMES NEGLIGIBLE POWER

DSRV-1 POWER CONTROL DATA FOR S&C EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS) MAX	RUN	MIN	NOTES
SHIP CONTROL ELECTRONICS	RACK	+28VDC		30		
	RACK	-28VDC		37		
ROTATIONAL HAND CONTROLLER						
TRANSLATIONAL HAND CONTROLLER						
DIRECTIONAL GYRO						PICKOFF EXCITATION POWER
RATE GYRO PACKAGE						PICKOFF EXCITATION POWER
VERTICAL GYRO						PICKOFF EXCITATION POWER
DIRECTIONAL GYRO	ESSEN	115VAC		30		WHEEL SUPPLY POWER
RATE GYRO PACKAGE	ESSEN	115VAC		20		WHEEL SUPPLY POWER
VERTICAL GYRO	ESSEN	115VAC		20		WHEEL SUPPLY POWER
SHIP CONTROL MODE PANEL						CONSUMES NEGLIGIBLE POWER
SHIP CONTROL PANEL						CONSUMES NEGLIGIBLE POWER
SHORT RANGE TRANSCEIVER	RACK	+28VDC		168		
	RACK	-28VDC		42		
SHORT RANGE TRANSDUCER ASSEMBLY						POWERED THROUGH TRANSCEIVER
SHROUD ANGLE METER PANEL						CONSUMES NEGLIGIBLE POWER
SONAR DISPLAY PANEL #1	ESSEN	115VAC		63		
SONAR DISPLAY PANEL #2	ESSEN	115VAC		63		
SONAR DISPLAY PANEL #3	UTIL	115VAC		63		
SONAR JUNCTION BOX						CONSUMES NEGLIGIBLE POWER
SOUND VELOCIMETER	ESSEN	115VAC		9		
SPECIAL EFFECTS UNIT	ESSEN	115VAC		85		
SPEECH & DATA RECORDER	RACK	-28VDC		40		
STATE DISPLAY PANEL	ESSEN	115VAC		150		
COMPUTER RECORDER REPRODUCER	RACK	-28VDC		15		

[illegible] POWER CONTROL DATA FOR SRC EQUIPMENTS

EQUIPMENT	BUS	VOLTAGE	POWER (WATTS) MAX	POWER (WATTS) RUN	POWER (WATTS) MIN	NOTES
TV CAMERA SELECT UNIT	ICAD	-28VDC		40		
TV MONITOR PANEL #1	ESSEN	115VAC		25		
TV MONITOR PANEL #2	UTIL	115VAC		25		
TV MONITOR PANEL #3	ESSEN	115VAC		25		
TV MONITOR PANEL #4	UTIL	115VAC		25		
TV LENS HEATERS	FWD	+112VDC		200		TOPSIDE PAN UNITS
TIMING COORDINATOR	RACK	+56VDC		35		
TRACKING TRANSPONDER TRANSCEIVER	ICAD	+28VDC		9		
TRACKING TRANSPONDER TRANSDUCER						POWERED THROUGH TRANSCEIVER
TRANSPONDER INTERROGATION TRANSCEIVER	RACK	+28VDC		10		
	RACK	-28VDC		3		
TRANSPONDER INTERROGATION TRANSDUCER						POWERED THROUGH TRANSCEIVER
UHF ELECTRONICS	ICAD	+28VDC	412	166	168	SURFACED OPERATION ONLY
UHF ANTENNA						POWERED THROUGH ELECTRONICS
UHF REMOTE						POWERED THROUGH ELECTRONICS
UNDERWATER TELEPHONE ELECTRONICS	ICAD	+28VDC	462	50	50	
TOP UNDERWATER TELEPHONE TRANSDUCER						POWERED THROUGH ELECTRONICS
BOTTOM UNDERWATER TELEPHONE TRANSDUCER						POWERED THROUGH ELECTRONICS
UNDERWATER TELEPHONE REMOTE						POWERED THROUGH ELECTRONICS
CW KEY PANEL						POWERED THROUGH ELECTRONICS
VERTICAL OBSTACLE TRANSCEIVER	RACK	+28VDC				
VERTICAL OBSTACLE TRANSDUCER						POWERED THROUGH TRANSCEIVER
VERTICAL OBSTACLE TRAIN MECHANISM	ESSEN	115VAC		110		
VOS TRAIN CONTROL PANEL						POWERED THROUGH TRAIN MECHANISM