NAVSEA 0905-LP-120-0010: TECHNICAL MANUAL FOR DSRV SYSTEM

NAVSEA 0905-LP-120-0010

Technical Manual
for
DSRV SYSTEM

PROPERTY OF THE
NAVAL UNDERSEA MUSEUM LIBRARY
KEYPORT, WA 98345

Declassified Statement A: Approved for Public Release; Distribution is unlimited.
2/4/2008 Patricia K. Dolan

DISTRIBUTION STATEMENT B: ~~DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; ADMINISTRATIVE/OPERATIONAL USE; DATE OF PUBLICATION. OTHER REQUESTS SHALL BE REFERRED TO THE NAVAL SEA SYSTEMS COMMAND (SEA-0982).~~

WARNING: ~~THIS DOCUMENT CONTAINS TECHNICAL DATA WHOSE EXPORT IS RESTRICTED BY THE ARMS EXPORT CONTROL ACT (TITLE 22, U.S.C. SEC. 2751 ET. SEQ.) OR EXECUTIVE ORDER 12470. VIOLATIONS OF THESE EXPORT LAWS ARE SUBJECT TO SEVERE CRIMINAL PENALTIES.~~

DESTRUCTION NOTICE: ~~DESTROY BY ANY METHOD THAT WILL PREVENT DISCLOSURE OF CONTENTS OR RECONSTRUCTION OF THE DOCUMENT.~~

**PUBLISHED BY DIRECTION OF,
COMMANDER, NAVAL SEA SYSTEMS COMMAND**

0905LP1200010

DATE OF ISSUE

TYPE OF ISSUE

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVE SE
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY TO:
5720/00DT
2008 - 0065
2/4/2008

Mr. William Galvani
Naval Undersea Museum
Navy Region Northwest
1103 Hunley Road
Silverdale WA 98315-1103

Dear Mr. Galvani:

Subj: TECHNICAL MANUAL FOR DSRV SYSTEM

Ref: Miscellaneous Others ltrNAVSEA 0905-LP-120-0010 of 1/4/2008

The attached material proposed for public release has been reviewed and is returned with the following response. Amendments may be indicated on the enclosure and reasons are attached.

Statement A: Approved for Public Release; Distribution is unlimited.

Rita M. Wilks
for PATRICIA K. DOLAN
Deputy Director, Office of
Corporate Communication

DEPARTMENT OF THE NAVY
NAVAL UNDERSEA MUSEUM
NAVY REGION NORTHWEST
1103 HUNLEY ROAD
SILVERDALE, WA 98315-1103

January 4, 2008

Naval Sea Systems Command
ATTN: Tamara Barbarin (SEA-00D1D)
1333 Isaac hull Avenue SE
Washington Navy Yard, DC 20376-0001

Dear Ms Barbarin:

The Naval Undersea Museum is requesting the evaluation of Technical Manual for DSRV System, NAVSEA 0905-LP-120-0010, for a Distribution Statement A classification. Enclosed please find the first 8 pages for your review. If you need the entire manual for review or have any questions, please call Mrs. Jennifer Heinzelman at 360-396-5806

Sincerely,

WILLIAM GALVANI
Director

Enclosures: 1. 8 pages from NAVSEA 0905-LP-120-0010

Technical Manual
for
DSRV SYSTEM

Declassified Statement A: Approved for Public Release; Distribution is unlimited. 2-4-2008 Patricia K. Dolan

DISTRIBUTION STATEMENT B: DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; ADMINISTRATIVE/OPERATIONAL USE; DATE OF PUBLICATION. OTHER REQUESTS SHALL BE REFERRED TO THE NAVAL SEA SYSTEMS COMMAND (SEA-0982).

WARNING: THIS DOCUMENT CONTAINS TECHNICAL DATA WHOSE EXPORT IS RESTRICTED BY THE ARMS EXPORT CONTROL ACT (TITLE 22, U.S.C. SEC. 2751 ET. SEQ.) OR EXECUTIVE ORDER 12470. VIOLATIONS OF THESE EXPORT LAWS ARE SUBJECT TO SEVERE CRIMINAL PENALTIES.

DESTRUCTION NOTICE: DESTROY BY ANY METHOD THAT WILL PREVENT DISCLOSURE OF CONTENTS OR RECONSTRUCTION OF THE DOCUMENT.

PUBLISHED BY DIRECTION OF,
COMMANDER, NAVAL SEA SYSTEMS COMMAND

PUBLICATION: 11 MARCH 1975

LIST OF EFFECTIVE PAGES

Page Numbers	Change in Effect	Page Numbers	Change in Effect
Title Page	Original	2-1 to 2-22	Original
ii to iii	Original	3-1 to 3-27	Original
v to ix	Original	4-1 to 4-24	Original
1-1 to 1-2	Original	5-1 to 5-16	Original
1-3	Original	6-1 to 6-11	Original
1-5 to 1-7	Original	7-1	Original
1-9	Original	I-1 to I-4	Original

APPROVAL AND PROCUREMENT RECORD

APPROVAL DATA FOR: NAVSHIPS 0905-120-0010

APPROVAL AUTHORITY: PMS 395

Contract or Purchase Order	Ships Applicable	Quantity of Manuals	Quantity of Equipment	Building Yard
N00024-74-A-1007	DSRV-1 DSRV-2	50	N/A	Lockheed

REMARKS:

DATE ________________

CERTIFICATION: It is hereby certified that NAVSHIPS 0905-120-0010 to be provided under contract or purchase order N00024-74-A-1007 has been approved by the approval data shown above.

Robert A Tyrrell

R. A. Tyrrell, DSRV Program Manager
Lockheed Missiles & Space Co., Inc.
1111 Lockheed Way,
Sunnyvale, Ca 94088
17077

VALIDATION PERFORMANCE

Title of Publication
Technical Manual for

DSRV SYSTEM

NAVSHIPS Number
0905-120-0010

Contractor:

Lockheed Missiles & Space Company, Inc.

Subcontractor (if performing validation):

Contract No(s) and Purchase Orders, if applicable

N00024-74-A-1007

Chapter	Section	Paragraph	Date Validation Completed	Check Here If Not Validated
	1		N/A	X
	2		N/A	X
	3		N/A	X
	4		N/A	X
	5		N/A	X
	6		N/A	X

Name and Authority of Validating Officer:
R. A. Tyrrell
Manager, DSRV Program

Signature of Validating Officer: Robert A Tyrrell

RECORD OF CHANGES

CHANGE NO.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY

CONTENTS

ILLUSTRATIONS

Section 1
INTRODUCTION

1-1. SCOPE.

1-2. This manual is intended to familiarize Navy personnel with the capabilities and operating characteristics of the Deep Submergence Rescue Vehicle (DSRV), a major component in the quick-reaction, worldwide Submarine Rescue System developed by the Deep Submergence Systems Project (DSSP) Office. The detail included has been limited to system and major subsystem descriptions, together with an explanation of their interfaces and interrelationships. Such a treatment will provide personnel responsible for operating and maintaining the DSRV with a basic system overview that can be expanded to any required level of detail by consulting other manuals in this series. Throughout this manual, special emphasis is placed on the integrated characteristics of the total DSRV System. This document is effective upon receipt. Extracts may be used to facilitate preparation of other Department of Defense publications.

1-3. DEEP SUBMERGENCE RESCUE SYSTEM (FIG. 1-1).

1-4. The Deep Submergence Rescue System provides a quick-response, worldwide capability for rescuing crew members from a fleet submarine that is disabled and bottomed at less than its collapse depth. To accomplish this, a small, highly maneuverable submersible – the DSRV – is used to transfer trapped personnel from the disabled submarine to a support vessel. To reach the vicinity of the disabled submarine, the DSRV is transported from its home port in the United States by any required combination of the following methods:

- Overland by truck-tractor/semitrailer (Land Transport Vehicle)
- Airlift by cargo aircraft (C-141A)
- Aboard a surface vessel – Submarine Rescue Ship (ASR) or ship of opportunity
- Piggyback on a mother submarine surfaced or submerged

1-5. The pattern of deployment of any rescue mission is determined principally by the location of the disabled submarine, although such factors as weather conditions and availability of support vessels must be considered. A disabled submarine that could be reached more quickly by direct dispatch of a DSRV from its home port would indicate use of sea transport rather than airlift. Under normal conditions, the DSRV is placed aboard a support vessel – either on the deck of an ASR or mounted piggyback on a mother submarine – and transported directly to the disaster site. Under abnormal conditions, where an ASR or mother submarine is not available, the DSRV and its support system can be either carried onboard a ship of opportunity or the DSRV can be towed by a ship of opportunity with the support equipment aboard. On the other hand, should the disabled submarine be located far from the DSRV home port, air transportation to the designated remote launch port is required. From this launch port, the DSRV is carried to the disaster site by one of the support ships mentioned above.

1-6. Once in the vicinity of the disabled submarine, the DSRV is launched from the support vessel and assumes its assigned mission role – that of a transfer vehicle which can mate, by means of a sealable skirt, with the forward or after escape hatch on the submarine and evacuate trapped crew members, and that of an underwater shuttle designed to carry as many as 24 rescuees on each return trip to the support vessel. During rescue operations, the support vessel (surface or submarine) will supply all services required by the DSRV: recharging main batteries, refilling high-pressure air flasks, refilling rescuee ballast tanks, replenishing life support systems, supplying decompression facilities and medical attention for rescuees, etc.

1-7. <u>SUBMARINE RESCUE SYSTEM ORGANIZATION (FIG. 1-2)</u>.

1-8. The principal component of the Submarine Rescue System is the DSRV, together with its 16-man operating and maintenance crew, land transport vehicle, support van, and mission equipment, supplies, and spares. These items and the crew, taken collectively, are termed a DSRV System. In accomplishing a rescue mission, the following elements are needed in addition to the DSRV System:

- Operational Ships (required for DSRV water transport and for mission support during rescue)
- Air Transport (required when a DSRV System has to be airlifted to a remote port)

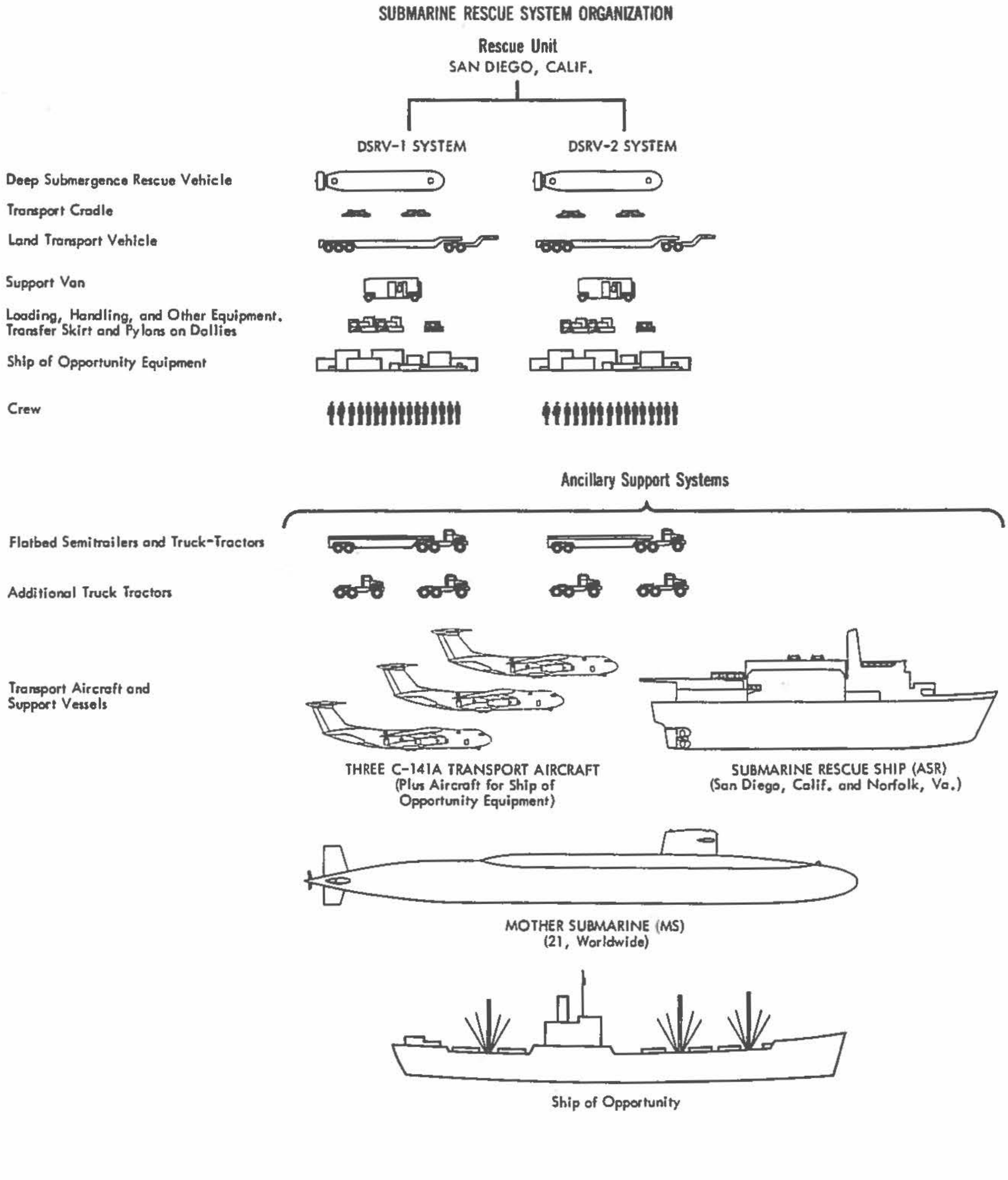

Fig. 1-2 Submarine Rescue System Organization

- On-Scene Commander (to direct rescue operations)
- Land Transport (trailers and truck-tractors)

1-9. DSRV SYSTEMS. Two complete DSRV Systems, as described above, make up the Submarine Rescue Unit. The rescue unit is permanently based at North Island, San Diego, with a second ASR located at Norfolk, Virginia. During routine operations, one of the DSRV Systems in the unit is maintained on an alert basis, while the other is engaged in maintenance, training, or on a secondary mission. The standby DSRV and its mission equipment are kept in a planned state of readiness that permits timely deployment from the rescue unit home port to match the availability of other elements of the system – i.e., C-141A aircraft and support ships. On an actual rescue mission, the two complete DSRV Systems are deployed to the disaster site. They can be used in leap-frog fashion between the disabled submarine and support vessels or one can be retained on a backup basis. A single ASR can support both DSRVs, but two mother submarines will be required if they are used in support. Ship of opportunity support will depend on the availability of such ships at the nearest disaster port at the time of the mission.

1-10. AIR TRANSPORT. When a rescue operation must be staged from a point other than the rescue unit's home port (RUHP), responsibilility for transport to the designated port rests with the USAF Military Airlift Command. Three C-141A cargo aircraft are required to carry all the elements of one DSRV System to an airfield near the remote launch port. Two additional C-141 aircraft are needed in case the interim rescue equipment is required to support a mission. One of these added aircraft is required for the interim rescue system equipment, the second for the Air Force K loader.

1-11. OPERATIONAL SHIPS. During mission deployment, the DSRV Systems are transported from the rescue port (home or remote) to the vicinity of the disabled submarine by either a specially equipped nuclear-powered mother submarine or an ASR (a 251-foot catamaran specifically designed to support DSRV operations), or a ship of opportunity with DSRV carried on deck or towed astern. The particular vessel selected for support is determined by its availability in or near the disaster area, or by some special environment condition; e.g., a rescue under ice would make mandatory the use of a mother submarine. During rescue, the DSRV operates from the support vessel selected.

1-12. ON-SCENE COMMANDER. Submarine rescue operations are the responsibility of the Submarine Operating Authority exercising control over the disabled submarine. This Commander becomes the officer-in-charge of Submarine Search and Rescue whenever the situation requires. In addition, he assumes the responsibilities of the On-Scene Commander upon reaching the disaster scene. Depending on circumstances, the Submarine Force Commander may assume one or more of these roles, or he may delegate his authority to the Submarine Area Commander for such a mission.

1-13. RESCUE MISSION PHASES (FIG. 1-3).

1-14. A mission of the Submarine Rescue System is typically divided into five discrete phases:

- Alarm
- Response
- Localization
- Initial Rendezvous and Mating
- Rescue

1-15. ALARM. The initial phase of the rescue mission begins when it is determined that a missing submarine is bottomed at less than collapse depth and ends when a decision is made to deploy the DSRV Systems.

1-16. RESPONSE. This phase begins with preparations to dispatch the DSRV Systems and ends when one DSRV and its support ship arrive at the disaster site.

1-17. LOCALIZATION. This phase begins with the arrival of the DSRV and the support ship at the disaster site; it ends when the DSRV has submerged and maneuvered to within visible range of the disabled submarine.

1-18. INITIAL RENDEZVOUS AND MATING. This phase begins when a DSRV has maneuvered to within visible range of the disabled submarine and ends with the first mating to the submarine.

1-19. RESCUE. The final phase of the mission begins with the first mating and ends when the DSRV has returned to the support ship with the last of the rescuees.

Section 2
THE DSRV SYSTEM

2-1. GENERAL.

2-2. The Navy's worldwide Submarine Rescue System has developed as one of its principal components the Deep Submergence Rescue Vehicle (DSRV), a small, transportable submersible designed to remove crew members trapped in a disabled submarine. Capable of operating below the collapse depth of any current fleet submarine, the DSRV can attach itself to either hatch of the disabled submarine, remove the trapped crew members, and transport and transfer them to an assisting support vessel. The high maneuverability that allows the DSRV to maintain list and trim attitudes up to 45 degrees while hovering or moving at extremely slow speeds along a linear axis gives it a special capability for navigating near and attaching itself to a disabled submarine. Movement or translation can be along any of the three linear axes of motion (fore/aft, port/starboard, or up/down), while maintaining any required vehicle heading (azimuth) and list/trim attitudes.

2-3. The vehicle's pressure capsule is designed to accommodate and support, in addition to its own three- or four-man operating crew, as many as 24 rescuees on each return trip to the support ship. Its power and life support subsystems can satisfy all requirements for one typical round trip between disabled submarine and support vessel. Replenishment from the support ship provides capability for additional trips. Its sensors, displays, and navigation aids provide a constantly updated picture of conditions and objects near the vehicle; of the spatial position of the vehicle itself relative to ocean bottom and surface, support ship, and disabled submarine; and of all conditions prevailing in subsystems aboard the DSRV. Its dimensions and weight allow speedy rescue mission deployment by a variety of methods – airlifted by a C-141A cargo aircraft, carried piggyback by a modified nuclear-powered fleet submarine,* transported on the deck of an ASR, transported on board a ship of opportunity, or towed by a ship of opportunity.

2-4. The principal systems of the DSRV itself, its support equipment subsystems, and the ancillary support systems are described briefly in the following paragraphs from a standpoint of performance and interrelationships. More detailed descriptions in terms of physical characteristics and functions are included in Sections 3, 4, 5, and 6. Elements considered in this section are the following:

- VEHICLE SUBSYSTEM (Section 3)
  Structure
  Propulsion and Maneuvering
  Power
  Ballast
  Life Support
  Mating
  Support Vessel Interfaces
- SENSORS AND CONTROL SUBSYSTEM (Section 4)
  Optics
  Navigation
  Sonars
  Communications
  Computers
  Vehicle System Operating Indicators
  Ship Control and Displays
- SUPPORT SUBSYSTEM (Section 5)
  Ground Transport
  Aircraft Loading and Transport
  Shipboard Loading and Handling
  Checkout and Servicing

*In accordance with an initial system requirement, the modifications for support of the DSRV do not reduce the nuclear submarine's military capabilities or jeopardize its safety.

- ANCILLARY SUPPORT SYSTEMS (Section 6)
  - Aircraft
  - Support Vessels
  - Truck-Tractors and Trailers
  - Home Port Facilities
  - Miscellaneous

2-5. VEHICLE SUBSYSTEM.

2-6. STRUCTURE. The structural system of the DSRV consists of a steel pressure capsule supported in an aluminum and titanium framework covered by an epoxy resin and fiberglass external hull. The three intersecting spheres of the pressure capsule, fabricated from high-strength steel (HY-140), provide a viable underwater environment for the crew and rescuees. The capsule can safely withstand hydrostatic pressures to 7,500 feet, with normal operations limited to 5,000 feet. Entrance to the capsule is through a lower and an upper hatch in the mid sphere. Two interior hatches give access to the aft sphere and to the control (forward) sphere. An exterior stub skirt integral with the mid sphere surrounds the lower hatch and provides a mounting support for the hemispherical transfer skirt used in mating with the disabled submarine, a support submarine, or the ASR decompression chambers. The control sphere has a forward viewport (equipped with an optical system); the mid sphere has two viewports and a smaller viewport in the lower hatch that allows direct or optically aided viewing. One other viewport is located in the control sphere but is inaccessible for viewing. The only other capsule penetrations provide for electric and electronic cabling requirements.

2-7. Supporting the pressure capsule and all external equipment is an aluminum and titanium framework consisting of a series of structural rings connected by intercostals and four midbody longerons. This framework also supports the free-flooding external hull, which serves principally as a fairing for hydrodynamic efficiency, and also contributes significantly to the longitudinal strength of the vehicle. The external hull can absorb, without damage, 1,000 pounds per square foot wave impact and collision with a blunt object when moving at speeds up to half a knot.

2-8. Basic dimensions of the pressure capsule and the external hull are shown in Fig. 2-1.

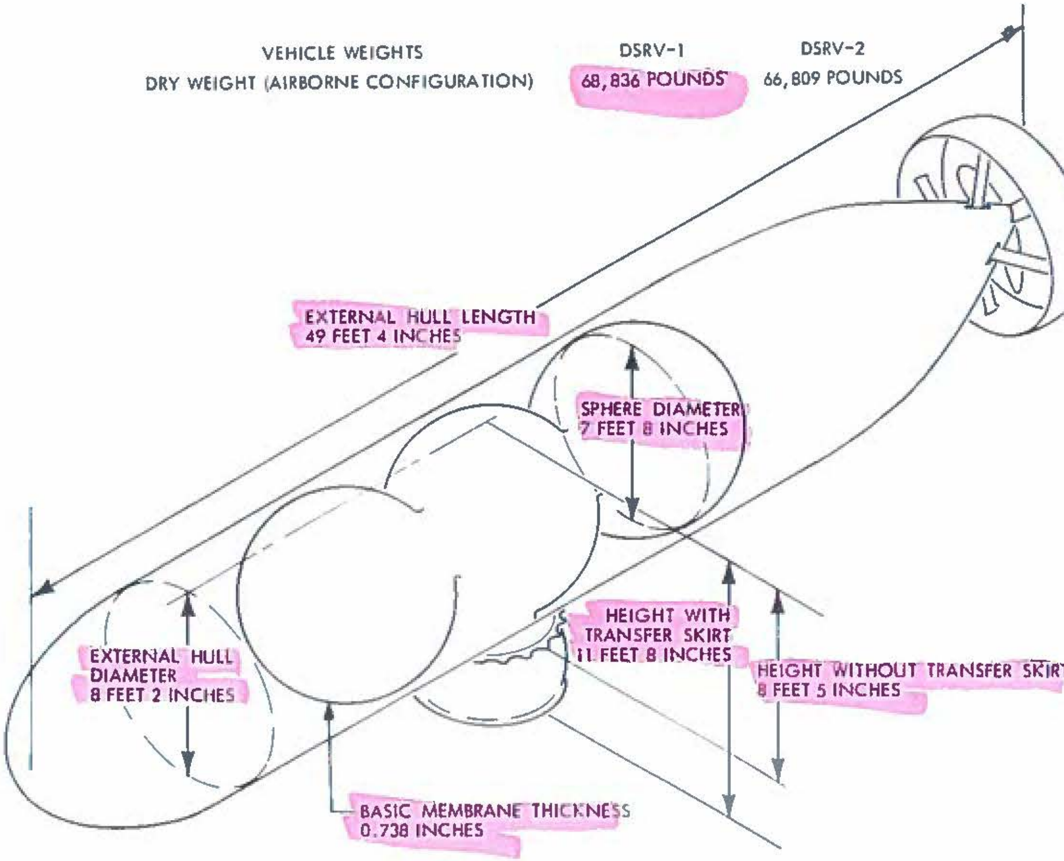

Fig. 2-1 DSRV Dimensions and Weights

2-9. The structural system, by its very nature, requires an interface with every component that makes up the completed vehicle. It must provide support, foundations, attachment points, protection, pressure hull penetrations, and the like for every subsystem in the DSRV. Additionally, it must interface with all handling and transportation equipment — the Land Transport Vehicle, the transport aircraft, the mother submarine, the ASR, dockside hoisting devices, and other ancillary support equipment. Perhaps most important of all, it must interface with the disabled submarine under a variety of conditions.

2-10. PROPULSION AND MANEUVERING. The propulsion and maneuvering system gives the DSRV a high-performance capability in both cruising and hovering operations.

It can attain a maximum forward speed while submerged of 4.1 knots for 10-minute periods only and maintain a cruising speed of approximately 3 knots. While hovering, the ship control system integrates feedback from sensing devices to coordinate the propulsion effectors (stern propeller and four ducted thrusters) and ballast systems into an attitude-holding accuracy of ±2 degrees on each angular axis. At the same time, it can maintain a spatial position along any lineal axis. Both position and attitude can be held against a 1-knot current. Sufficient electric power is stored in the vehicle's main batteries for one worst-case round trip between support vessel and disabled submarine under normal circumstances. Varying conditions, however, can increase or decrease power demands and affect endurance capability.

2-11. Propulsion is provided by five electrically driven propellers – a conventional three-blade stern propeller operating within a steerable shroud, a horizontal and a vertical ducted thruster forward, and an identical pair aft. Each of the five propellers can be reversed, and the four thrusters can be operated in various rotational combinations to produce sway or yaw and heave or pitch. Hydraulic actuators control the steering angle of the shroud to impart pitch and yaw. The maximum speeds possible along the translation axes, and the rates of attaining these speeds are shown in Fig. 2-2. Rotational axes, the maximum angles achievable around the rotational axes, and the rates of attaining these angles are shown in Fig. 2-3.

2-12. POWER. Electric power for DSRV system requirements is supplied from two 60-kwh (5-hour rate) silver-zinc batteries, located outside the pressure capsule. The batteries, one forward and one aft, are contained in oil-filled, pressure-compensated boxes. Similar containers are provided for other components of the electrical system – principal circuit breakers, transfer switches, shore power relays, etc. – located in the free-flooding portion of the vehicle. In addition to the 115 Vdc primary supply from the batteries, inverters and converters provide ±28 Vdc and 115 Vac, 400 Hz, single phase and three phase. In case of power failure, a 1.5-kwh (2-hour rate) silver-zinc battery in the control sphere supplies 28 Vdc to the emergency bus. Distribution to the various subsystems requiring electrical power is by means of controllers, converters, inverters, buses, bus ties, relays, switches, circuit breakers, and cables. Vehicle subsystems requiring electricity include propulsion, hydraulic power, ballast, life support, sensors, navigation, communication, optical, integrated controls and displays, electrical systems controls, etc.

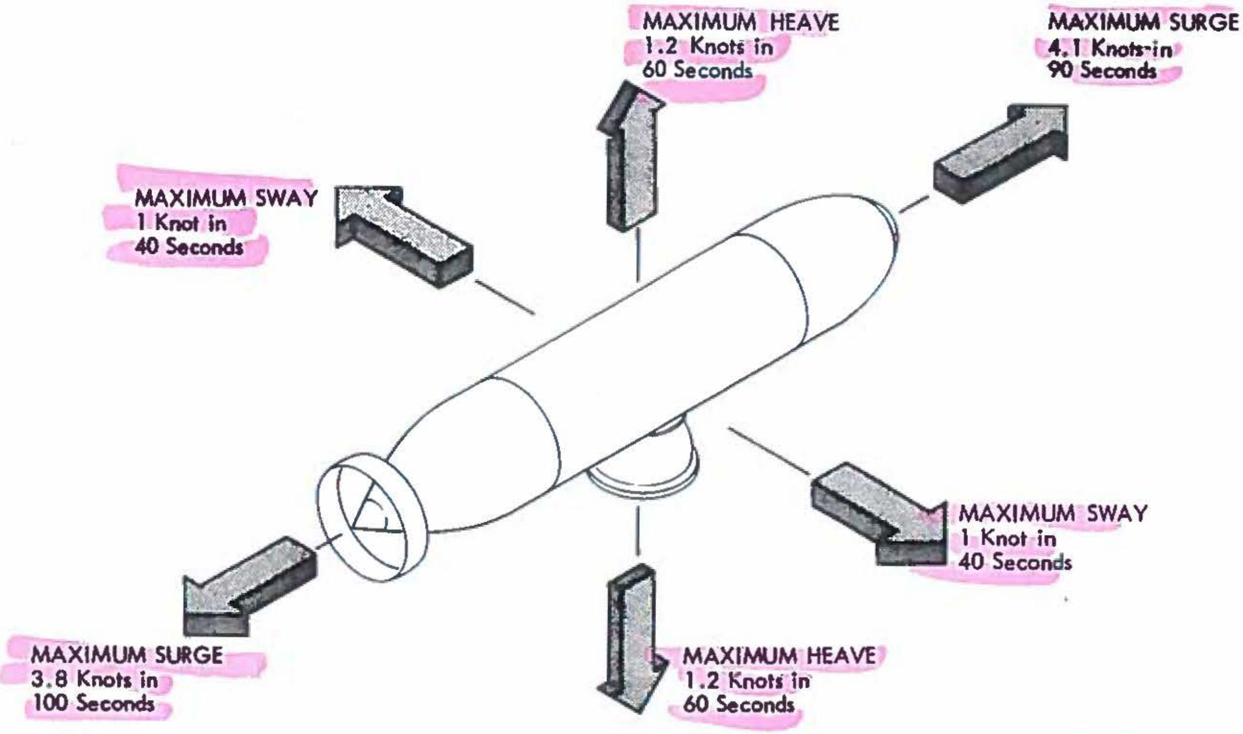

Fig. 2-2 Maximum Speeds and Attainment Rates on Translation Axes

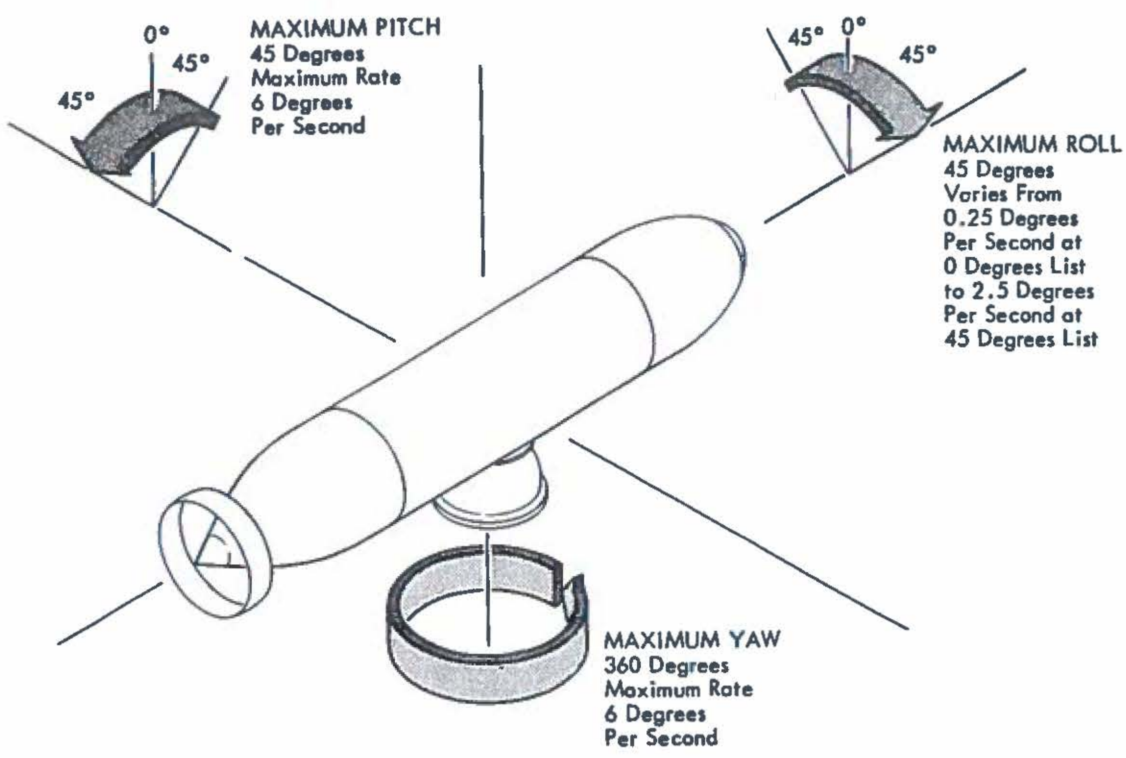

Fig. 2-3 Maximum Angles and Attainment Rates Around Rotation Axes

2-13. Hydraulic energy is supplied by electrically driven pumps in two hydraulic power units (HPUs), one located forward and one aft of the pressure capsule. Hydraulic fluid under 3,000 psid with a flow rate of 3.5 gallons per minute from each HPU is distributed to hydraulically operated subsystems by a network of piping, solenoid-operated selector valves, check valves, relief valves, and monitors. The following systems convert oil pressure to the mechanical energy required for their operation: the variable ballast system, the list and trim systems, TV and camera mounts, mating system elements (skirt dewatering, shock mitigation), manipulator arm, ASR retrieval arms, and steering shroud.

2-14. BALLAST. The variable ballast system and the list and trim systems provide buoyancy control, attitude control, and list and trim control for the DSRV at all operating depths. The list and trim systems, in addition to their capability for accurate attitude holding during hover, serve in additional capacities. The list system can be used to damp roll disturbances and to vary the center of buoyancy/center of gravity distance (BG). Reduction of BG is required for trim angles between 30 and 45 degrees. The trim system can, by altering the pitch up or down, assist the propulsion and maneuvering system in attaining an ascending or descending path. The variable ballast system compensates for changes in the displacement of the DSRV and the density of sea water under conditions of depth and/or temperature changes, thus maintaining neutral buoyancy at all depths when submerged. The main ballast system is used to achieve neutral buoyancy for submerging and positive buoyancy for surfacing — by flooding the bags with sea water or expelling the sea water with high-pressure air supply. The main ballast system gives the DSRV an excess buoyancy of 6,400 pounds, which provides 16 inches of freeboard when the vehicle is on the surface.

2-15. LIFE SUPPORT. This system provides a safe and comfortable environment for personnel aboard the DSRV. It also provides for their other physical requirements and, at the same time, protects electronic equipment in the control sphere from potentially damaging temperatures. The environmental control equipment supplies crew members and rescuees with a breathable atmosphere, temperature regulation, and relative humidity control. Other physical provisions include seating, illumination, body waste disposal, first aid supplies, and fire protection. Sufficient oxygen and nitrogen are carried aboard the DSRV to provide a breathable atmosphere for the following periods: (1) in the control sphere, 48 manhours normal supply, 48 manhours reserve; (2) in each of the other spheres, 144 manhours including reserve. Air conditioning equipment maintains approximately the following temperature and relative humidity levels: in the control sphere, 65° to 85°F with 30 to 85 percent relative humidity; in the other two spheres, 65° to 100°F with 95 (maximum) percent relative humidity. LiOH cannisters are carried aboard to scrub CO_2 and maintain a normal CO_2 level. The control sphere has 84 manhours supply; the mid and aft spheres, 144 manhours supply each.

2-16. MATING. Included in this category are those vehicle components and systems used principally for mating with the disabled submarine and transferring its crew members to the DSRV pressure capsule. These elements include the transfer skirt, shock mitigation ring, manipulator, transfer ballast system, and the rescuee ballast system.

2-17. The transfer skirt, a hemisphere made of the same high-strength steel (HY-140) as the pressure capsule, bolts to the flange on the stub skirt surrounding the mid sphere lower hatch. A vertical fin, the splitter plate (made of material similar to the epoxy-fiberglass external hull), is attached immediately aft of the transfer skirt and the shock mitigation assembly. It serves to reduce the turbulent wake set up by this assembly during submerged cruising, and acts as a fin keel for some degree of roll damping. The skirt, shock mitigation system, and splitter plate must be removed for road or aircraft transport.

2-18. The manipulator is used prior to mating to cut and remove the messenger buoy cable, and to remove any obstructions around the rescue hatch. Then the initial shock of mating contact is reduced by the shock mitigation ring, a hydraulic fender assembly surrounding the transfer skirt. Control of the final few inches of descent is achieved by using the vertical thrusters downward and slowly retracting the shock ring.

2-19. Immediately prior to contact, the transfer pump is started and circulates water from the skirt to the sea at a rate of 100 gallons per minute. As a seal becomes effective between the two vehicles, the differential pressure causes the pump to stall. At this time the circulating valve is closed, pressure is equalized between the skirt and the transfer tanks, and the outflow from the pump is redirected to the transfer ballast tanks. Once dewatering of the skirt is accomplished, the DSRV lower hatch can be opened. The pressure associated with the mating depth holds the DSRV firmly to the escape hatch seat.

2-20. With an effective seal established between the two vehicles, hatches are opened. The planned load of rescuees (up to 4,080 pounds) is estimated, and compensatory water ballast contained in collapsible bags in the mid and aft spheres is released into the disabled submarine's escape trunk before rescuees are taken aboard. When emptied, these rescuee ballast bags collapse flat to provide seating room for rescuees, who may then be taken aboard.

2-21. The mating sequence used in the DSRV in attaching itself to the mother submarine is generally the same used in mating with the disabled submarine. The principal difference is that a support cradle on the mother submarine is used to position and hold down the DSRV.

2-22. SUPPORT VESSEL INTERFACES. Special components, either integral with the vehicle structure, or attachable as required, serve as physical interfaces between the DSRV and the support vessel. When operating with a mother submarine, four attachment points on the bottom of the DSRV are latched to the submarine cradle bolted to the mother submarine. When support is from an ASR, a set of retrieval arms forward on the DSRV assists proper positioning on the submerged cradle, which is used for recovery through the ASR's center well. When a ship of opportunity is used, a flotation device is lowered into the water, attached to the sides of the surfaced DSRV by divers, and inflated to raise the DSRV in the water to facilitate rescuee transfer and consummables replenishment.

2-23. SENSORS AND CONTROL SUBSYSTEM.

2-24. This system provides the DSRV crew with comprehensive information on conditions exterior to and aboard the vehicle, on its rate of movement, and on its spatial position relative to external reference points, while at the same time providing complete control over angular and linear movement. The sensors receive inputs from various physical sources — ship's motion, differential pressure transducers, power consumption, acoustic or optical signals, etc. Outputs from these sensors are either directly displayed or computer-processed and then displayed. Certain processed sensor information is at the same time routed to the ship control equipment, which provides the means for pilot control of the vehicle in six degrees of freedom. In the following paragraphs, the elements that collect, process, display, and integrate this information and provide vehicle control are described briefly and their interrelationships indicated. For convenience these elements have been grouped into the following categories: optics, navigation, sonars, communications, computers, and ship control and displays.

2-25. OPTICS. In this category are those devices which contribute a visual image of conditions exterior to the DSRV. Direct vision is provided by transparent viewport penetrations in the pressure capsule — two in the control sphere (forward down and aft starboard down but presently inaccessible), two in the midsphere (port down and starboard down with an optical column), and one in the center of the lower hatch. An optical column to the control sphere forward viewport gives pilot or copilot a direct binocular view. Six television cameras — two topside on retractable mounts, four below, one directly forward, one pointed down through the lower hatch viewport, two on retractable mounts forward and aft — feed closed-circuit TV images to display screens in the control sphere. Four of these cameras can be manipulated to scan wide areas. Mercury vapor and quartz-iodide lamps provide illumination for the TV cameras. One 35-mm still camera with a synchronized strobe light mounted below the bow provides a photographic record of mission operations. A movie camera may be mounted in place of the still camera if desired and the still camera moved to the other lower retractable mount unit.

2-26. NAVIGATION. The navigation sensors, their output data processed by the central processing computer, determine the DSRV's position, velocity, and heading. The redundant information in these data is compared during processing and the resulting integrated best estimate achieves a higher degree of accuracy than output from a single sensor. Navigational sensors include the inertial navigator, the doppler sonar and sound velocimeter, the altitude/depth sonar, the transponder interrogation sonar, and the depth pressure transducers.

2-27. The inertial navigator or binnacle is the primary source for information on the vehicle's heading, pitch, and roll angles. It consists of a stable platform assembly of gyros and accelerometers rigidly mounted to the pressure hull and aligned with the vehicle's three axes, plus the required control electronics. Output from the inertial navigator is displayed and at the same time transmitted for use by the ship control system.

2-28. The doppler sonar measures the vehicle's velocity along its three axes by sensing the frequency shift between a projected acoustic signal and its echo. It consists of four pairs of projector/hydrophones arranged symmetrically and mounted on the under side of the DSRV aft of the transfer skirt. Output from the doppler sonar is displayed in knots for the fore/aft and port/starboard movements and in feet per minute for the vertical axis. Output is also transmitted to the ship control system via the central processing computer. A sound velocimeter provides a continuous measure of the speed of sound in the water adjacent to the DSRV. This sound velocity, which varies with water temperature and pressure, is required by the central processing computer to determine vehicle velocity from outputs of the doppler sonar.

2-29. The altitude/depth sonar measures the altitude of the vehicle above the ocean floor and depth below the ocean surface by computing the travel time of a sonic pulse from the vehicle to the reflecting surface and back. The depth pressure transducers compute the distance between the vehicle and the ocean surface by measuring hydrostatic pressure.

2-30. Two other navigational aids use the acoustic signal from a transponder to determine range and bearing. The tracking transponder aboard the DSRV will emit a sonic signal upon interrogation by a suitably equipped support vessel. This, provides a means for accurate tracking of the DSRV by such a support vessel during mission operation. The transponder interrogation sonar aboard the DSRV can interrogate and receive acoustic signals from transponders carried and placed by the DSRV to mark the disabled submarine's position, thus enabling the DSRV to home in on the disabled submarine.

2-31. SONARS. In addition to the sonar devices used primarily as navigation aids, other sonars aboard the DSRV provide a capability for detecting obstacles and for aid in mating with the disabled submarine. The vertical obstacle sonar is designed to sweep vertically and give an indication of the height from a reference plane of any object in the path of the DSRV. The horizontal obstacle sonar indicates range of objects which lie in the swept horizontal plane. The short range sonar measures range and attitude of the disabled submarine and its escape hatch looking downward through the DSRV transfer skirt. Under conditions of poor visibility the short range sonar will aid the pilot in positioning the DSRV over the escape hatch and in determining the roll/pitch attitude of the disabled submarine.

2-32. COMMUNICATIONS. Communication devices give DSRV crew members a capability for voice or continuous-wave keyed communication contact with support ships and with the disabled submarine while surfaced or submerged. In addition. an intercom system provides voice communication among the three spheres of the DSRV. When surfaced, an UHF radio allows two-way, line-of-sight communication with the support ship. This radio can also transmit a continuous signal for homing on and locating the DSRV by the support ship. When submerged, an underwater telephone gives voice and continuous wave manually keyed communication to the support ship and the disabled submarine. Directional listening hydrophones permit the DSRV to home on the source of underwater acoustic signals, such as hull hammering from a disabled submarine. All communications activity during mission operations are recorded on channels of a magnetic tape speech and data recorder.

2-33. COMPUTERS. Computing equipment aboard the DSRV provides the integrating interface between sensors, both external and internal, and the controls and displays.

The central processing computer, divided into general purpose and digital differential analyzer sections, automatically processes specific sensor output signals, computes navigation parameters, monitors vehicle system status, and activates display panel alarms when required. Certain selected parameters are automatically logged on channels of the speech and data recorder. Programs are loaded into the computer from magnetic tape in a recorder/reproducer unit. Another component of the central processor is a sequential timing/switching device – the timing coordinator – whose primary function is to reduce interference between sonar sensors by coordinating their transmissions. A second digital differential analyzer in the autopilot provides iterative processing for ship control. Communication between pilot and the central processing computer is provided by the computer display panel – projected film messages controlled by the computer program, numeric and status displays, and an input keyboard.

2-34. VEHICLE SYSTEMS OPERATING INDICATORS. Sensors in this category monitor conditions and operations of the vehicle itself as opposed to those that sense external conditions. Included are such items as tachometers, thermostats, partial-pressure sensors, flowmeters, leak and smoke detectors, pressure-differential transducers, absolute pressure transducers, and position sensors for pan and pan and tilt units, ASR retrieval arms, and the shock mitigation ring.

2-35. SHIP CONTROL AND DISPLAYS. The ship control system provides the pilot and his copilot with a means for controlling every aspect of DSRV operation. The displays give them the information required for reaching action decisions; the controls provide the means for implementing these decisions.

2-36. Control. The pilot is primarily concerned with two basic vehicle maneuvers: one, to cruise as quickly and as directly as possible between the support vessel and the disabled submarine; the other, to hover at the required angular attitude and to move slowly into contact with the disabled submarine. The ship control system is designed to provide complete maneuverability during these two regimes of operation. Cruise-type control is used at speeds greater than 2.3 knots, hover-type control at slower speeds.

2-37. Direct control over vehicle maneuvering is by two hand controllers (Fig. 2-4) on the console shelf immediately in front of the pilot (seated on the left). Each of the controllers resembles a short vertical stick that can be tilted back-and-forth and from side-to-side, as well as rotated in a clockwise and counterclockwise fashion. A ball-shaped grip atop each controller allows these movements to be made comfortably and with a minimum of effort. The left-hand controller (termed the translation controller) is used to translate or move the vehicle along the three linear axes, i.e., fore/aft, port/starboard, up/down. The right-hand controller (termed the rotation controller) is used to alter the vehicle's attitude or angle about the three rotational axes, i.e., the pitch angle fore/aft, the list angle starboard/port, and the yaw or heading angle. Changes in translation speed or in attitude angle are proportional to the degree of deflection of the hand controllers.

2-38. During the cruise regime, the translation controller is deflected to control forward speed of the vehicle by altering main propeller revolutions, but no direct lineal movement is provided along the port/starboard and up/down axes. To move to port or to starboard, the vehicle's heading is changed by rotating the rotation controller in the desired direction thereby changing the steering shroud angle. Similarly, to change the vehicle's trajectory to an ascent or descent path, the rotation controller is deflected fore or aft. This in turn deflects the steering shroud up or down as required.

2-39. During the hover regime, the translation controller, by proper deflection or rotation, is used for translating the vehicle along any of the three linear axes. This is accomplished by automatically selecting the required combination of main propeller, vertical and horizontal thrusters, and direction of propeller rotation. In a similar manner, the rotation controller is used to change vehicle attitude angles around the the three rotational axes. The vertical and horizontal thrusters, their propeller rotation direction, and the list and trim ballast systems are combined to achieve these angle changes.

2-40. In addition to direct maneuver control over the vehicle, the pilot and copilot are provided with control devices, principally switch panels, for every system

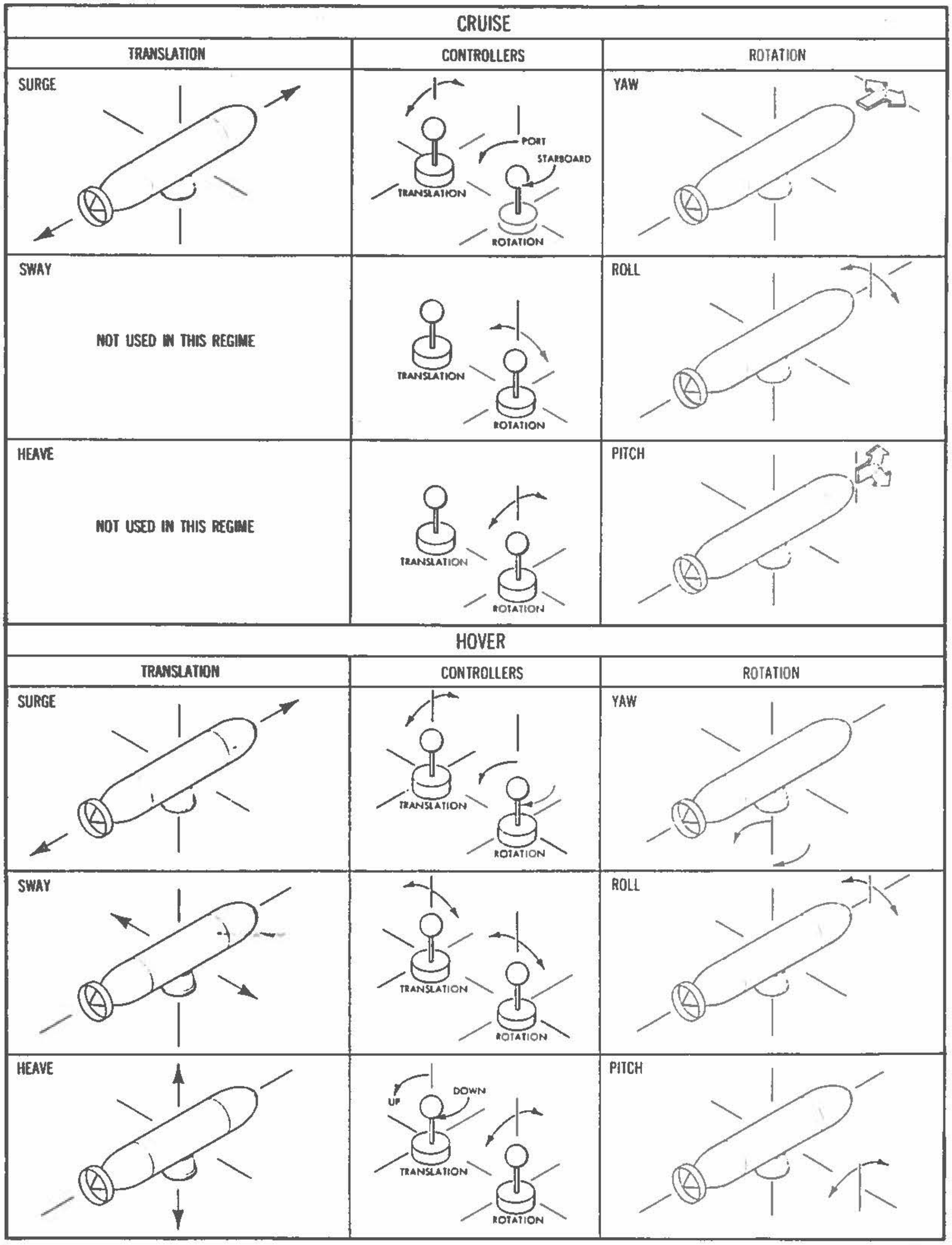

Fig. 2-4 Function of Hand Controllers in Cruise and Hover Regimes

aboard the DSRV. These cover operation of such equipment as optics, obstacle-avoidance sonar, communications, mating systems, life support system, manipulator, power, lighting, and the like. Emergency panels give backup control in the event of failure in certain systems. As an example, the emergency ship control panel allows operation, on a switch-on/switch-off basis, of the main propeller, the thrusters, and the shroud should the automatic subsystem supporting the hand controllers fail. Another panel provides the same type manual operation for the list and trim ballast subsytems.

2-41. Displays. Information gathered by all types of sensors is continuously updated and displayed in the control sphere by means of meters, TV and sonar screens, graphic plotter, graphic recorder, alarm lights, audio devices, switch position indicators, and others. In some instances, data from several sensors or a continuing stream of data from a single sensor must be processed by the ship computer to provide a meaningful display. Several representative display panels are described below.

2-42. The State Display panel, located directly in front of the pilot, presents the following information concerning vehicle movement and attitude:

- Speed of main propeller and four thrusters in revolutions per minute
- Velocity fore/aft and port/starboard in knots; up/down in feet per minute
- List and pitch angles in degrees
- Heading (compass card from binnacle)
- Pitch, roll, and yaw rates in degrees per second
- Range in yards to a transponder (aboard support vessel or dropped as a marker near the disabled submarine)
- Sonar depth from surface in feet
- Sonar height from bottom in feet
- Pressure depth in feet

2-43. The following information items are displayed on the ship control panel (also located directly in front of the pilot):

- Main ballast air flask pressure (psig)
- Trim ballast (pounds of mercury in forward and aft tanks)

- List ballast (pounds of mercury in port, starboard, and reservoir tanks)
- Variable ballast (pounds of water in forward and aft tanks)
- Hydraulic power (psig in forward and aft units)

2-44. Sonar displays can be directed to any one of three sonar screens; four television screens are available for selectively displaying outputs from the closed-circuit TV cameras. An X-Y position plotter graphically traces vehicle movement in relation to a reference point.

2-45. SUPPORT SUBSYSTEM.

2-46. The Deep Submergence Rescue System, to satisfy its demands for fast, long-range deployment, requires that the DSRV System be transportable by land, sea, and air, and that during mission deployment, the necessary handling and support equipment be readily available. This specialized equipment is considered an integral part of the DSRV System. In general, the support equipment can be grouped into the following categories: ground transport, aircraft loading and handling, shipboard loading and handling, and checkout and servicing equipment.

2-47. GROUND TRANSPORT. Transportation of the DSRV overland is accomplished by a heavy duty, flatbed semitrailer (termed the Land Transport Vehicle or LTV) attached to a truck-tractor. The LTV jeep dolly, with its adjustable gooseneck, permits use of truck-tractors with the fifth wheel interface varying in height from 50 to 60 inches. During land transport, the DSRV is supported at four points by a cradle assembly that distributes the weight evenly on four rows of rollers installed on the bed of the LTV. The LTV carries its own power system for a hydraulically operated winch and for its pneumatically operated brake and suspension systems. Weight of the LTV and jeep dolly is approximately 45,000 pounds; they are designed for a payload of 72,000 pounds. Towing speeds as high as 30 mph can be reached on suitable highways and 10 mph on curves.

2-48. The hemispherical transfer skirt and shock mitigation assembly, attached to the DSRV during rescue missions, are normally transported and handled on a special three-wheel dolly that permits lifting, lowering, positioning, and rotating these components during dockside installation. The dolly jacks are operated by built-in screw jacks. The mother submarine pylons, used for DSRV piggyback transport on the mother submarine, are carried on a special pylon handling dolly. All associated controls and cabling are also carried.

2-49. AIRCRAFT LOADING AND TRANSPORT The DSRV, supported on its transport cradle, is carried by a C-141A transport aircraft when deployment to a distant launch port is required. Transferring the vehicle to the aircraft is accomplished by backing the LTV against the aircraft's loading ramp, attaching a spreader bar and line to the transport cradle, and winching the DSRV into the cargo compartment. Rows of rollers on the LTV and in the aircraft permit low friction support during this transfer. During loading, the aircraft is stabilized by special jacks and a fuselage cradle and the LTV is stabilized by a built-in jacking system. The loading ramp, which serves as a bridge between aircraft and LTV, is supported by additional cradles. These loading jacks and cradles are considered integral parts of the DSRV System and are transported along with the LTV, support van, all other mission necessities, including the 16-man crew, in two additional C-141A transports (three additional transports for a ship-of-opportunity mission).

2-50. SHIPBOARD LOADING AND HANDLING. Transportation of the DSRV from the launch port dock to the vicinity of the disabled submarine can be accomplished in four different ways: 1) aboard the deck of the ASR, 2) mounted piggyback over the aft hatch of a fleet nuclear-powered submarine, 3) aboard the deck of a ship of opportunity, or 4) put into the water and tow lines attached to a ship of opportunity. In each instance, certain interfacing equipment is required. This equipment is considered integral with the DSRV System and is carried on mission deployment.

2-51. <u>ASR or Ship of Opportunity.</u> A hoisting sling assembly (dual pickup configuration) which attaches to four lift fittings on the upper midbody of the DSRV is used to remove the vehicle from the LTV, launch it, or place it aboard the support ship. Dual hoists of 150,000-pound lift capacity on the ASR's overhead bridge crane can be positioned to load the DSRV from dockside onto a deck stowage cradle, where it is supported at the same four bottom support points as on the transport cradle. For ship of opportunity operations, a suitable 50-ton crane is needed for loading. The DSRV SSN cradle assembly, supported by structural steel beams, is placed on the deck of the ship of opportunity. The steel beam structure is welded to the deck. The DSRV is lifted and positioned on the cradle assembly, and the cradle assembly latches are closed/opened using the pylon control panel. For ships that do not have DSRV carrying capability, the DSRV is placed in the water and towing lines rigged from DSRV to the towing vessel.

2-52. Mother Submarine. The hoisting sling assembly in a single-point pickup configuration is used to load the DSRV from dockside onto a four-pylon cradle installed about the aft rescue hatch of the mother submarine. The same four fittings that support the DSRV on the LTV's transport cradle perform a similar function atop the mother submarine, and electrically operated hydraulic latches hold the vehicle securely in place.

2-53. Towing by Surface Vessel. A tow bridle with tow line will be attached to the two forward lift fittings and used for emergency towing by a surface vessel. DSRV will be towed on the surface out of the harbor at about 5 knots, then towed submerged to the disaster area at about 10 to 12 knots.

2-54. CHECKOUT AND SERVICING. During mission operation, the DSRV requires such support as battery recharging, life support subsystem replenishment, periodic subsystem checkout and servicing, and similar services. Equipment to provide such services is contained in a mibile support van that can be towed on land, airlifted, or carried aboard a surface support vessel. For interim rescue, portable charging equipment, air compressors, buoyancy beams, cable reels, and other auxiliary equipment are grouped together to be carried aboard the support vessel. For convenience, the support operations can be grouped into the following categories: electrical, subsystem servicing, and life support resupply and servicing.

2-55. Electrical Support Units. The electrical support equipment provides capability for recharging the DSRV main batteries and for supplying shore power to the DSRV. The electrical power required to operate the support equipment is supplied either by an external source or by the ship of opportunity equipment diesel generator. Primary power sources are supplied by both the ASR and the mother submarine. Whatever the operational mode, support equipment is available to regulate and distribute electrical power.

2-56. When an ASR is used for mission support, the support van (less its running gear) is loaded on board and serves as the connecting link between the ship's power supply and DSRV requirements, except for recharging the main batteries at a fast rate. The ASR has facilities for recharging the DSRV batteries directly. Charging is controlled and monitored by the ASR system. A slower rate of charge — up to 125 amps — can also be accomplished with support van battery charging equipment. When the mother submarine is serving as the support vessel, the van remains at dockside, and gear required for power regulating and for battery charging and monitoring is loaded aboard the mother submarine. This also includes electrical equipment for pylon latch control and monitoring during DSRV/mother submarine underwater mating. When a ship of opportunity is serving as the support vessel, a portable diesel powered generator and battery charging console is used to provide DSRV shore power and battery charging capability.

2-57. Life Support Checkout and Resupply. This category of support is concerned with maintaining the system that provides an acceptable environment inside the capsule during submergence. Checkout devices are provided for testing and adjusting sensors that monitor oxygen and carbon dioxide content of capsule atmosphere, and for detecting leaks in gas storage and distribution subsystems. Resupply items include fresh tanks of nitrogen, air, and oxygen, and replacement cartridges for the lithium hydroxide scrubbing units that remove carbon dioxide, odors, and various contaminants from the atmosphere.

2-58 Servicing Support Units. Special units are provided for replenishing oil in the electrical distribution system's pressure compensators, fluid in the hydraulic power units, and fluids in the list and trim ballast systems. A rescuee ballast service unit controls sea water supplied from the support ship into the collapsible ballast bags that are emptied as rescuees are taken aboard the DSRV. A manual portable pump is used to remove condensate and to drain bilges in the capsule. Servicing cables, hoses, etc. for hydraulic fluid, conditioned air, water ballast, and high-pressure air are provided as interfaces between the DSRV and the checkout and servicing equipment.

2-59. ANCILLARY SUPPORT SYSTEMS.

2-60. Ancillary elements include all those items required by the DSRV to perform its assigned mission, but not considered integral in the DSRV System proper. In this ancillary category are transport aircraft, support vessels (both surface and underwater), truck-tractors and other trucks, home port facilities, and miscellaneous items.

2-61. AIRCRAFT. Three transport aircraft (C-141A) are needed to airlift one complete DSRV System to any launch port other than the rescue unit's home port. Another aircraft is needed if ship of opportunity rescue equipments are to be transported. Elements carried by these aircraft are the DSRV itself, the LTV, the transfer skirt and shock mitigation assembly on its dolly, the support van, aircraft and support ship loading equipment, special mother submarine equipment, and the 16-man crew with personnel baggage. For ship of opportunity rescue, the DSRV support cradle, a portable diesel generator, a charging battery console, cable reels, buoyancy beams, and portable air compressors are required to be transported.

2-62. SUPPORT VESSELS. The DSRV is supported during rescue operations either by a surface vessel (ASR or ship of opportunity) or by a mother submarine.

2-63. Surface Vessel. The ASR is a specially designed catamaran, 251 feet in length and with a beam of 86 feet. The dual hoists on its overhead bridge crane can extend outboard from the ASR and load the DSRV and its accompanying equipment from a pier. This hoist is also used to launch and recover the DSRV through the ASR's center well. Stowage cradles to port and starboard of the center well provide deck space for two DSRVs. Space is also provided for stowing one support van (less running gear). Onboard support includes high-pressure air supply, electric power, ballast water, washdown water, photographic processing, stowage space, crew quarters, etc. A ship of opportunity must be able to carry DSRV servicing equipment for tow operations, or otherwise, be large enough to hold the DSRV cradle and DSRV, provide DSRV lift capability, and have space for DSRV servicing equipment.

2-64. Mother Submarine. The mother submarine is one of several specially equipped nuclear-powered fleet submarines capable of transporting, supporting, launching, and recovering the DSRV while submerged. Since all of these operations can be accomplished without returning to the surface, submarine rescues can be effected in spite of adverse weather and sea state conditions, and can be made under ice. The mating aids, monitoring equipment, and servicing units are installed or carried aboard the mother submarine at dockside. The support van and most of its equipment, not required for mother submarine support, are stored ashore during mission operation.

2-65. TRUCK-TRACTORS AND TRAILERS. Prime movers in the form of truck-tractors are required to tow the LTV and the support van during overland operations. Additional trucks are needed for moving all other items of system equipment, and a bus for carrying crew members. All of these vehicles are obtained locally, either from a motor pool or from some commercial source.

2-66. HOME PORT FACILITIES. A permanent building to house both of the DSRV Systems in a rescue unit is located at the unit's home port. This building consists of a high-bay center section flanked by two-story wings for offices, work shops, personnel facilities, storage, and housekeeping areas. An overhead bridge crane in the high bay handles the DSRV and DSRV subassemblies. Areas for standby, checkout, maintenance, and disassembly are provided. A wet tank is provided for vehicle wet test checkouts.

2-67. MISCELLANEOUS. Forklifts are required for handling crated and palletized equipment during rescue mission deployment. Dockside cranes must be available for installing pylons on the mother submarine, and for positioning the DSRV on the pylons.

Section 3

VEHICLE SUBSYSTEM

3-1. GENERAL.

3-2. The DSRV vehicle subsystem, summarized in terms of its principal elements in Section 2, is described in greater depth in this section. Order of presentation is the same and conforms to the following arrangements:

- STRUCTURE
  - Pressure Capsule
  - External Hull
- PROPULSION AND MANEUVERING
- POWER
  - Electrical
  - Hydraulic
- BALLAST
  - Main
  - Variable
  - List
  - Trim
- LIFE SUPPORT
  - Environment Control
  - Personnel Fittings and Furnishings
- MATING
  - Transfer Skirt
  - Shock Mitigation
  - Manipulator

Transfer Ballast (Dewatering) System
Rescuee Ballast System
Holddowns

- SUPPORT VESSEL INTERFACES
  ASR or Ship of Opportunity
  Mother Submarine

3-3. STRUCTURE (FIG. 3-1).

3-4. Essentially, the DSRV structure consists of a pressure capsule for crew and internal equipment supported within a metal framework which is, in turn, covered by an external hull. This external hull serves as a hydrodynamic fairing for the pressure capsule and associated external subsystems and protects external equipment from wave slap; it is flooded when submerged and does not experience any significant pressure differentials.

3-5. PRESSURE CAPSULE. The pressure capsule provides the basic hard structure protection for crew members and rescuees, and for interior systems against underwater pressures. The capsule consists of three intersecting 92-inch diameter spheres, plus a bolt-on hemispherical transfer skirt below the mid sphere, all fabricated of HY-140 high-strength steel. Wall thickness of the three spheres is approximately 0.75 inch, of the transfer skirt 0.41 inch, and of the stub skirt 1.00 inch. This stub skirt is integral with the mid sphere and provides a mounting flange for the transfer skirt. Capsule wall thickness has been increased to provide reinforcement in all areas where stresses are greater than basic capsule membrane stress. These high-stress areas include sphere intersections, viewports, electrical penetrations, stub skirt intersection with mid sphere, hatch penetrations, trunnions, etc. The designed operating depth of the pressure capsule is 5,000 feet, with a collapse depth of 7,500 feet.

3-6. The pressure capsule is supported within the vehicle framework by titanium yoke rings surrounding the two intersections of the three spheres. Loads are distributed from each yoke ring to an adjacent pair of titanium support rings (one located 11 inches forward, the other 11 inches aft of the yoke ring) by eight struts (four on each side) arranged symmetrically. Both yokes and support rings consist of upper and lower

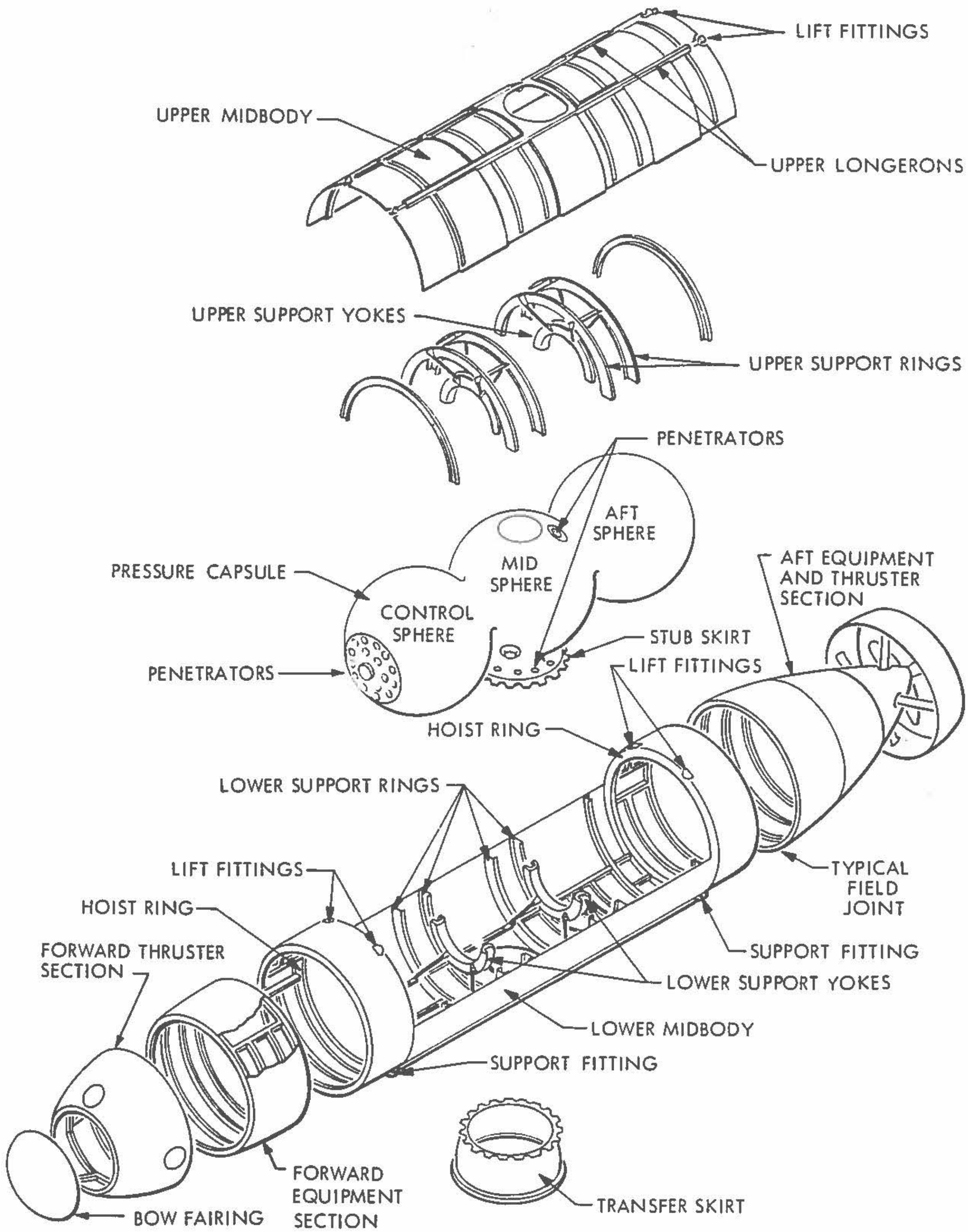

Fig. 3-1 Components of DSRV Structure

sections which, when unbolted, allow removal of the pressure capsule. The inner ring portion of each yoke is covered with an elastomer liner to allow for tightening around the intersection of the spheres.

3-7. Pressure capsule entrance and intersphere access are provided by four mid sphere hatches – two external and two internal. Both external hatches open outward, the two internal hatches open into the mid sphere. The upper, exterior access, hatch is a 28-inch diameter plug type; the lower exterior hatch is a 25-inch diameter face-seating type with a 3-inch diameter viewport for observation of the transfer skirt area. Both external hatches are convex to the mid sphere. The two internal hatches are 25-inch diameter face-seating configurations convex to the mid sphere, and can be opened from either side. Exterior hatches are normally operated from within the capsule, but under emergency conditions they can be opened from outside the capsule with a special hatch wrench.

3-8. The internal hatches allow for pressure differentials among the three spheres should circumstances require, e.g., should the internal pressure of the DSRV have to be raised to match that in a disabled submarine.

3-9. Four 5-inch viewports, each with a 90-degree angle of view, are provided for observing the outside environment. The optically transparent material in the viewports is 2-inch polymethyl methacrylate. It can withstand the hydrostatic pressure at more than 5,000 feet, as well as elevated internal atmospheric pressures up to 5 atmospheres when surfaced. In the control sphere, the forward viewport is used with a binocular optical column for search and for mating with the mother submarine; the aft viewport is currently not used, but an optical system may be developed. In the mid sphere both port and starboard viewports can be used for search and to a limited extent for observing the disabled submarine. The starboard viewport is also used during manipulator operations.

3-10. Electrical penetrator holes are provided in all three spheres and in the stub skirt. All sphere-to-sphere wiring is run external to the pressure capsule. Penetrations are provided in the stub skirt for electrical and hydraulic equipment, along with air and water lines.

3-11. EXTERNAL HULL. The free-flooding external hull consists of a fiberglass skin secured to a framework of transverse rings, connecting intercostals, and four midbody longerons. This hull, which floods when the DSRV is submerged, surrounds and supports the pressure capsule and all external operating equipment and components. The hull and its supporting framework are divided into six structural sections, which bolt together at separation points termed field joints. These field joints, essentially pairs of parallel rings that can be bolted together into single rigid elements, allow separation of the various structural sections for removal and installation of large components.

3-12. The external hull – skin, structural framework, and equipment foundations – has been designed to prevent entrapment of air and water during submergence and recovery. Voids within the hull are filled with blocks of syntactic-foam material cut to shape as required. This material, which does not deform under high hydrostatic pressure, provides the positive buoyancy required to bring the vehicle as a whole to a neutral buoyancy condition.

3-13. The external skin is a laminate of epoxy-resin-impregnated fiberglass cloth. Skin thickness varies from about 0.13 inch in the nose dome to about 0.53 inch around cutouts and other high-stress areas. Mean thickness is approximately 0.26 inch. The number of layers of fiberglass cloth laminate varies from 1 to 26 layers. The epoxy-fiberglass skin is removable in the upper section of the external hull midbody; in the other sections, the skin is permanently attached to the metallic framing.

3-14. The principal load-bearing structure, which protects and supports the pressure capsule and bears all hoisting and transport loads in the midbody, consists of a series of titanium rings connected and stabilized by intercostals, longerons, and external shell. The ends of this structure are formed by two heavy hoist rings of machined titanium with I-beam cross section. The four longitudinal longerons terminate at these hoist rings. All hoisting and transport loads are transmitted directly to the hoist rings through lift fittings and support fittings that are bolted directly to them.

3-15. Other structural elements making up the vehicle framework include aluminum support rings, aluminum wave slap rings, aluminum field joint rings, aluminum intercostals, and skin-support rings of epoxy-fiberglass. The support rings and wave slap rings, both with I-beam cross sections, are load-bearing members. The wave slap rings are not continuous, but are interrupted with gaps that allow access to interior components. Adjacent field joint rings are bolted together with segmented aluminum splice rings. Fiberglass stiffening rings of the same material as the skin serve to stiffen the skin in the midbody of the vehicle as required to withstand wave slap loads up to 1,000 pounds per square foot.

3-16. A yoke-and-strut arrangement within the vehicle's primary load-bearing structure supports the pressure capsule. A two-piece titanium ring yoke surrounds each of the two sphere intersections of the capsule and in turn is supported by eight titanium struts secured to the adjacent titanium U-channel support rings. Titanium intercostals between the parallel support rings at the strut attachment points provide additional rigidity and strength. Surrounding the stub skirt on the underside of the mid sphere. is another ring yoke attached to the vehicle structure by means of torque-reaction tie rods which serve to restrain the pressure capsule in roll relative to the external hull structure.

3-17. Foundations and support brackets for all equipment external to the pressure capsule are attached to structural components of the external hull. This equipment includes such items as ballast tanks, main batteries, main propeller with motor and controller, ducted thrusters with motors and controllers, hydraulic power and distribution system, cabling, sensors, lights, etc. In addition, foundations, external to the hull but attached to the primary load-bearing structure, are provided for such items as the shock mitigation system and the splitter plate aft of the transfer skirt.

3-18. Detachable fairings of material similar to the vehicle skin are provided to reduce drag caused by externally mounted components. These include the shock mitigation mounts, the interrogation sonar transducer, and the underwater telephone transducer. Cutouts in the external skin are provided for retractable items — TV units, manipulator, etc. — and for viewports in the pressure capsule.

3-19. <u>PROPULSION AND MANEUVERING (FIG. 3-2).</u>

3-20. The propulsion and maneuvering system provides the forces and moments required to propel, control, and maneuver the DSRV during transit, hover, and work

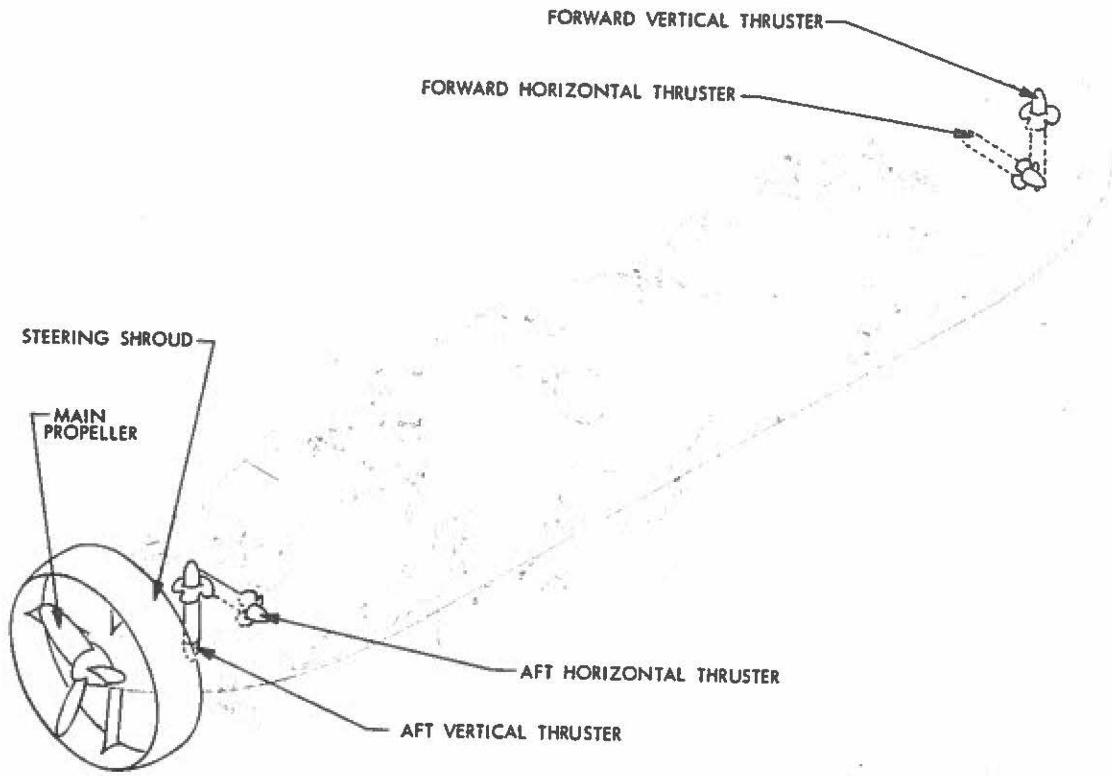

Fig. 3-2 Main Propeller, Steering Shroud, and Thrusters

activities. The system consists essentially of an electrically powered main propulsion unit, four electrically powered ducted thruster units, and a hydraulically operated steering shroud unit. These units are used in various combinations for the two basic operating regimes: cruise, or translating along the vehicles fore-and-aft linear axis, usually at speeds in excess of 2.3 knots; and hover, or maintaining an angular attitude, while translating at slow speeds or holding a spatial position.

3-21. The basic units for the cruise regime are the main propulsion unit and the steering shroud unit. However, at low speeds the steering shroud is ineffective, and the ducted thrusters must be used to produce the required maneuvers in pitch and yaw. The main propulsion unit, consisting of a 3-blade propeller, a 3-phase 15-horsepower motor, and an inverter/controller, provides the forward and aft movements. A maximum forward submerged sprint speed of 4.1 knots can be attained in 90 seconds. The steering shroud unit, consisting primarily of a circular ring with hydrofoil cross section, four support struts, and four hydraulically operated linear actuators, produces both pitch and yaw control at speeds of 2.3 knots or more.

3-22. The basic units for the hover regime are the main propulsion unit and the four ducted thruster units. A ducted thruster unit consists of a 4-blade propeller and a 3-phase, 7.5-horsepower motor mounted in an open-end duct, and an inverter/controller. The ducted thrusters are located in pairs (a vertical and a horizontal) forward and aft in the vehicle. During hover operations, the main propulsion unit produces surge in both fore and aft directions. The horizontal thrusters produce sway by thrusting simultaneously to port or to starboard, and yaw by thrusting opposite to each other. Maximum sway velocities of 0.9 knot can be attained in 45 seconds starting from a rest position. The vertical thrusters are used in a similar manner to produce heave and pitch movements. Maximum heave of 1.2 knots can be attained in 60 seconds starting from a rest position.

3-23. Minimum turning radius for the DSRV, at maximum forward speed and maximum yaw shroud deflection, is less than 100 feet. A full 360-degree turn can be completed in 1.3 minutes. During the hover regime, with horizontal thrusters operating in opposition at maximum speed, the vehicle can execute a full turn in approximately 1.5 minutes.

3-24. While cruising at maximum forward speed, a maximum pitch down in shroud deflection from a neutral position will give the vehicle a pitch angle of 25 degrees in 13 seconds with an initial forward velocity of 3.7 knots. With the vehicle hovering and using maximum differential vertical thrusters, a 30-degree pitch angle can be reached in 12 seconds. Pitch angles between 30 and 45 degrees require adjustments in trim ballast.

3-25. Maneuver commands are initiated by the pilot through a pair of hand controllers in the control sphere. The left controller covers linear movement or translation along the vehicle's three linear axes. The right controller provides changes in attitude along the vehicle's rotational axes. During cruise operations, the translation controller provides control of surge along the fore-and-aft axis by varying speed and rotation direction of the main propeller (direct heave and sway translation is not used in this operating regime, and the thruster propellers are allowed to free-wheel). The right-hand or rotational controller imparts changes in yaw and pitch angles by manipulating shroud deflections and changes roll angles by inputs to the trim ballast system. Hover operations are similar, but direct heave and sway translation are added. The translation controller, in addition to surge, provides sway and heave by activating the horizontal thrusters and the vertical thrusters respectively. The rotation controller activates the vertical thrusters in opposition to each other to provide changes in the pitch angle and the horizontal thrusters in the same mode for yaw changes. List angles are changed by inputs to the list system.

3-26. POWER (FIG. 3-3).

3-27. A forward main battery, an aft main battery, and an internal emergency battery provide the source of power for all operations aboard the DSRV. Much of the equipment uses electrical energy directly, but, for those devices requiring it, hydraulic power from electrically driven pumps is provided.

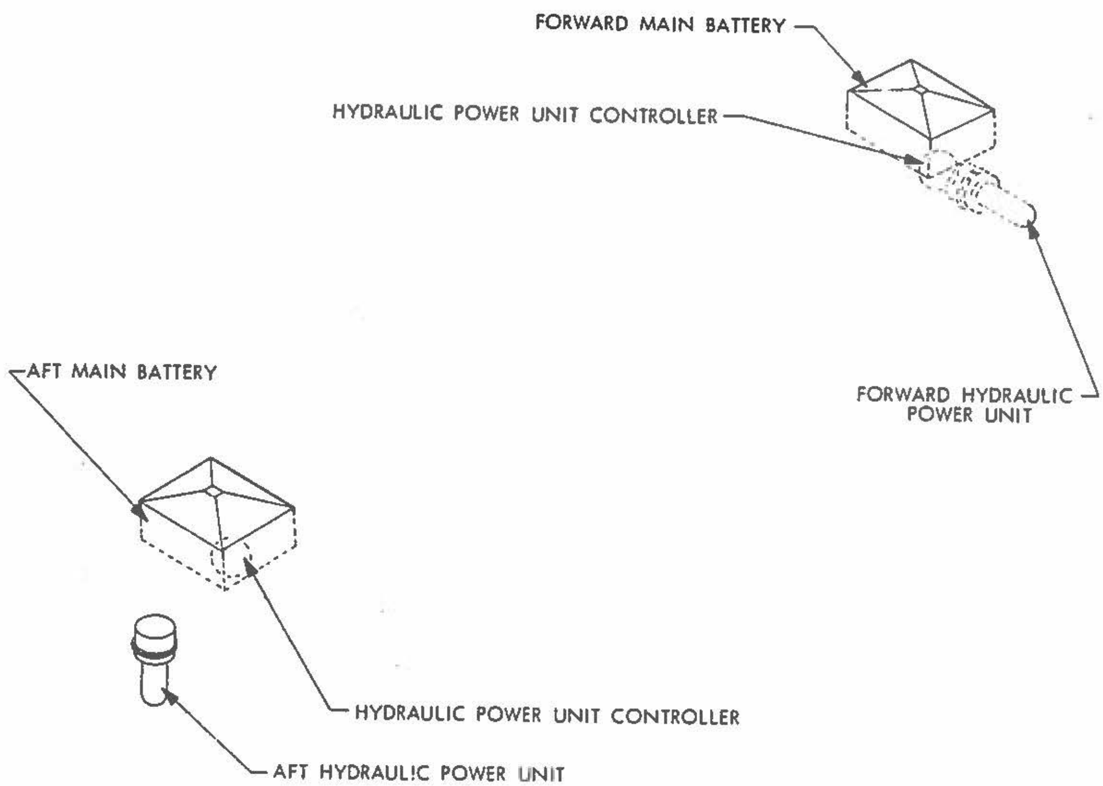

Fig. 3-3 Power Components

3-28. ELECTRICAL. The electrical system stores, converts, and delivers electrical power to all systems requiring it, either for power or for control. Two 76-cell silver-zinc main batteries supply nominal 115 Vdc to what are essentially two separate distribution systems (Fig. 3-4). When necessary, these systems can be tied together to allow one battery to supply the entire network. When fully charged, each battery has a capacity of 60 kwh at a 5-hour rate. The two batteries have a combined capacity sufficient for one round trip between the disabled submarine and the support ship with a margin of power remaining. The batteries can be recharged at various charging rates according to the operational requirements and time allowance, and either through the stub skirt or through a connection topside aft of the forward main battery.

3-29. The two main batteries, principal circuit breakers, transfer switches, shore power relays, and other external components of the power distribution system are contained in oil-filled, pressure-compensated boxes in the free-flooding external hull. All other electrical system components are located in the pressure capsule. The oil-filled boxes are automatically protected from increasing sea pressure by a piston compensator which maintains a positive internal pressure from 1 to 3 psi above sea ambient.

3-30. Power from the main batteries is distributed via two external buses to controllers for the propulsion units and the hydraulic pump, and to other systems from the internal 112 Vdc buses. The two external buses also connect to a pair of buses inside the control sphere through an isolation relay panel. Failure of the 112 Vdc supply from either external bus causes the isolation relay in that circuit to deenergize. The bus-tie relay (in the isolation relay panel) may then be energized by a switch on the main propulsion panel to connect both internal buses to the same external bus.

3-31. Two inverters in the control sphere supply 115 Vac, 400 Hz, single-phase power to an essential bus and a utility bus. Should power from one inverter fail, output from the other inverter is automatically switched to feed the essential and utility buses. The rated load for each inverter is 3.5 kva.

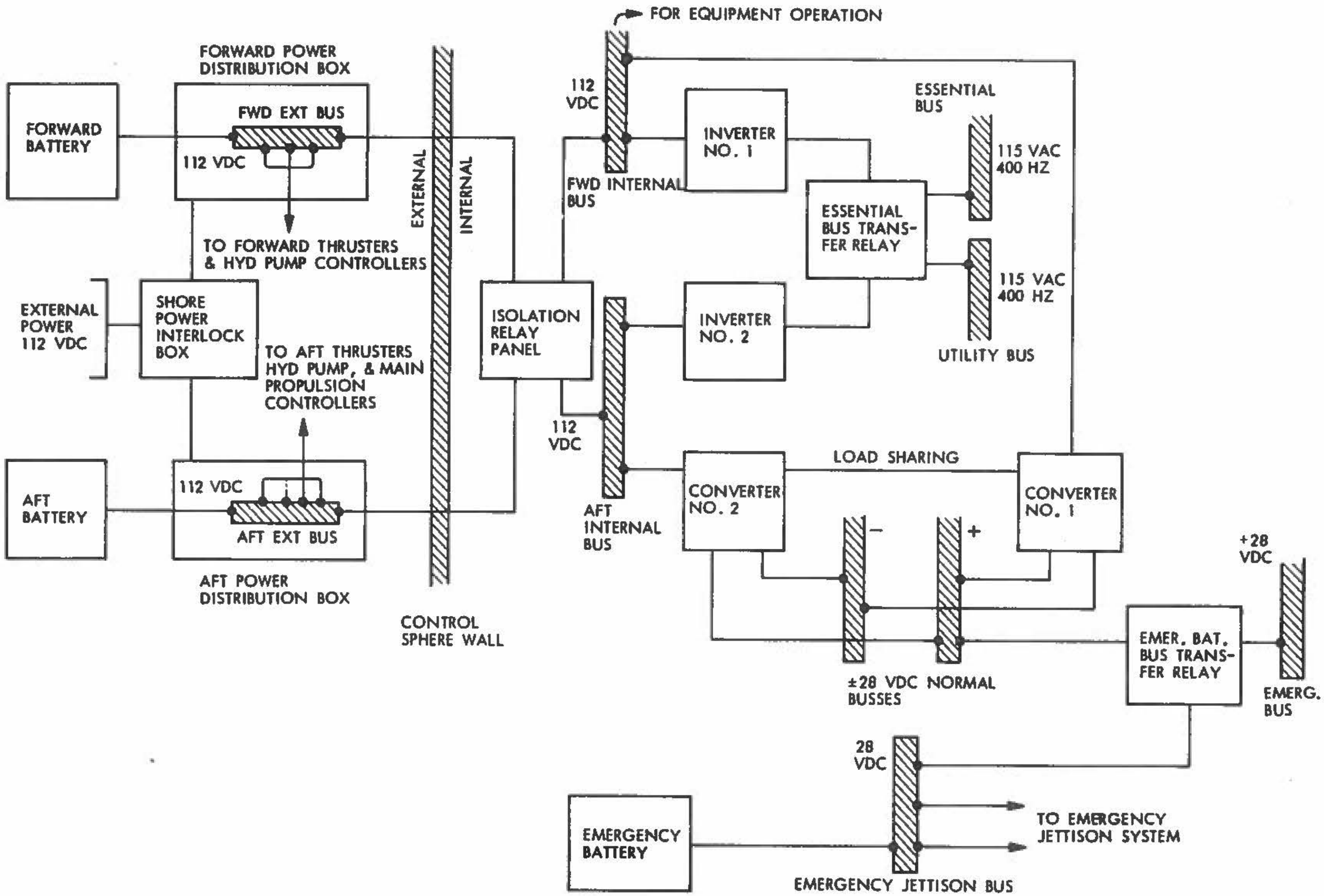

Fig. 3-4 Electrical Distribution System

3-32. Two converters in the control sphere jointly supply the -28 Vdc normal bus and +28 Vdc normal bus. A load-sharing circuit limits load balance ratio between the converters to a maximum of 60/40 whenever the combined load exceeds 1.5 kw. The rated load for each converter is 3.3 kva.

3-33. A 28 Vdc emergency bus is normally supplied from the +28 Vdc normal bus through the emergency battery bus transfer relay. In case of loss of power from the normal bus, the relay automatically deenergizes to disconnect the normal bus and to connect emergency battery output to the emergency bus.

3-34. Each of the main batteries consists of 76 individual cells, each having a normal open-circuit voltage of 1.86 volts. A solid-state scanner in each battery box monitors the voltage of each cell sequentially. The scanner output is fed to a solid-state voltage detector unit located in the control sphere. This unit compares each cell voltage to a selectable standard voltage (normally 1.25 volts) and closes an alarm circuit if any cell voltage is less than standard. The alarm is displayed on the detector unit. The detector also sends a signal representing this value to the central processing computer (CPC). The operator may retrieve each voltage reading and cell number with which it is associated from the CPC or from the voltage detector unit. The voltage detector unit can be set to scan either or both batteries at a variable scan rate period ranging from 0.33 to 5 seconds on each cell. Cell voltages can be read directly or printed on a paper tape for record. When a battery cell voltage drops to or below the standard low limit level, the scanner will stop and the voltage detector will display an associated battery alarm light and alert the pilot to a low cell and its voltage value. The scanner can then be stepped to continue monitoring the cells. The CPC also makes a comparison calculation and starts a low-voltage alarm independently of the low-voltage detector. Each of the pressure-compensated battery boxes in the power system contains a saltwater detector that warns (via the alarm panel) of leakage in any individual box.

3-35. Various meters in the control sphere supply the operator with the following readouts:

- Battery amperage load and battery ampere hours consumed
- Voltage across each external bus
- Voltages across essential and utility buses
- Voltage across +28 Vdc normal bus

- Voltage across -28 Vdc normal bus
- Voltage across emergency battery bus
- Ground resistance readings of each bus

3-36. HYDRAULIC. The hydraulic power system, located outside the pressure capsule, consists primarily of two units each having an electrically driven pump and a reservoir plus a distribution and control network. A single pump is capable of supplying the normal demands of the vehicle in the cruise regime but, whenever the load requires, the other unit can be set to start or be started manually. The hydraulic oil pressure is routed by means of remotely controlled valves to selected systems where it is converted to the necessary mechanical energy. The following DSRV systems require hydraulic power:

- Main Ballast
- Variable Ballast
- List Ballast
- Trim Ballast
- Transfer Ballast
- Steering Shroud
- Manipulator
- Hauldown Winch
- Shock Mitigation Ring
- ASR Retrieval Arms
- TV Pan Units and Pan and Tilt Units

3-37. Electrical power is converted to hydraulic power in both forward and aft units by a 7.5-horsepower, 3-phase motor that drives a variable-volume, constant-pressure, pressure-compensated pump to produce a fluid flow of 3.5 gallons per minute at 3,000 psi above ambient pressure. A relief valve in the pump output pressure lines relieves hydraulic pressure at 3,500 psi difference to protect the system if the pump's pressure compensator malfunctions. The line pressure is monitored by a differential pressure transducer whose outputs drive a meter on the control panel.

3-38. Each of the hydraulic power units consists of a reservoir with the motor and pump mounted in one end, and the control valve manifold and fluid pressure compensator in the other. The spring-loaded compensator maintains internal reservoir pressure 5 psi above external sea pressure. Sensors warn of a loss of more than 200 cubic inches of hydraulic fluid and of the presence of sea water in the reservoir in an amount sufficient to endanger the system.

3-39. Each reservoir manifold incorporates 14 fluid control valves, the high-pressure relief valve, and the sensors. In addition, it contains the outlet and return ports for transmitting fluid power to various hydraulically actuated components in the vehicle. Fluid in the high-pressure line passes through a 15-micron filter, ensuring that only clean oil leaves the HPU.

3-40. Two relief valves protect the reservoir: one is set to release sea water into the reservoir if the internal pressure falls below the external pressure by more than 15 psi, and the other to release hydraulic fluid to the sea if the internal pressure rises above the external pressure by more than 75 psi. Quick-disconnect fittings on the manifold allow for servicing during surface support operations.

3-41. BALLAST.

3-42. The ballast systems are essentially means for increasing or decreasing the weight of the DSRV, for shifting internal weights in order to change the attitude of the vehicle, and for increasing vehicle displacement to attain surface freeboard. In the first case, the altering of vehicle weight allows it to submerge or to surface. In the second case, the shifting of internal weight elements provides adjustment of the roll and pitch angles, either for attitude control or as a maneuvering aid. In the last case, 6,400 pounds of excess displacement are provided, which gives the vehicle a freeboard of approximately 16 inches when surfaced.

3-43. MAIN BALLAST (FIG. 3-5). The main ballast system allows the DSRV to achieve neutral buoyancy (for submerging) and positive buoyancy (for surfacing). It provides approximately 16 inches of freeboard when the vehicle is surfaced. Neutral buoyancy is established by flooding the main ballast bags with sea water and making final adjustment to buoyancy with the variable ballast system. Positive buoyancy is obtained by expelling sea water from these bags with high-pressure air.

3-44. Essentially, the system consists of four saddle-type bags of elastomer material (two forward and two aft), with a 6-inch flood port and a vent valve for each bag, and a blow valve for each pair of bags. Air pressure for forcing sea water from the bags is stored in a 3,000-psi, 3.7-cubic-foot air flask. Separate controls and valving permit the forward and aft bags to be flooded or blown independently. The high-pressure air flask can be charged from an external source through a manual valve and quick-disconnect fitting inside the stub skirt and topside near the forward main battery. Flask air pressure is monitored by a pressure transducer and a display in the control sphere.

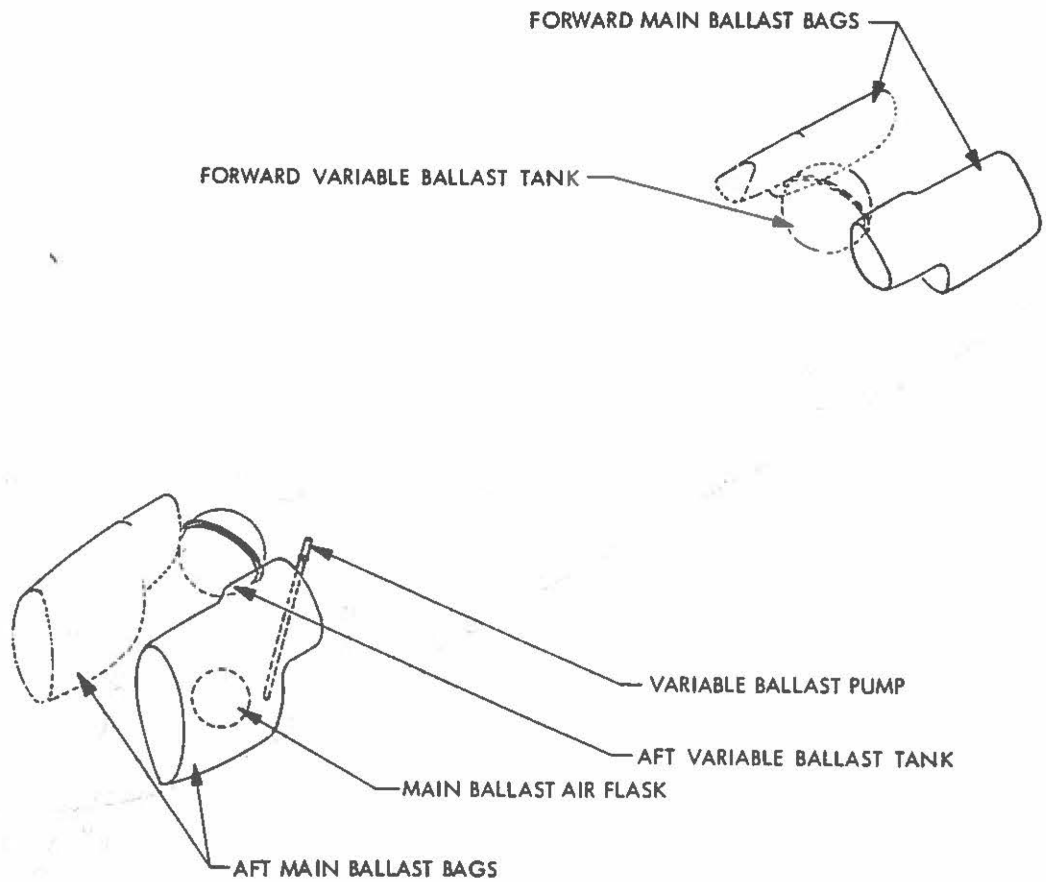

Fig. 3-5 Main and Variable Ballast Systems

3-45. The main ballast bags are flooded for submerging by opening the vent valve at the top of each bag, thus allowing entrapped air to escape and sea water to enter through the flood ports. A single hydraulic actuator controls both forward vent valves; another controls the two aft valves. When the DSRV is floating on the surface, the main ballast bags flood completely in 60 seconds.

3-46. To surface the vehicle from a submerged position, sea water is forced from the ballast bags by momentarily opening the two blow valves (one for the forward pair of bags, one for the aft pair) to admit high-pressure air into the bags. These blow valves are solenoid operated by 28 Vdc power from the emergency bus. "Either/or" controls and a fail-safe design (spring-loaded closed) assure that the vent valves are always closed when the blow valves are open and vice versa. Excessive air pressure in the bags is prevented by flood ports at the bottom of each bag, which are open to local ambient.

3-47. VARIABLE BALLAST (FIG. 3-5). The variable ballast system compensates for variations in vehicle displacement and sea water densities with changes in depth, salinity, and temperature. The system capacity includes a buoyancy reserve of approximately 500 pounds in each tank when the vehicle is neutrally buoyant with 200 pounds of water in each tank at the surface. This system is capable of compensating buoyancy changes at vehicle vertical rates as great as 250 feet per minute below a depth of 600 feet and approximately 50 feet per minute at lesser depth. Net buoyancy is controllable within 20 pounds of neutral under normal conditions. The system is operable at any vehicle angle up to 45 degrees while hovering, and at pitch angles up to 30 degrees while cruising.

3-48. The variable ballast system consists essentially of two high-strength steel tanks (one forward and one aft) and a hydraulically operated sea water pump capable of transferring water ballast to and from the sea via piping, flow control valves, flow-meter, and strainer at a flow rate of 2 gallons per minute. Flow valves are hydraulically actuated.

3-49. During the on-loading of ballast water to increase negative buoyancy, air in the tanks is compressed to accommodate the volume of incoming water. Two relief valves protect the system components from damage that might occur from internal pressures created by the pumping operation. Valves release at 100 psig. Sensors monitor the water weight in each tank and drive meters which display this information in the control sphere.

3-50. Emergency solenoid valves can be used to isolate the ballast tanks should a line rupture or leakage in the system threaten uncontrolled flooding. A manual shut-off valve in the top of each tank permits filling the system with water without pumping.

3-51. LIST AND TRIM BALLAST (FIG. 3-6). These ballast systems are used in both the cruise and hover operation regimes to assist in acquiring and maintaining required vehicle attitudes about the list and pitch axes. During the DSRV mating operations, either with the disabled or the mother submarine, both systems may be used to attain parallelism between the transfer skirt mating flange and the mating surface. Angles of up to 45 degrees on both axes can be attained. The list system is also used to create a compensatory moment for damping out roll disturbances and to vary the distance between the center of buoyancy and the center of gravity (BG). When cruising, the trim system can be used to aid the propulsion and maneuvering system in attaining the desired ascent or descent trajectory by changing the vehicle's pitch up or pitch down attitude to a maximum of 30 degrees. Both list and trim systems depend on the transfer of mercury between tanks to alter the vehicle attitude. In case of emergency, such as loss of buoyancy, the mercury can be jettisoned either by an emergency jettison pump or by gravity drain.

3-52. List Ballast. Essentially, the list system consists of the following: two high-strength steel tanks (one to port, the other to starboard) located near the top side of the external hull in approximately the longitudinal center of the vehicle, one reservoir tank (DSRV-1 only; two smaller diameter reservoir tanks on DSRV-2) directly beneath the top pair in the under side of the hull, a network of piping and control valves connecting the three (four) tanks, and a hydraulically operated pump for transferring contents of the tanks. Each tank is divided internally by a flexible membrane or bladder which separates the oil and mercury in the system.

3-53. In the neutral position, all mercury (approximately 2,845 pounds) is collected in the lower reservoir tank(s) and both upper tanks are completely filled with oil. By selectively rearranging the distribution of oil and mercury among the tanks, the list angle can be changed, the roll disturbances damped, and the BG varied. Mercury is transferred among the tanks by a hydraulically driven pump that moves oil from tank to tank, thereby pushing mercury in the opposite direction.

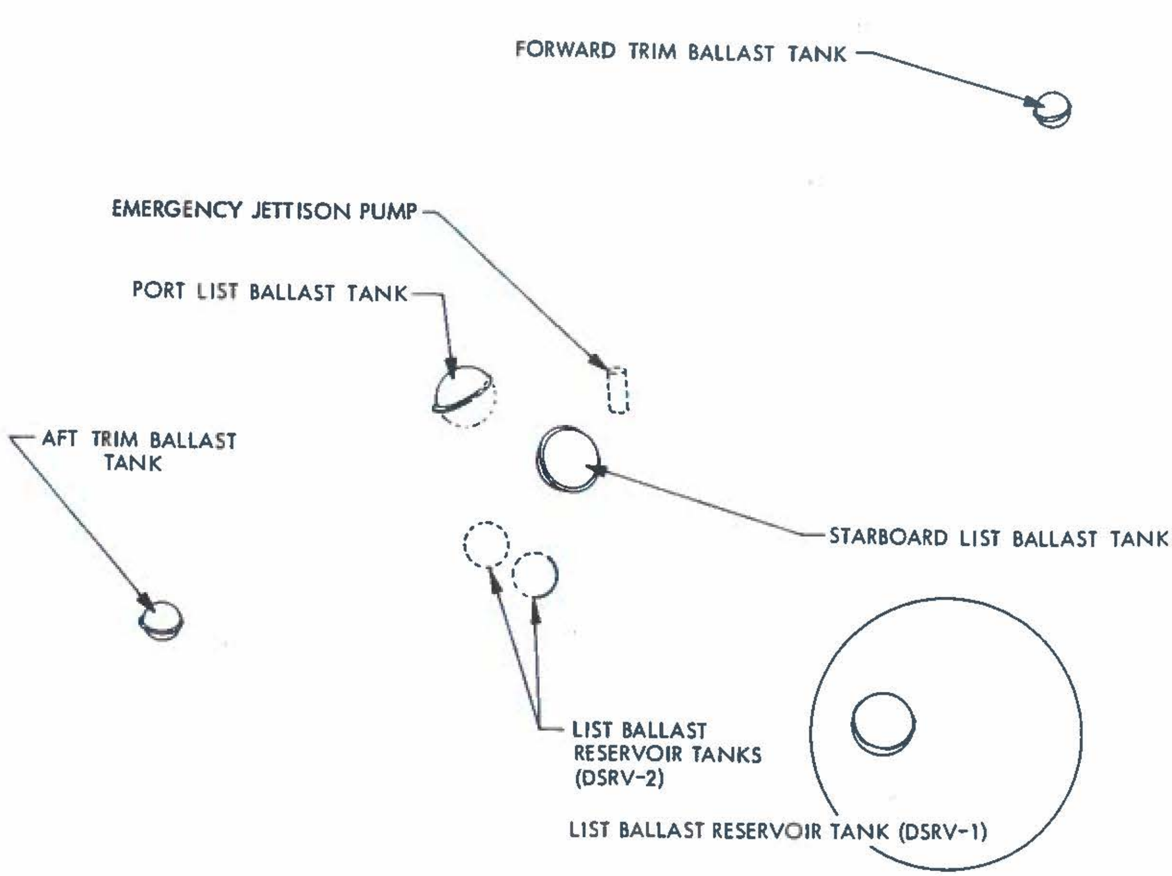

Fig. 3-6 List and Trim Ballast Systems

3-54. To cause the vehicle to list to port from a neutral position, for example, requires the transfer of mercury from the reservoir(s) to the port tank. This is accomplished by positioning control valves so that oil is pumped from the port tank to the reservoir tank. During this transfer, the starboard tank has been isolated from the circuit by the control valves. Reversing pump direction results in transferring mercury from the port tank back to the reservoir(s). Similarly, mercury can be redistributed among all tanks to accomplish any listing requirement. During hover operation of the vehicle, a list angle selected by the pilot will be maintained by the autopilot until countermanded.

3-55. Roll damping moments are provided by transferring mercury between the two high tanks. Because precise movements are required for effective damping, control is supplied by a closed loop through the autopilot. Variation of BG is effected when required by shifting mercury between both high tanks and the reservoir(s). Based on the vehicle displacement of approximately 75,750 pounds, the BG can be reduced to as little as 0.75 inch.

3-56. Oil in the list system is maintained at a pressure of approximately 0.5 to 1.5 psi above the outside environment by two compensators. A relief valve, set to release at 3.0 psid, protects the system from excessive internal pressure. A series of flow control and check valves prevents a hydraulic short circuit or inadvertant dumping of oil during momentary pressure surges.

3-57. Each tank contains a manually operated air bleed valve for oil. Manually operated valves allow for oil and mercury replacement and for mercury drainage. Displays in the control sphere provide a constant indication of the weight of mercury in each of the three (four) tanks. If an emergency requires, approximately 2,845 pounds of mercury in the list system can be jettisoned in 3-1/2 minutes (maximum) at vehicle attitudes as great as 90 degrees in roll and/or pitch.

3-58. Trim Ballast. The trim system operates in much the same manner as the list system; i.e., it transfers mercury ballast (440 pounds) between forward and aft tanks located near the top side of the external hull to alter the vehicle's pitch angle. Unassisted it can achieve pitch up or pitch down angles as much as 25 degrees; with the vehicle BG reduced to its minimum by the list system, angles as great as 45 degrees can be reached.

3-59. Operation of the trim system is by opening and closing a hydraulically actuated control valve and by altering the direction of oil pump rotation. Any pitch angle selected by the pilot during the hover regime will be maintained by the autopilot until countermanded. Pressure compensation in the oil portion of the system, refill and drainage, and jettison are accomplished in the same manner as for the list system. Content of each tank in pounds of mercury is displayed on a continuing basis in the control sphere.

3-60. LIFE SUPPORT.

3-61. The life support system aboard the DSRV provides a safe and comfortable environment for personnel and at the same time protects the electronic equipment in the control sphere against potentially damaging temperatures. The environment provided the crew and rescuees includes a comfortable temperature (heated or cooled as required), an acceptable level of relative humidity, a breathable oxygen/nitrogen atmosphere (with carbon dioxide removed as required), and provision for such personnel fittings and furnishings as seating, restraint harness, illumination, body waste disposal, first aid supplies, and fire protection equipment.

3-62. ENVIRONMENT CONTROL. Each of the three spheres is provided with a separate air conditioning subsystem that controls atmospheric temperature and relative humidity, removes contaminants, prevents the formation of condensate on viewports and display surfaces, and, in the control sphere, cools electronic equipment. The subsystem is capable of maintaining the following temperatures and levels of relative humidity.

Area	Temperature (°F)	Relative Humidity (%)
Control Sphere		
Crew Compartment	65 – 85	30 – 85
Equipment Compartment	45 – 118	No rqmt.
Mid Sphere	65 – 100	95 (max.)
Aft Sphere	65 – 100	95 (max.)

3-63. In the control sphere, the heart of the air-conditioning subsystem is a self-contained Freon compressor refrigeration unit. In operation, the refrigeration unit Freon compressor loop cools a separate glycol-water coolant loop which has separate coils for the crew compartment and sensors and controls equipment. Air, circulated by blowers, is cooled by passing over these coils. Heat, extracted from the air by the glycol-water coolant loop, is in turn absorbed by the refrigeration unit and dissipated to the sea via a separate glycol-water loop to hull-mounted heat exchangers. Should the refrigeration unit malfunction, the two water-glycol loops can be connected directly for modified emergency cooling by hull-mounted heat exchangers.

3-64. Air in the control sphere crew compartment is circulated through filters and lithium hydroxide scrubbers for removal of contaminants and carbon dioxide. Condensate from the cooling coils is collected in a condensate tank. Temperature is thermostatically controlled by throttling the glycol-water coolant loop and, when necessary, activating a resistance heater.

3-65. Three inverters and two converters in the crew compartment are cooled by air circulated by the cabin blower and by independent glycol-water loops that circulate through hull-mounted heat exchangers. All other electronic components in the control sphere are isolated in the equipment compartment. Here cooling results from passing air circulated by two blowers directly over an exposed area of the pressure hull. Additional cooling is provided by two coils of the main glycol-water coolant loop when the air temperature exceeds 96°F.

3-66. Air conditioning in the mid and aft spheres is provided by identical subsystems. Each consists of a single blower which circulates filtered and decontaminated air through two hull-mounted heat exchangers or through two resistance heaters as required (no mechanical refrigeration is provided). A bypass valve controlled by a temperature control valve directs air flow into either the heating or cooling ducts. A tank is provided to collect condensate from the heat exchangers. A portable dehumidifier and blower in the aft and mid spheres can be used to supplement the air-conditioning subsystem when required.

3-67. An atmosphere of approximately one part oxygen and four parts nitrogen is supplied by independent breathing subsystems in each of the three spheres. Essentially each subsystem consists of high-pressure nitrogen and oxygen flasks plus devices for regulating and monitoring pressure and atmosphere content. Partial-pressure sensors determine the oxygen content and automatically actuate valves to correct levels and imbalance. Additional sensors monitor carbon dioxide content and warn of increasing pCO_2 content that results from saturation of the lithium hydroxide scrubbers.

3-68. Under normal cabin atmosphere operation enough oxygen for 48 manhours of consumption is provided in the control sphere, with a reserve supply capable of providing an additional 48 manhours. In both aft and mid spheres, a total of 144 manhours of oxygen is provided. Lithium hydroxide canisters become saturated and must be replaced with onboard spares after approximately 12 hours in the control sphere and after approximately 3 hours in the mid and aft spheres, depending on the CO_2 buildup. Should the normal cabin atmosphere become contaminated by conditions in the disabled submarine, a closed-loop emergency breathing subsystem is available in each sphere. Each emergency subsystem consists of inhale and exhale manifolds (separated by lithium hydroxide canisters), a partial-pressure oxygen sensor, breathing bags, and masks. Masks are provided for pilot and copilot in the control sphere, and for 13 individuals in each of the other two spheres. Oxygen consumption with the emergency breathing subsystem is the same as that of open atmosphere operation, each being dependent only on metabolic activity.

3-69. PERSONNEL FITTINGS AND FURNISHINGS. This category includes two adjustable seats in the control sphere and bench seating provisions for 13 individuals in each of the other spheres. Safety belts are provided at each seat. Personnel movement is aided by convenient handholds, an aluminum ladder, a personnel or cargo winch, and a personnel hoisting sling.

3-70. Interior illumination is provided in all three spheres and in the transfer skirt. An emergency backup system is available should the normal system fail. Portable battery-powered flashlights are also provided. Additional furnishings include body waste containers, first aid supplies, and the necessary stowage containers. Fire extinguishers are provided in each sphere.

3-71. MATING (FIG. 3-7).

3-72. These systems and components of the DSRV are used primarily for the mating sequence of the rescue mission. Mating is essentially the positioning of the DSRV transfer skirt directly over the rescue hatch of a disabled submarine (or the mother submarine), making a watertight seal between the two vessels, removing sea water in the skirt, and opening hatches to provide passageway. The following components and systems are described here: transfer skirt, manipulator, shock mitigation ring, skirt dewatering (transfer ballast), rescuee ballast and holddowns. Those systems which assist the pilot in locating and approaching the disabled submarine's rescue hatch are described in Section 4, Sensors and Control Subsystem.

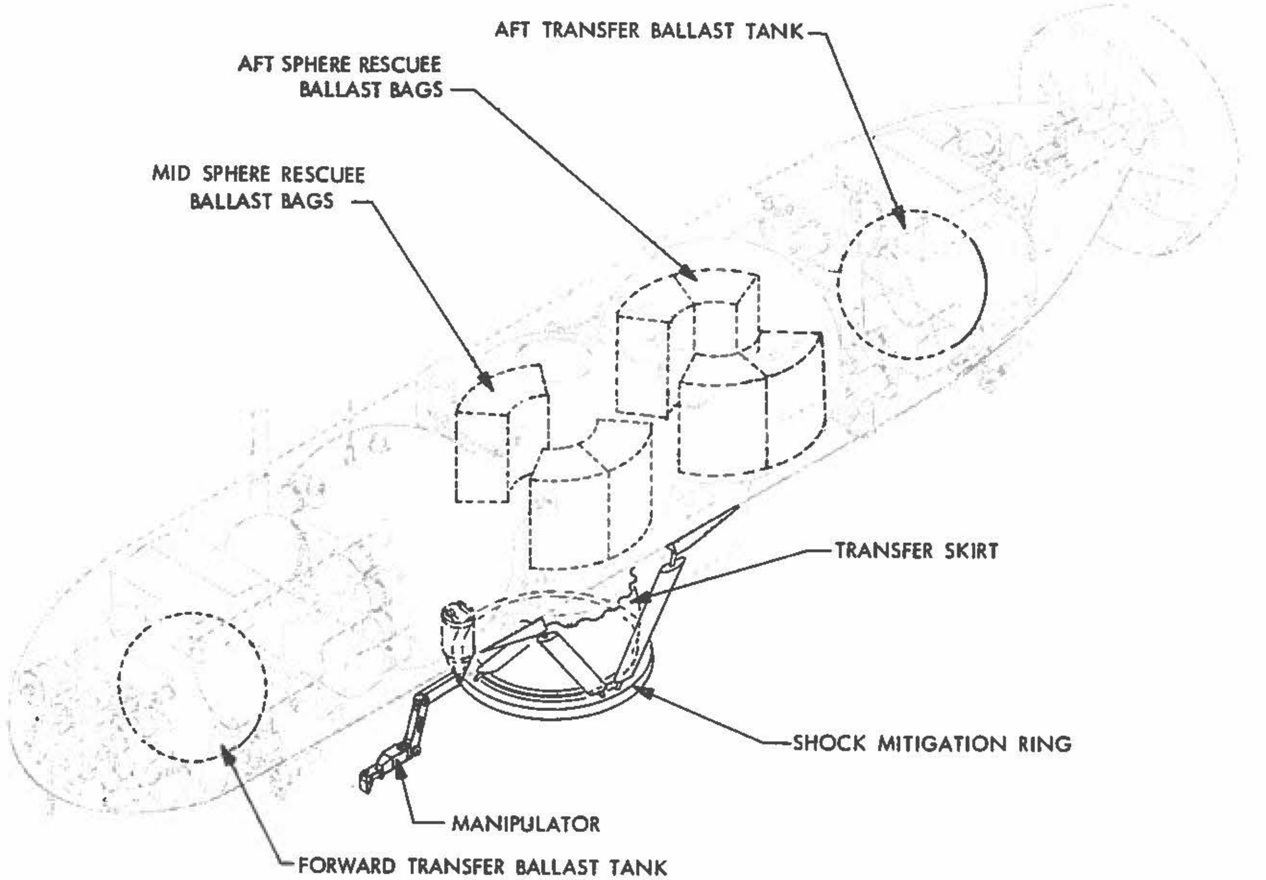

Fig. 3-7 Mating Systems

3-73. TRANSFER SKIRT. The transfer skirt, roughly hemispherical in configuration, is made of the same HY-140 high-strength steel used in the DSRV pressure capsule. It measures 65 inches at its greatest diameter and has a wall thickness of 0.41 inch.

3-74. For mission operation, the transfer skirt is bolted to a stub skirt surrounding the lower hatch of the DSRV. Two O-ring seals at the interface of these mounting flanges ensures a watertight joint. Electrical and mechanical penetrations are provided in the stub skirt for all mating requirements. There are no penetrations in the transfer skirt itself. A double-lip rubber gasket in the under side of the transfer skirt enables the DSRV to maintain a seal with the disabled submarine or mother submarine rescue hatch seat.

3-75. SHOCK MITIGATION. The shock mitigation system provides the means of attenuating impact loads encountered during mating and of protecting the skirt. It consists of a toroidal bumper ring surrounding the transfer skirt and suspended from the external hull structure by eight hydraulic shock absorbers/actuators. The entire assembly can be extended 10 inches below the bottom of the transfer skirt or retracted 3 inches above this point by hydraulically extending or retracting the shock absorbers. A check valve in the fluid line protects other DSRV systems from high transient hydraulic pressures during shock mitigation.

3-76. The shock mitigation ring is at its maximum extension when contact is made with the disabled submarine. It is then gradually retracted as the DSRV is thrust down into contact, and remains retracted while the two vehicles are mated. During demating it is again extended to provide shock mitigation should accidental recontact occur.

3-77. MANIPULATOR. The manipulator is a hydraulically operated mechanical arm capable of remotely controlled maneuvers in six degrees of motion. It is essentially an extension of the arm and hand of an operator inside the pressure capsule. It can perform such tasks as cutting and removing the messenger buoy cable from the escape hatch and removing debris and other obstructions from the mating area. It is stowed within the external hull just forward of the transfer skirt.

3-78. The DSRV manipulator consists of the following components: 1) a mechanical arm assembly which has an operating radius of 93 inches; 2) a terminal device which can grip objects within the 4-inch opening of its jaws, cut wire cables as thick as 5/8 inch, and clean surfaces with a high-velocity water jet; 3) a base pivoting assembly attached to the external hull structure; 4) a stowage actuator; and 5) a portable control device. This control device, consisting of controls and switches, can be removed from the control sphere and operated in the mid sphere when necessary. The jaws in the terminal device are capable of exerting a gripping force from 0 to 1,000 pounds. The manipulator can transmit a 300-pound push/pull force along a line 3 feet below the shoulder joint, and grip and support a 2,000-pound load when fully extended downward. In case of entanglement, the entire manipulator below base assembly can be jettisoned either hydraulically or by pyrotechnics.

3-79. TRANSFER BALLAST (DEWATERING) SYSTEM. The transfer ballast system removes sea water from the transfer skirt after mating in order to provide a suitable passageway between the DSRV and the disabled submarine. The system is capable of pumping 95 percent of the water in the skirt to temporary storage in a pair of high-strength steel transfer ballast tanks. Immediately prior to demating, this water is returned to the transfer skirt.

3-80. As the two vessels approach mating contact, the hydraulically driven pump in the system is started, the circulation valve is opened, and water is pumped out of the skirt and into the sea. Upon touchdown, a seal begins to develop and water flow is restricted. As flow continues to be restricted, the pump, by continuing to remove water from the skirt, develops a pressure differential between the internal skirt and the sea environment, thus tightening the seal by increasing the holddown force between the DSRV and the disabled submarine. After a seal is established, the pump continues until it stalls at a pressure differential of approximately 15 psi. Pressure between the skirt and one of the transfer ballast tanks is equalized at this point by momentarily opening a depressurization valve. The pump can then be restarted and the remaining water directed to either the forward or aft tank (choice depends upon the mating attitude of the vehicle, with the high tank being filled first to allow gravity drain later if neccessary). The hatch is then opened and the remaining water pumped out of the skirt with the flexible suction line or drained into the escape trunk of the disabled submarine.

3-81. Return of transfer ballast to the skirt is essentially the reverse of the process described above. After both tanks have been emptied into the skirt, the skirt-to-sea pressure equalization valve is opened. Once this pressure is equalized, the seal is no longer effective and demating can be achieved. Entrapped air in the transfer skirt after demating is released through an electrically operated vent (burp) valve.

3-82 RESCUEE BALLAST SYSTEM. This ballast system is used to maintain DSRV neutral buoyancy by discharging water ballast equal in weight to that of the rescuees taken on board. Primary components of the system are seven collapsible nylon and neoprene fabric bags supported on the personnel benches in the mid and aft spheres, flexible hose lines, air flasks, and a flowmeter. They contain a total of approximately 4,100 pounds of sea water.

3-83. In operation, the flexible hoses are positioned so that water ballast can be discharged down the escape trunk of the disabled submarine. The rescuee's weight is estimated on boarding the DSRV and an equal weight of water is discharged. The amount of water discharged is measured by a flowmeter which produces a readout in pounds on a display panel in the mid sphere. Pounds remaining are also displayed. Water flow is begun initially by opening the drain valve and, if required, momentarily applying air pressure to start a siphoning action. Empty containers collapse in an accordion fashion to provide seating space for rescuees.

3-84. Bags are refilled between rescue trips from the support ship's sea water system. The flowmeter registers the number of pounds taken on board. Venting valves and pressure relief valves are provided. Air flasks are portable and can be replaced with spares carried in the life support resupply unit if required.

3-85. HOLDDOWNS. The holddown system consists of four steel turnbuckles which provide a mechanical connection between the transfer skirt and the disabled submarine. This ensures a watertight seal whenever external hydrostatic pressure is insufficient to maintain such a seal, e.g., when mating in shallow water, during mated surface transit, or when mated to the forward hatch of the mother submarine. Turnbuckles are removed prior to demating.

3-86. ALTERNATE MISSION. Refer to NAVSHIPS 0905-097-7010.

3-87. SUPPORT VESSEL INTERFACES.

3-88. Included in this category are those components, either integral with the DSRV structure or attached as required, that provide the physical interfaces between the vehicle and the support vessel.

3-89. ASR OR SHIP OF OPPORTUNITY. The DSRV regular lift fittings provide sling attachment points when hoisting the vehicle from dockside onto either the ASR or the ship of opportunity. When on board, the DSRV regular support fittings are latched to a cradle/dolly.

3-90. Special hydraulically actuated retrievel arms, attached forward at points on the port and starboard sides of the DSRV, serve as positioning devices when submerged recovery is made through the ASR center well. These arms may be removed when not operating from the ASR. In operation, a rectangular platform, suspended by cables at each corner and carrying a support cradle, is lowered through the well by the ASR overhead bridge crane. The DSRV maneuvers through the aft pair of cables, extends the retriever arms outboard when clear of these cables, and uses the arms to capture the forward cables. With these forward cables engaged, the DSRV thrusts down until the support fittings engage the cradle latches. Thus secured, the vehicle is hoisted to deck level.

3-91. MOTHER SUBMARINE. The DSRV is hoisted atop the mother submarine from dockside, using a sling attached to the regular lift fittings and a locally available hoisting unit. In the piggyback position on the mother submarine, the DSRV regular support fittings latch into four pylons bolted to the submarine hull. In this position, the DSRV transfer skirt is mated to the submarine's aft rescue hatch. The same hold-downs used for rescue mating may be used as an adjunct to the pylon latch mechanisms.

ICAD Replaced

Section 4
SENSORS AND CONTROL SUBSYSTEM

4-1. GENERAL.

4-2. The DSRV sensors and control system, summarized in terms of its principal elements in Section 2, is described in greater depth in this section. Order of presentation is the same and conforms to the following arrangement:

- OPTICS
  - TV Cameras
  - Still Camera
  - Lights
  - Viewports
- NAVIGATION
  - Inertial Navigator
  - Doppler Sonar
  - Navigation Data Plotter
  - Altitude/Depth Sonar
  - Depth Pressure Transducer
  - Transponder Interrogation Sonar
  - Homing Transponder
- SONARS
  - Horizontal Obstacle Sonar
  - Vertical Obstacle Sonar
  - Short Range Sonar
- COMMUNICATIONS
  - UHF Radio
  - Underwater Telephone
  - Directional Listening Hydrophones
  - Internal Communications

- COMPUTERS
  - Central Processing Computer
  - Timing Coordinator
  - Computer Control and Display Panel
  - Autopilot Digital Differential Analyzer
- VEHICLE SYSTEMS OPERATING INDICATORS
  - Propulsion
  - Ballast
  - Mating
  - Life Support
  - Power
- SHIP CONTROL
  - Control Regimes
  - Control Modes
  - Emergency Jettison

4-3. The DSRV is equipped with an array of sensing devices that gives the pilot and copilot current information on conditions prevailing in every system of the vehicle and in the adjacent ocean environment, on the position of the vehicle relative to known reference points, and on changes (and rates of change) affecting this position. Information obtained by these sensors is displayed by meters, sonar and television screens, digital readouts, plotters, sound reproducers, and other devices. In addition to actuating these display devices, some of this information is computer-processed and routed to ship control equipment where it serves as feedback for automatic corrective action.

4-4. Ship controls provide the pilot and copilot with mechanisms for maneuvering the vehicle along its three linear axes, for rotating it around these axes, and for operating all other subsystems aboard the vehicle. Controls have been designed with various levels of redundancy to provide backup modes of operation in the event of component failure.

4-5. <u>OPTICS (FIG. 4-1).</u>

4-6. The DSRV optics provide a capability for visual sighting, pictorially displaying, and photographically recording scenes and events in the ocean environment immediately

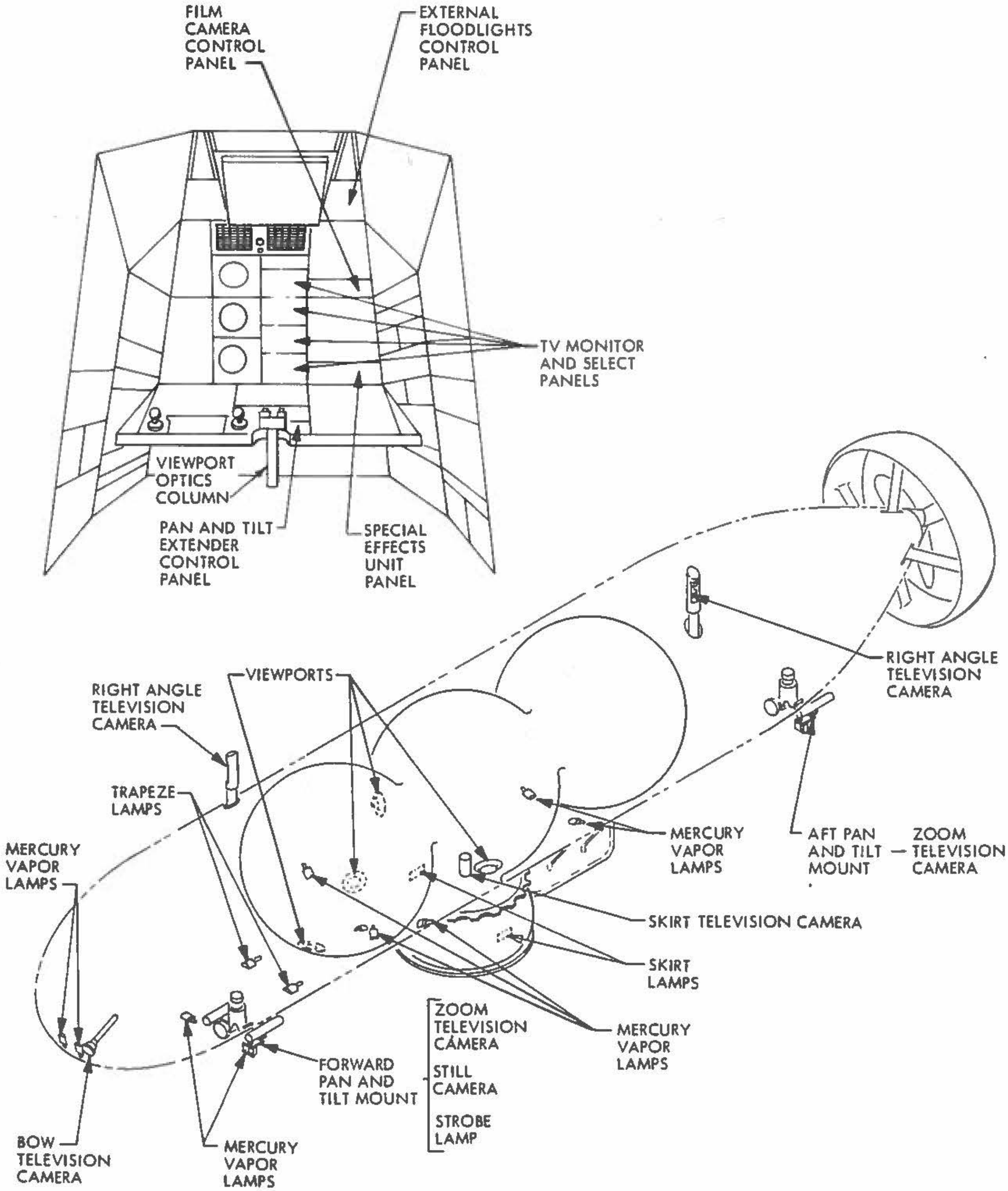

Fig. 4-1 Optics Sensors, Controls, and Displays

surrounding the vehicle. Six television cameras (five on the external hull and one in the mid sphere) electronically photograph the surrounding area and transmit their video signals to four TV monitors in the control sphere. Viewports in the control and mid spheres provide a direct viewing capability. A still camera supplies permanent records of external events. A 16-mm motion picture camera can be mounted externally for alternate missions. A floodlighting arrangement supplies the necessary illumination for viewing and photography.

4-7. TV CAMERAS. Two wide-angle television cameras – one in the bow pointing forward and 20 degrees below horizontal, the other pointing down through a viewport in the mid sphere lower hatch – provide views in these areas. The cameras are identical and are supported on fixed-direction mounts. Each is equipped with a 7.9-mm, f/1.5 lens that can be focused from 3 inches to infinity. Its field of view in water is 72 degrees horizontal and 57 degrees vertical. Focus and iris control is provided by switches near the television monitor screen. The mid sphere camera provides a view of the rescue hatch of the disabled submarine during the mating operation. A cue dot, projected by the special effects unit onto the TV image, aids the pilot in aligning the transfer skirt over the rescue hatch.

4-8. Two television cameras which can be rotated and tilted are mounted on the underside of the vehicle, one forward of the control sphere, the other aft of the aft sphere. These mounts allow the cameras to be withdrawn completely inside the external hull or extended for viewing. Switches controlling retraction and extension together with position indicators are located on the pan and tilt extender panel. Each camera is equipped with an f/2 lens whose focal length can be varied between 13 to 52 millimeters. Fields of view vary as to focal length selected and range from 10 to 36 degrees horizontal and from 7.5 to 27 degrees vertical. The camera mount can be rotated through 350 degrees in the horizontal pan axis and through 210 degrees in the vertical tilt axis. Controls for pan, tilt, focus, iris, and zoom are located adjacent to the TV monitor screens.

4-9. Two additional television cameras are mounted on the topside of the vehicle, one forward of the control sphere and slightly to starboard of the centerline, the other aft of the aft sphere and to port. Their mounts, retractable inside the external hull, can be extended and rotated through 350 degrees in the horizontal pan axis.

Cameras are mounted with their longitudinal axis vertical; a 45-degree mirror provides for horizontal viewing. Each camera is equipped with an f/1.2, 12.5-mm lens that can be focused from 3 inches to infinity. The field of view is 44 degrees horizontal by 33 degrees vertical. Panel controls are the same as those provided for the pan and tilt cameras.

4-10. STILL CAMERA. An electrically driven 35-mm still camera is located on the forward pan and tilt mount. It is equipped with a special f/4.5 lens designed to compensate for distortion caused by the water-glass-air interface. The camera field of view is 51 degrees horizontal by 33 degrees vertical with a focal range from 3 feet to infinity. The camera is capable of exposing approximately 500 frames from a standard 100-foot roll of film. With each exposure, the camera also photographs an internal chamber containing a depth gage, clock, and frame counter. Single exposures can be made manually or the camera can be set to expose a frame every 4, 6, 8, 10, 12, or 14 seconds. Controls for single exposures or automatic cycling, together with a frame counter for the camera, are located on the film camera control panel. For secondary missions, a 16-mm movie camera and light can be substituted for the still camera, if desired. The still camera and its strobe light are then moved to the aft pan and tilt.

4-11. LIGHTS. Illumination for direct viewing and for the field of view covered by all TV cameras (except that in the mid sphere) is supplied by 175-watt mercury vapor lamps. Lamps for the bow TV camera are fixed but those for the topside pan cameras and the underside pan and tilt cameras are mounted on and move with these units. Two 75-watt quartz-iodide lamps in the transfer skirt illuminate the area covered by the mid sphere TV camera. Other areas are illuminated by four mercury vapor lamps (two forward of the transfer skirt and two aft) and two quartz-iodide lamps aft of the forward pan and tilt unit. Switches for all mercury vapor and quartz-iodide lamps are located on the external floodlights control panel. A high-intensity strobe lamp synchronized with the shutter of the 35-mm still camera provides illumination for this unit. If a movie camera is installed, a 1,000-watt incandescent floodlight replaces the strobe light on the forward pan and tilt unit.

4-12 VIEWPORTS. These transparent penetrations through the walls of the pressure capsule provide a direct viewing capability. Two viewports are located in the control sphere (one forward, one aft and to starboard, both pointing downward at an angle of approximately 45 degrees). Another two are in the walls of the mid sphere (one to port, the other to starboard, both pointing about 45 degrees downward). The mid sphere starboard viewport permits observation of the manipulator arm and its terminal device when they are used to cut the disabled submarine message cable and clear the disabled submarined escape hatch. A fifth in the center of the lower hatch is used by the skirt television camera or for visual observation of conditions in the skirt.

4-13. An optical column allows observation through the control sphere forward viewport by pilot and copilot from their seated operating positions. It provides stereoscopic observation by either man or simultaneous monocular viewing by both men while seated in their regular positions. The principal use for this viewport optical system is observation while mating with the mother submarine and for general observation. Field of view is approximately 70 degrees at unit magnification. Maximum viewing distance with the vehicle's floodlight system is approximately 100 feet in clear water. The column can be folded between the seats when it is not used.

4-14. NAVIGATION (FIGS. 4-2 AND 4-3).

4-15. For accurate navigation in deep ocean environments, an inertial platform and other onboard sensors are used on the DSRV to generate accurate indications of geographic positions (latitude, longitude, and depth). This navigation task includes return to a given location (e.g. , disabled submarine or mother submarine) after a period of search and maneuvers. The equipments used in DSRV navigation are as follows:

- Inertial Navigator
- Central Processing Computer
- Doppler Sonar
- Altitude/Depth Sonar
- Transponder Interrogation Sonar
- Sound Velocimeter

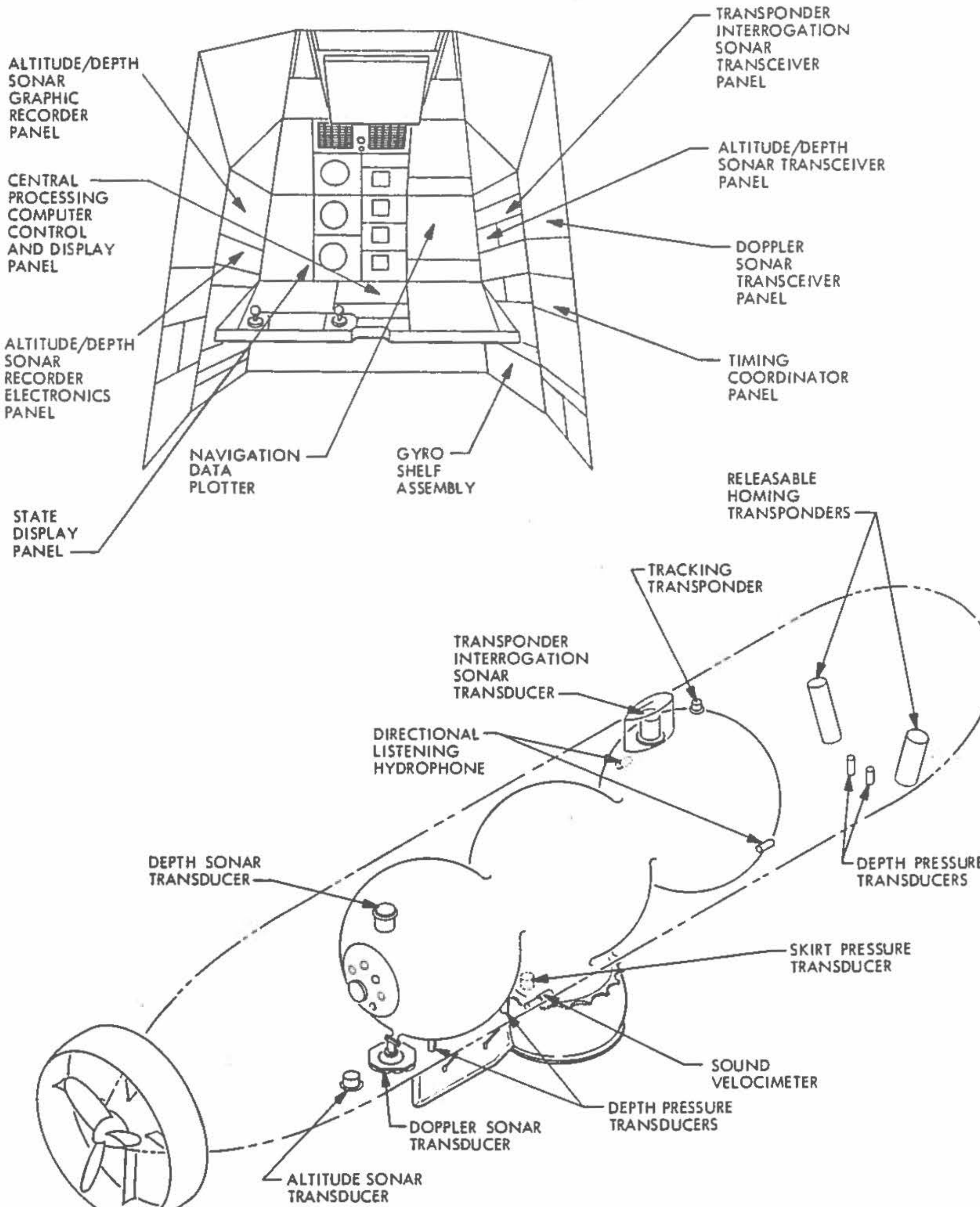

Fig. 4-2 Navigation Sensors, Controls, and Displays

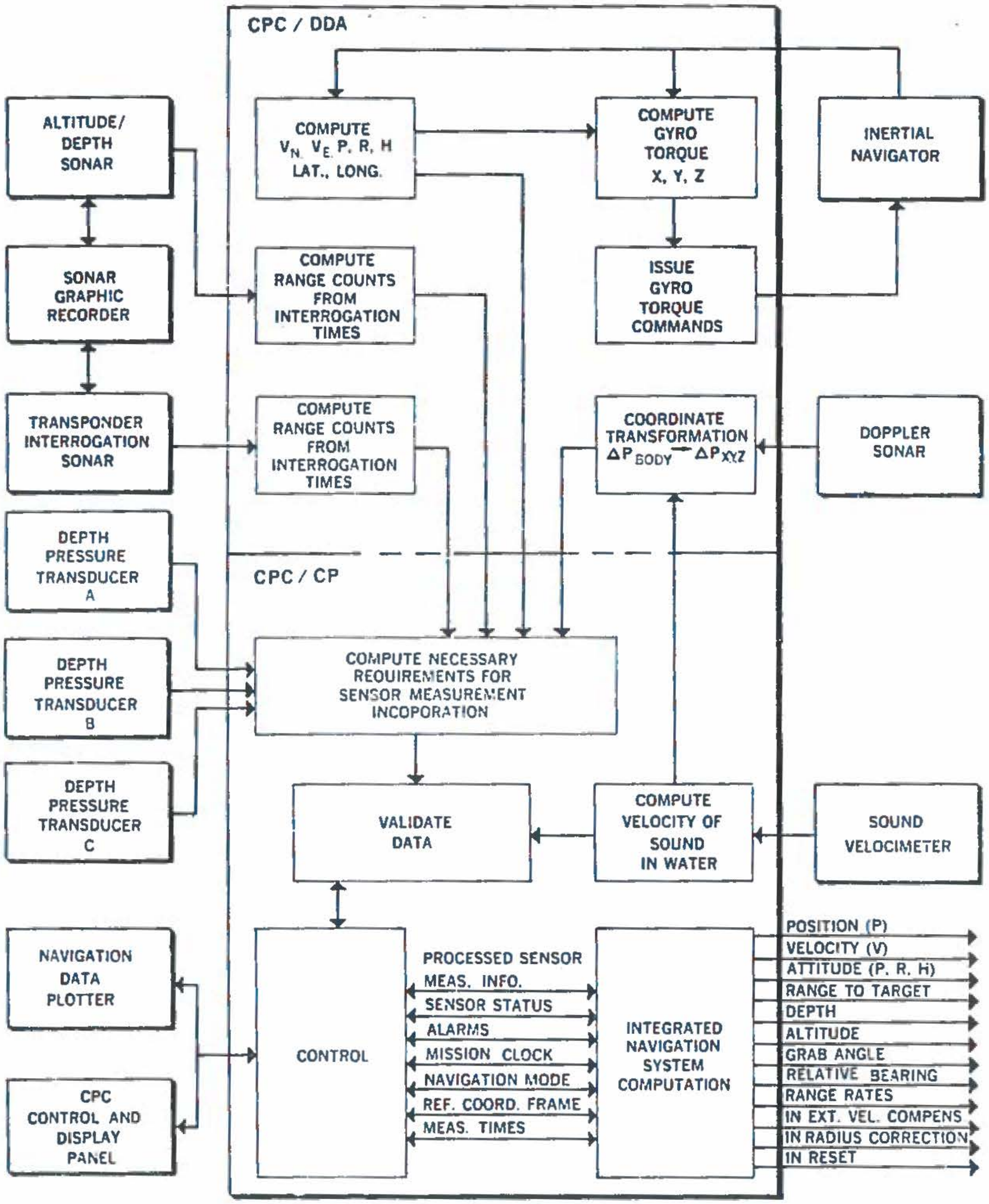

Fig. 4-3 Navigation Functional Block Diagram

- Depth Pressure Transducer
- Navigation Data Plotter (ancillary equipment)
- Sonar Graphic Recorder (ancillary equipment)

4-16. Each navigation sensor provides 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 Fig. 4-3. As shown, there is redundancy in the information available from the sensors, and 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 are accomplished in a Kalman filtering formulation. This technique provides a method by which navigation data, as they become 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 establishing the relative weights 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 technique, therefore, makes it possible to integrate the various navigation sensors into a single navigation system.

4-17. Following is a simplified description of navigation computation process. 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 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.

4-18. INERTIAL NAVIGATOR. The inertial navigator performs the following functions:

- Provides a true north reference for vehicle heading (on azimuth) data
- Provides a local vertical reference for vehicle pitch and roll data

This information is used as the primary source for 1) displaying vehicle attitude/heading indication to the pilot, 2) inputs to the vehicle navigation system, and 3) attitude control of the vehicle (after some coordinate transformation).

4-19. The inertial navigator consists of three single-degree-of-freedom integrating gyros, two single-degree-of-freedom integrating accelerometers, gimbal mounting for these operational elements in an inertial "platform" arrangement, and a helium-filled sealed aluminum housing. The accelerometers are used to sense the earth gravity vertical; the sensed signals are used to align the inertial navigator platform precisely perpendicular to the vertical. The gyroscopes are used to align the platform to true north.

4-20. The output from the inertial navigator is obtained from the platform gimbal angles. These outputs are displayed on the state display panel (prime azimuth, fine roll, and pitch) as vehicle attitude with respect to the inertial reference. At the same time these initial data are fed to the central processing computer, which processes the data for navigation purposes and for attitude control of the vehicle.

4-21. Backup in the event of inertial navigator failures is provided by a gyro shelf assembly which senses vehicle pitch, roll, and yaw, and drives course pitch and roll displays. The directional gyro in this assembly is normally slaved to the inertial navigator to correct its approximate drift of 6 degrees an hour.

4-22. DOPPLER SONAR. The doppler sonar is used to provide an accurate measurement of velocity along the DSRV's three linear axes. The outputs are used 1) to drive displays on the ship state display panel (knots for the fore/aft and port/starboard axes; feet per minute for the vertical axis), 2) for vehicle stationkeeping to automatically maintain the vehicle stationary with respect to ocean bottom, 3) as input to the DSRV navigation system for use in automatically computing vehicle dead-reckoning position.

4-23. In operation, four sonar beams are directed 30 degrees to the vehicle vertical axis and 45 degrees to the vehicle fore-aft axis. This is accomplished by a symmetrical array of projectors/ hydrophones mounted on the underside of the vehicle aft of the transfer skirt. Within approximately 350 feet of the bottom, velocity relative to the ocean floor is measured by the doppler shift of each of the four beams.

4-24. A sound velocimeter automatically measures precisely the velocity of sound in water. It is used to calibrate the doppler sonar and all other sonars which incorporate the speed of sound in their operations. In operation, two electro-acoustic transducers and a reflector are mounted on the external hull to form a sound path of known length. A signal is transmitted by one transducer, reflected, and received by the other transducer. Timing circuits measure the time of travel.

4-25. NAVIGATION DATA PLOTTER. The navigation data plotter produces a permanent trace of the vehicle dead-reckoning track in the horizontal plane. It is also used for hand plotting transponder locations and other selected targets. The plotter operates from signals generated by the central processing computer. In the event of plotter failure, the operator can acquire DSRV position from the computer and manually plot his position on the plotting surface with a felt tip pen.

4-26. ALTITUDE/DEPTH SONAR. The altitude/depth sonar is used to measure accurately and to make a permanent record of the DRSV's position relative to the ocean's bottom and surface. Measurements of altitudes and depths for ranges up to 10,000 feet are permanently traced on calibrated paper by a graphic recorder. These measurements are also displayed in digitized form on the state display panel. Accuracy indications of altitude or depth is not affected by vehicle attitudes up to ± 7.5 degrees of trim or list.

4-27. In operation, the altitude/depth sonar projects acoustic signals in two 15-degree vertical cones through transducers mounted on the top and underside of the vehicle, and measures travel time of their reflections from ocean bottom and surface.

4-28. DEPTH PRESSURE TRANSDUCERS. Two transducers located in the bow section of the vehicle and one transducer located in the aft lower midbody section are used to measure hydrostatic absolute pressure for determining vehicle's depth from ocean surface. Output of the bow transducer is processed by the central computer, then routed in digitized form to the state display panel and also to the navigation system. Range of output is from 0 to 4,000 psia (9,000 feet). Through continuous comparison by the computer of depth transducer outputs, the computer automatically selects one of the three as the operating transducer.

4-29. TRANSPONDER INTERROGATION SONAR. This sonar projects an acoustic signal which triggers a return signal from a transponder carried aboard a support vessel or from a moored transponder dropped to mark a specific navigation reference point, e.g., the site of the disabled submarine. The transponder can be preset to operate on any one of ten different frequencies between 12.5 and 17 kHz and thus can be positively identified. The return signal is detected and identified by the receiver portion of the interrogation sonar, is then sent to the graphic recorder as a range display, to the central computer for navigation computation, and to the state display panel where it is displayed as bearing. Maximum range is 6,000 yards.

4-30. Two deep ocean transponders (homing transponders) which can be dropped as marker beacons are carried aboard the DSRV. In addition, a similar transponder, permanently mounted on the vehicle (known as the tracking transponder), can be interrogated by a surface ship or mother submarine. From the return signal the support vessel can determine the range and bearing of the DSRV.

4-31. SONARS (FIG. 4-4).

4-32. Sonars in this group are concerned with obstacle avoidance (the horizontal obstacle sonar and the vertical obstacle sonar) and with providing a visual display of the disabled submarine for close approach and mating operations (the short range sonar).

4-33. HORIZONTAL OBSTACLE SONAR. The horizontal obstacle sonar is used to detect the bearing and range of objects lying in the longitudinal plane of the DSRV. It

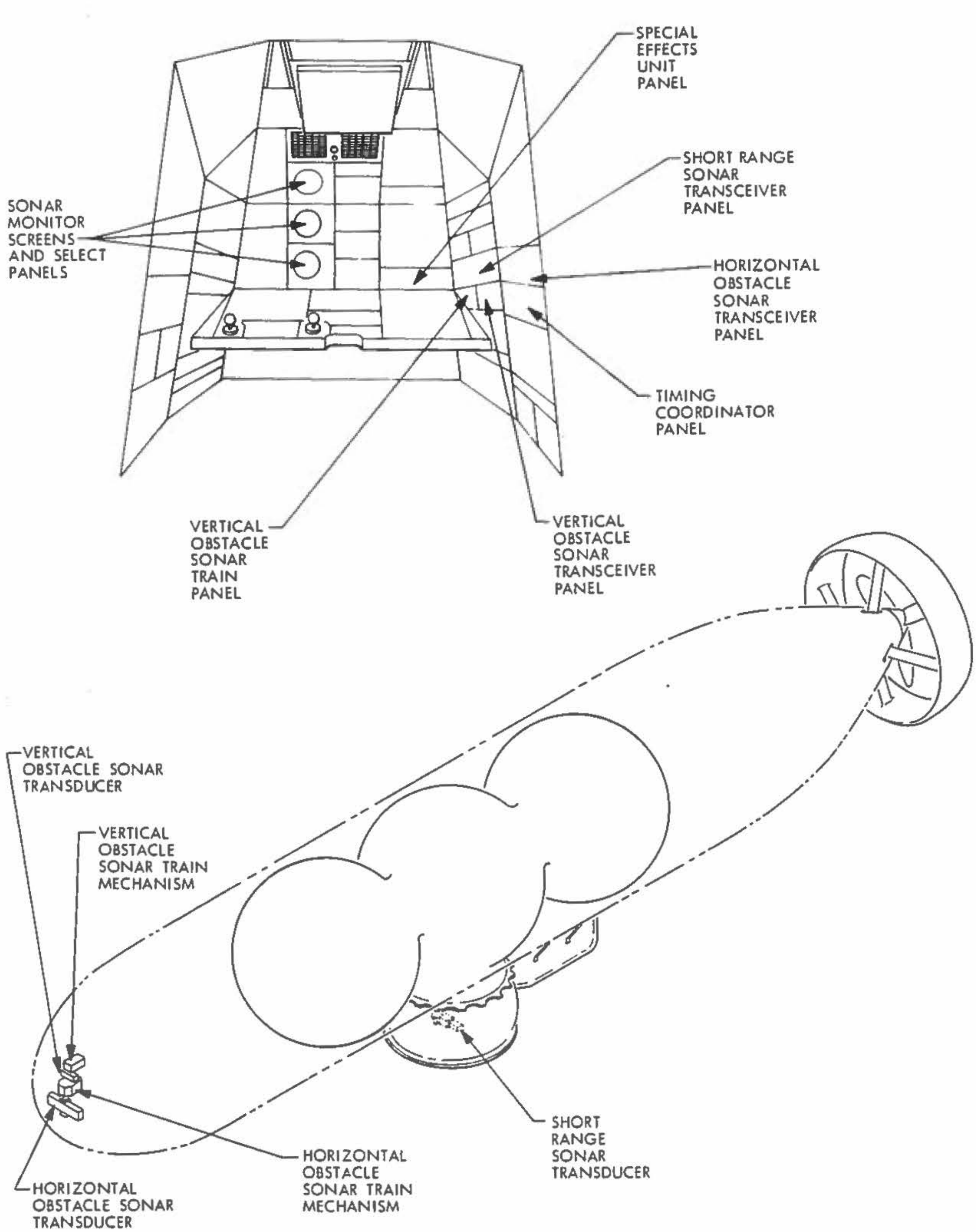

Fig. 4-4 Obstacle Avoidance and Mating Sonar Sensors, Controls, and Displays

is capable of this detection in a sweep that extends approximately 90 degrees to port and to starboard of the bow, and at ranges from 10 to 1,500 yards (in four range scales). Visual displays are monitored on one of the three sonar screens in the control sphere; audio signals are monitored by speaker or headset.

4-34. Scan modes can be either automatic or manual. In automatic, the transducers rotate 25 degrees per second to scan a sector of 180 degrees (centered on the vehicle's heading) or a narrower sector 60 degrees wide centered on any azimuth position. In the manual mode, the scanning transducers can be stopped or controlled to rotate in either direction within the limits of ±90 degrees to port or starboard. Resolution is approximately ±2 percent of full scale for range and ±2 degrees for bearing. The vertical angles of the transducers are 15 degrees from horizontal.

4-35. VERTICAL OBSTACLE SONAR. The vertical obstacle sonar is used to indicate the height and range of objects that lie ahead of the vehicle, and serves to complement the horizontal obstacle sonar for the obstacle avoidance function. A train control allows the sonar beam (60 degree high by 5 degrees wide) to be aimed within ±45 degrees from the vehicle fore/aft axis. The vertical obstacle sonar does not automatically train or rotate back and forth. A 100- or 500-yard range can be selected. Resolution is approximately 3 yards for range and 2 degrees for height of obstacle.

4-36. SHORT RANGE SONAR. The short range sonar provides a visual display of the view looking downward through the DSRV transfer skirt and thus assists the pilot in locating the disabled submarine's rescue hatch and successfully mating with it. The sonar is designed to operate in two ranges – a 20- to 150-foot medium range and a 2- to 15-foot high-resolution range. The former is used for locating and identifying the rescue hatch, the latter for the actual mating. Approximate range and the relative angles between the DSRV and the hatch can be determined from the sonar displays.

4-37. In operation, two transducers are rotated to scan the area of view – one transducer scans fore and aft, the other from port to starboard, each through a 90-degree arc. Results from each scan are displayed on separate sonar monitor screens. The special effects unit superimposes on the displays a floating dot for range determination and the relative attitude of the two vehicles.

4-38. COMMUNICATIONS (FIG. 4-5).

4-39. The equipment in this category provides personnel aboard the DSRV the means of communication with support ships and the disabled submarine. Also provided is internal communication between the control sphere and the other two spheres.

4-40. UHF RADIO. This UHF receiver-transmitter provides two-way radiotelephone communication between the DSRV when surfaced and the support ship or other surface vessel. It is amplitude-modulated and capable of transmitting and receiving on any one of 20 preset channels in the 225 to 400 MHz band. A separate emergency operating frequency (guard) of 243 MHz is also provided. In addition to its use as a voice transceiver, it can also be used to transmit a tone-modulated signal to aid the support vessel to home in and locate the DSRV after surfacing.

4-41. UNDERWATER TELEPHONE. The underwater telephone provides voice or continuous wave (CW) communication between the DSRV and its support vessel (either the mother submarine or the surface support ship) and the distressed submarine. Normal voice communications are transmitted in the form of amplitude modulated sound waves; continuous wave transmissions are in the form of constant amplitude, manually keyed sound waves. Transducers mounted on both the top and under sides of the vehicle allow for transmission when submerged or surfaced. Operating frequency is 8.087 kHz. Depending on sea state and ambient noise level, a maximum operating range of approximately 3 miles horizontally and over 7,500 feet vertically can be attained.

4-42. DIRECTIONAL LISTENING HYDROPHONE. This unit provides a means of determining the direction of underwater sounds. It permits the DSRV, through biaural or stereo detection of acoustic signals (particularly those sonic signals generated by hull hammer blows),to home in on such an acoustic source. Signals are received by two hydrophones mounted on opposite sides of the external hull and separated acoustically by the control sphere. The operator, by listening to the time delay and intensity difference between the two signals, can determine the direction of the signal source. The effective range for detecting hammer blows is about 5,000 yards.

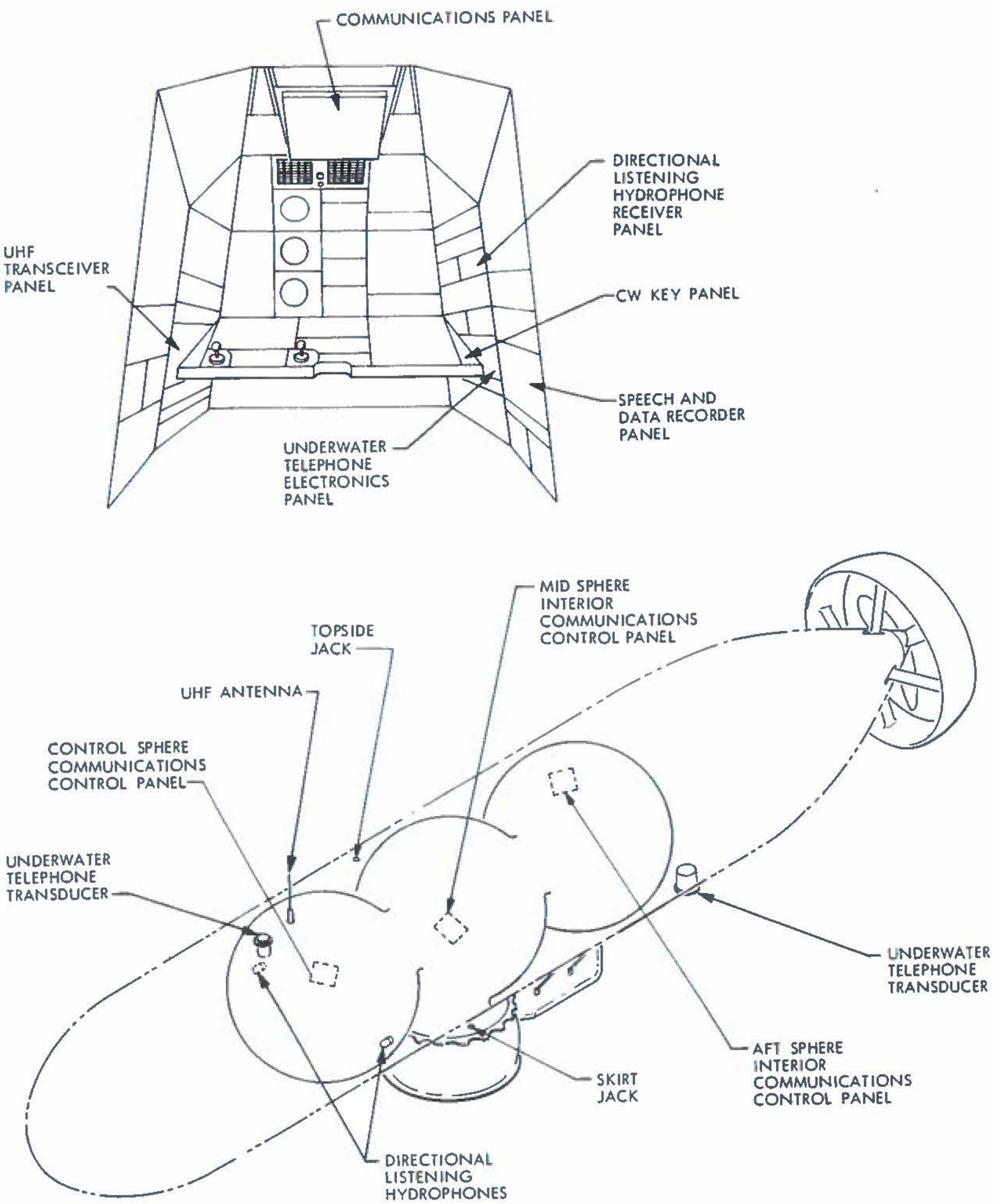

Fig. 4-5 Communications Sensors, Controls, and Displays

4-43. INTERNAL COMMUNICATIONS. Communication between the control sphere, the two other spheres, and the two external stations (inside the DSRV skirt and upper trunk) is supplied by an internal communications system. A speaker and connections for a headset and microphone and a hand microphone with push-to-talk switch are located in each sphere. Controls, in the control sphere, for both internal and external communications are located on the communications control panel directly in front of and slightly above the pilot and copilot. All voice signals, a timing code, and inputs from both channels of the directional hydrophone are recorded on magnetic tape in a speech and data recorder during mission operations. It records the following: all ICS voice, computer timing signals, UHF radio, DLH signals, UWT communications, and computer digital information.

4-44. COMPUTERS.

4-45. A central computer, coupled with a timing coordinator and a recorder/reproducer, satisfies the bulk of data processing requirements aboard the DSRV. A separate digital differential analyzer in the autopilot processes inputs from sensors on vehicle attitude and rates and from pilot commands for ship control.

4-46. CENTRAL PROCESSING COMPUTER. The central processing computer is an integral package incorporating 14 major integrated circuit elements. It includes 18 logic modules, 4 analog modules, 2 memory core units, a delay line, and a power supply. It is divided into two operating sections: 1) a general purpose section for performing low iterative, random real-time computations, used primarily for decision functions and interface servicing; and 2) a digital differential analyzer for high iterative, continuous real-time computations used for control purposes. The latter is addressed through the general purpose section.

4-47. TIMING COORDINATOR. The timing coordinator is a sequential timing-switching electronics package used primarily for reducing interference among the sonar acoustic beams by correlating their transmissions. It also provides interfacing between the central processing computer, the speech and data recorder, and the sound velocimeter.

4-55. BALLAST. Meters on the ship control panel display the following data concerning DSRV ballast systems: 1) main ballast: pressure of air in the high-pressure flask used for blowing the main ballast bags: 2) trim ballast: pounds of mercury in the forward and aft tanks; 3) variable ballast: pounds of sea water in the forward and aft tanks; 4) list ballast: pounds of mercury in the port, starboard, and reservoir tanks; the meter for the reservoir also indicates list and trim angles achievable for any given BG condition.

4-56. MATING. Meter indications of the elements involved in DSRV mating are 1) shock mitigation ring: whether fully extended or retracted; 2) transfer skirt: internal/external differential pressure, absolute pressure; 3) transfer ballast: pounds of sea water in forward and aft tanks; and 4) ASR retrieval arms: whether extended and whether engaged.

4-57. LIFE SUPPORT. Meters monitor temperature, pressure, and atmosphere content in various areas and display this information on the life support panel: 1) equipment compartment of the control sphere: temperatures and pressure differentials in selected areas; 2) crew compartment of control sphere: absolute pressure of oxygen and carbon dioxide in the atmosphere; and 3) mid and aft spheres: absolute pressure of oxygen and carbon dioxide in the atmosphere in each sphere.

4-58. POWER. Meters monitor voltage levels, main battery current drain, and line isolation in the power systems and display this information on the main power monitor panel. The hydraulic power supply pressure is monitored on the ship control panel.

4-59. <u>SHIP CONTROL.</u>

4-60. The ship control and display system provides operators of the DSRV with adequate knowledge of the vehicle's position, attitude, and systems operation, and with mechanisms for maintaining or changing these conditions. In essence, the displays supply data required for decision-making; the controls provide the requisite devices for implementing these decisions. Displays have been considered earlier in this section along with the sensors which supply them with appropriate inputs, and will be considered here only as they relate to the pilot's operation of the ship control subsystem.

4-61. CONTROL REGIMES. Ship controls on the DSRV have been designed to ensure complete control of the vehicle during all phases of the rescue mission. These phases impose two basic requirements: high-speed travel between the support vessel and low-speed hovering maneuvers, with explicit control in six degrees of freedom that allows successful mating with a disabled submarine. The high-speed cruise regime is characterized by a surge velocity in excess of 2.3 knots and the use of the steering shroud to effect changes in yaw and pitch. The hover regime prevails at speeds less than 2.3 knots and uses the ducted thrusters to achieve direct translation along the port/starboard and up/down axes. The shroud and thrusters are mutually exclusive in the two regimes.

4-62. Under ordinary circumstances, the pilot will select the cruise or hover regime based on the vehicle velocity and battery power available.

4-63. Commands to the vehicle effectors (main propeller, shroud, thrusters, and list and trim ballast) to change or maintain position and attitude are received from two sources: closed-loop sensor feedback (i.e., rate gyros and attitude gyros) and inputs from the pilot hand controllers. The extent of automatic sensor feedback control to be employed is a function of the different control modes available. These modes are described in detail in later paragraphs. Pilot commands are primarily through a pair of hand controllers located before him on the console shelf. The left, or translation, controller is used to command the vehicle propulsive device to move the vehicle along its three linear axes. The right, or rotation, controller allows attitude changes to be made around these three axes by commanding list ballast and either the shroud or the thrusters differentially.

4-64. CONTROL MODES. The DSRV pilot has available to him four modes of ship control, each succeeding level of which is less sophisticated than the preceding one in terms of automatic characteristics. In addition to this hierarchy of sophistication, each succeeding level ensures a backup mode of operation should some component fail in the previous level. The four available modes are the following:

- Aided manual prime
- Aided manual backup
- Disconnect
- Emergency

4-65. Aided Manual Prime. In this mode, the pilot controls DSRV attitude and position by using the rotation and translation hand controllers. The autopilot, using feedback from various sensors, automatically assists in attitude rate damping, attitude and position holding, and control-axis decoupling. The pilot uses the information given him from displays to decide how and when to maneuver.

4-66. Aided Manual Prime – Cruise. Surge is controlled by tilting the translation hand controller fore and aft. Velocity is controlled by amount of deflection. A velocity switch can be set to maintain the selected velocity. In this cruise regime, deflection of the translation controller to port or starboard and rotation of the controller have no effect. To change heading, the rotation controller is rotated to port or to starboard. This controller is deflected fore or aft to change the vehicle pitch attitude. Rotation (or twist) of this controller changes vehicle heading. Zero list is maintained by keeping the controller in neutral port-starboard position.

4-67. Displays used during cruise include the state display panel, ship control panel, ship control mode panel, shroud angle meter, sonar monitors, navigation data plotter, and alarm panel.

4-68. Aided Manual Prime – Hover. Surge, sway, and heave are achieved in this regime by appropriate deflection and rotation of the translation hand controller (counterclockwise rotation for heave up, clockwise for heave down). Pitch, roll, and yaw are controlled by deflection and rotation of the rotation hand controller (port/starboard for roll, fore/aft for pitch, counterclockwise for yaw to port, clockwise for yaw to starboard). Velocity along the linear axes is proportionate to the amount of deflection or rotation of the translation controller. Attitude change rates are proportionate to the amount of deflection or rotation of the rotation controller.

4-69. In changing and holding a new spatial position or attitude, the appropriate hand controller is deflected or rotated until the vehicle approaches the desired position or attitude. The hand controller is then returned gradually to the neutral position. The autopilot takes over and holds the new position or attitude until a countermanding order is input by the pilot.

4-70. Displays of primary interest during hover include the state display panel, ship control panel, ship control mode panel, sonar monitors, TV monitors, and alarm panel.

4-71. Aided Manual Backup. No automatic position or attitude hold is provided in the aided manual backup mode, nor is automatic axis decoupling available. The only closed-loop assistance for the pilot is automatic rate damping in pitch and roll. The translation and attitude angle loops are closed only through the pilot observing the displays and moving the hand controllers as required. When in the hover regime, he can be aided in positioning the DSRV over the disabled submarine's rescue hatch by a floating cue dot available on the monitored image from both the skirt TV camera and the short range sonar.

4-72. Disconnect (Manual). The disconnect mode is similar to aided manual backup, except damping is provided only for roll disturbances. Both hover and cruise regimes are available. Direct proportional linking of the hand controllers to the effectors is provided.

4-73. Emergency. All effectors can be operated on a switch on/switch off basis if required. The main propeller is controlled by a three-way toggle switch on the emergency ship control panel. Thrusters build up to 75 percent of their full rpm and remain at this level until the switches are positioned to OFF. Similar switches on the same panel allow actuation of the ducted thrusters and the shroud. Shifting weights in the list and trim systems and increasing or decreasing buoyancy in the variable ballast system can be accomplished with switches on the ship control panel. It is necessary to shift mode switches to manual on both the emergency ship control panel and the ship control panel before using effector switches.

4-74. EMERGENCY JETTISON. Should an occasion arise when it is impossible to disengage from entanglements or fouling, or when positive buoyancy in excess of that available from the variable and main ballast systems is required, one or more of the following can be jettisoned:

- Forward pan and tilt unit
- Aft pan and tilt unit
- Manipulator arm
- Mercury from the trim and list systems

4-75. Each jettisonable device or element employs pyrotechnic devices to cut cables or mounting bolts, open mercury drain lines, or otherwise break a connection holding one of the above items. In each instance, two independently powered pyrotechnic cartridges are provided in the event one fails to fire. Jettison controls are mounted on the emergency jettison panel in the control sphere and are protected with a transparent cover to guard against inadvertent firing.

Section 5

SUPPORT SUBSYSTEM

5-1. GENERAL.

5-2. The DSRV support subsystem, summarized in terms of its principal elements in Section 2, is described in greater depth in this section. Order of presentation is the same and conforms to the following arrangement:

- GROUND TRANSPORT
  Shore Handling Vehicle
  Land Transport Vehicle
  Transport Cradle
  Transfer Skirt Dolly
  Pylon Handling Dolly
  Support Van
- AIRCRAFT LOADING AND TRANSPORT
  Aircraft No. 1
  Aircraft No. 2
  Aircraft No. 3
  Aircraft No. 4 and Aircraft No. 5
- SHIPBOARD LOADING AND HANDLING
  Mother Submarine (MS)
  Submarine Rescue Ship (ASR)
- CHECKOUT AND SERVICING
  Standby Checkout and Servicing
  Operational Checkout and Servicing
  Preventive Maintenance
  Corrective Maintenance
- SUPPORT AND SERVICING EQUIPMENT
  Electrical Support
  Servicing Support
  Life Support Resupply

5-3. GROUND TRANSPORT.

5-4. All rescue mission transport movements involving a remote deployment of the DSRV are accomplished with the land transport vehicle (LTV). A support van and two flatbed trailers carry prime mission support equipment. These movements include transport from the rescue unit's permanent facilities to an adjacent airfield. In this instance, the entire DSRV system is flown in separate aircraft to an airfield near the remote launch port. Transport overland from this point to dockside is by LTV, support van, and other flatbed trailers.

5-5. SHORE HANDLING VEHICLE (SHV). The SHV (Fig. 5-1) is used to transport a fully assembled DSRV around the rescue unit home port (RUHP) area. The SHV is moved at very slow speeds (2 to 5 mph) due to the DSRV height and stability factors.

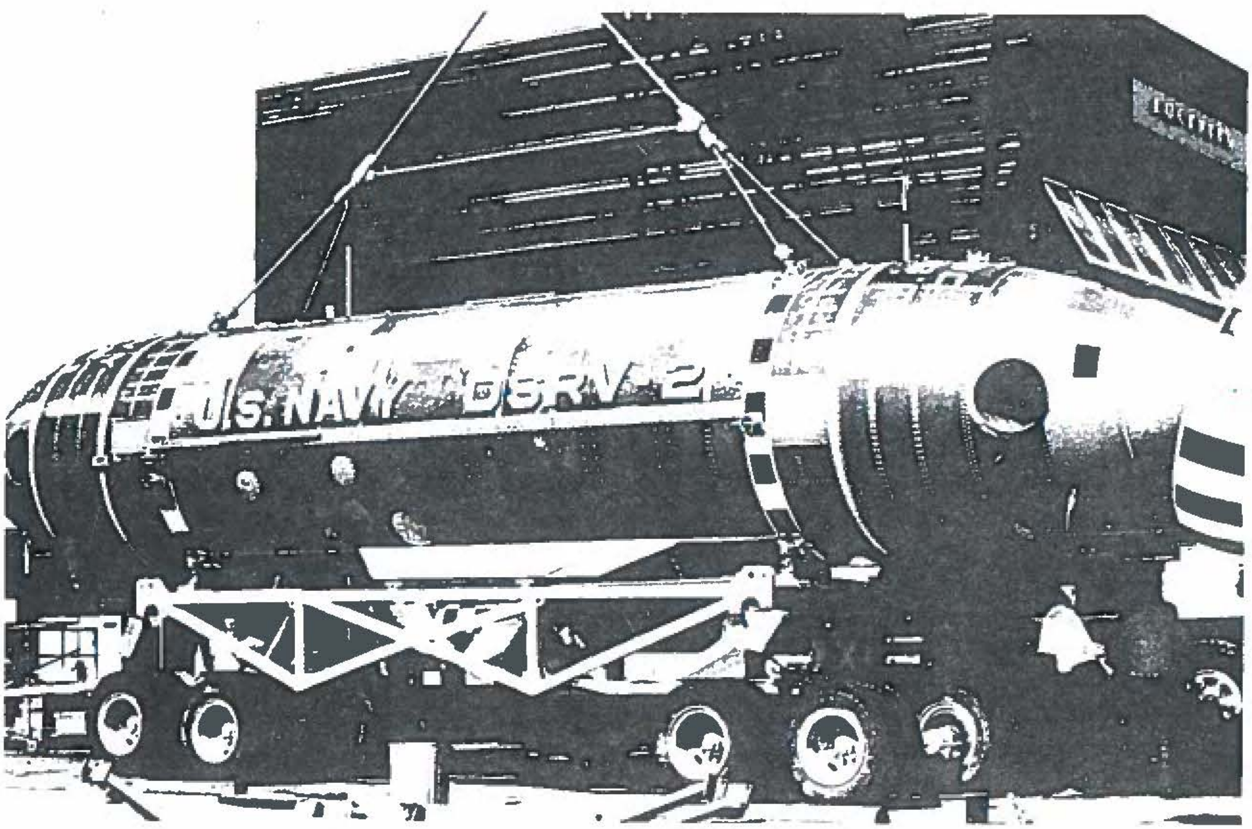

Fig. 5-1 Shore Handling Vehicle

5-6. LAND TRANSPORT VEHICLE (LTV). The LTV (Fig. 5-2) is a flatbed semi-trailer attached to a prime mover by means of a dual-wheel, two-axle jeep dolly. It has a payload capacity of 72,000 pounds and can be towed safely at speeds as high as 30 mph on paved highways. It is made up of the following principal components: chassis and deck, suspension, jeep dolly, brakes, power unit, control panel, and lights, plus tiedowns, bumper struts, etc.

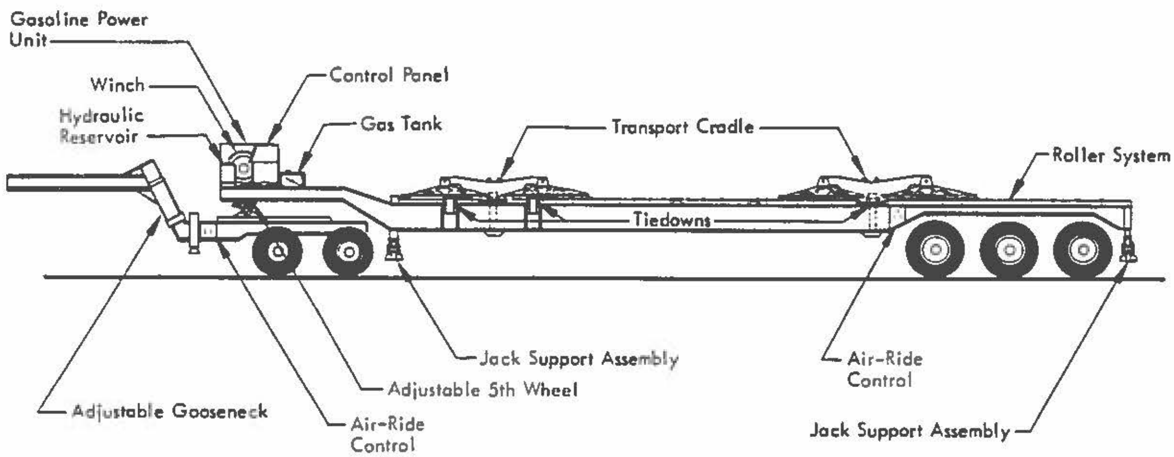

Fig. 5-2 Land Transport Vehicle and Transport Cradle

5-7. Chassis and Deck. The chassis and deck supports the DSRV, mounted on a transport cradle, and also provides a dockside support to permit DSRV servicing and installation of the transfer skirt and splitter plate prior to loading on the support vessel. To achieve sufficient clearance for this installation, the DSRV is hoisted from the transport cradle, dockside supports are unstowed and installed on the LTV deck, and the DSRV is repositioned on top of them. A square hole in the deck's midsection is open for access during transfer skirt installation. The crane must remain in place to hold most of the DSRV's weight.

5-8. Roller bearings (188 in four equal rows) on the LTV deck support the transport cradle and the DSRV during transport and provide a low-friction surface when the DSRV is winched in or out of the transport aircraft. Jack assemblies at each corner of the LTV provide for alignment stability during loading/unloading and dockside operations.

5-9. Suspension. Suspension is provided by three dual-wheel axles on the LTV proper and two dual-wheel axles on the forward jeep dolly, plus an air-suspension subsystem (supplied from the vehicle's own compressor) for all axles. In addition to its normal shock-absorbing function, the air suspension subsystem can be used to raise or lower the LTV 3.5 inches from its usual 55-inch height for alignment with the aircraft's loading ramp. The subsystem is deflated during air transport. Individual control panels are located on the sides of the LTV and jeep.

5-10. Jeep Dolly. This dolly serves as the link between the LTV and the truck-tractor, and at the same time supports much of the forward weight of the LTV. Jack assemblies similar to those on the LTV are provided at the forward end of the dolly. The dolly's fifth wheel can be adjusted horizontally fore and aft (60 inches) to distribute the LTV's gross load. The gooseneck can be adjusted vertically (10 inches) to interface with a variety of truck-tractor prime movers.

5-11. Braking. The LTV has its own integral service and parking brake subsystem, both actuated by air from the LTV air compressor unit or from the tow tractor. Service and parking brakes each have fail-safe springs which apply braking pressure in the event of air supply failure. Quick disconnect air-line fittings are used between the LTV and dolly, and the dolly and prime mover. Stop lights are provided in conjunction with the service brakes.

5-12. Power Unit. The LTV power unit, mounted forward in a ventilated metal case, consists of a 4-cylinder, 25-horsepower, air-cooled gasoline engine; an air compressor; a hydraulic system; an electrical system; and a hydraulically actuated winch. The air compressor, belt-driven by the engine, can provide air for air suspension and brakes. The electrical system includes a 30-ampere belt-driven alternator, a 12-volt storage battery, and required manual controls. The hydraulic system includes a direct drive hydraulic pump, a hydraulic fluid reservoir, and a control coupling to the hydraulically driven winch. The winch contains a double wound drum with 100 feet of 0.375-inch stainless steel cable on one side and 230 feet on the opposite side (22,800-pound breaking strength). A built-in brake stops and holds the winch should the hydraulic power fail.

5-13. Control Panel. This panel contains controls to start and operate the power unit engine, the electric power alternator, the hydraulic system, and the winch. Gages and indicators display subsystem conditions. Panel lights for night operation are provided.

5-14. Lights. Running, side clearance, turn indicator, and stop lights on the LTV comply with DOT regulations for transport over public highways. Electricity for lights is supplied by the prime mover or by the LTV electrical system.

5-15. Miscellaneous Items. Tiedowns are provided to restrain the transport cradle and the DSRV to the LTV. Two spreader bar and cable assemblies (one forward, one aft) are used in conjunction with the LTV winch to onload and offload the DSRV. During DSRV loading and offloading, a pair of adjustable struts are inserted between the rear of the LTV bed and the aircraft loading ramp to prevent damage to the aircraft. Two lockable compartments in the LTV provide stowage space for these and other miscellaneous items. Special tiedowns are provided by the Air Force for securing deck cargo to the LTV after the DSRV is offloaded.

5-16. TRANSPORT CRADLE. The DSRV is supported on the transport cradle when being moved overland by the LTV or when air-lifted by the cargo aircraft. In addition to providing support, the cradle also restrains the DSRV against loads encountered in both modes of transport. Included with the cradle is a set of tiedown assemblies that permits the DSRV to be secured to the LTV and the aircraft.

5-17. The transport cradle is made up of four assemblies, each of which consists of two low pyramidal structures supporting on their apexes a load-bearing beam. Each of the four DSRV support fittings rests on and is latched to a fitting in the center of one of these beams. The four cradle assemblies have attached skis that facilitate sliding the transport cradle on the aircraft or on the LTV deck and distribute the weight to many rollers. Tiedown fittings secure the transport cradle to the transporting vehicle.

5-18. TRANSFER SKIRT DOLLY. This unit is used for handling, shipping, and storing the transfer skirt and the shock mitigation ring assembly when detached from the DSRV. It is capable of raising, lowering, rotating, and translating the skirt and shock ring to facilitate attachment and removal of these components to and from the vehicle. Three casters with lockable wheels permit rotating and translating the dolly; a manual screw jack over each caster permits raising the skirt and shock ring for installation.

5-19. PYLON HANDLING DOLLY. The pylon handling dolly is used for handling, shipping, and storing the pylons when detached from the mother submarine. The dolly provides support, protection, and mobility for the pylon assemblies during periods between missions and serves as a work stand during post-maintenance procedures. When the DSRV is transported by land or air during mission operations, the dolly is also transported as the shipping container and protective device for the pylon assemblies. At dockside (outbound on the mission), the pylons are transferred via crane to the mother submarine for installation. After return to dockside and removal of the DSRV, the pylon assemblies are removed from the mother submarine and again stored on the dolly for reshipment to the home base. A fitted dust cover, provided with the dolly, is used to protect the pylons during shipment and storage.

5-20. SUPPORT VAN. The support van provides storage space and transportation for the DSRV's battery charging and shore power system. The van provides a shelter for the operator to monitor the control panel during battery charging operations, as well as storage space for the following items:

- Life support replenishment material
- Pressure-compensating fluids
- Hydraulic fluid
- Rescuee ballast service unit
- Pressure capsule heater and air conditioning unit
- Hull cooling water pump
- Spare DSRV components
- SSN/DSRV cables

The prime mover (tractor) required for over-the-road operations supplies electric power for running lights and pneumatic power for service brakes.

5-21. Four sling attachment fittings allow the trailer body (running gear detached) to be hoisted aboard the ASR. Four V-groove casters on the body's underside mate with an inverted angle track system for on-board stowage. Tiedowns prevent the van from rolling while aboard the ASR.

5-22. Detachable separate front and rear running gear assemblies are attached to the payload body for towing. The front running gear is composed of axles, wheels, brakes, suspension, and a tow bar with lunette eye. The rear running gear has a single axle, wheels, brakes, suspension, and a towing eye for winching the vehicle backward into the transport aircraft. Air for operation of the vehicle's service brakes is supplied by the prime mover. Manual mechanical parking brakes are provided for both front and rear running gear assemblies.

5-23. AIRCRAFT LOADING AND TRANSPORT (FIG. 5-3).

5-24. AIRCRAFT NO. 1 The following items of equipment are required to stabilize the C-141A transport Aircraft No. 1 and to support its loading ramp when transferring the DSRV and its support cradle from the LTV to the airplane or vice versa.

5-25. Fuselage Supports. Two 30-ton jacks, two 70-ton jacks, an adjustable fuselage cradle and two ramp cradles are provided to stabilize the aircraft during loading and offloading operations. The jacks are hydraulic; the cradles are equipped with screw-type leveling jacks. All are equipped with spring-loaded casters that compress under load and allow ground-seating of base plates.

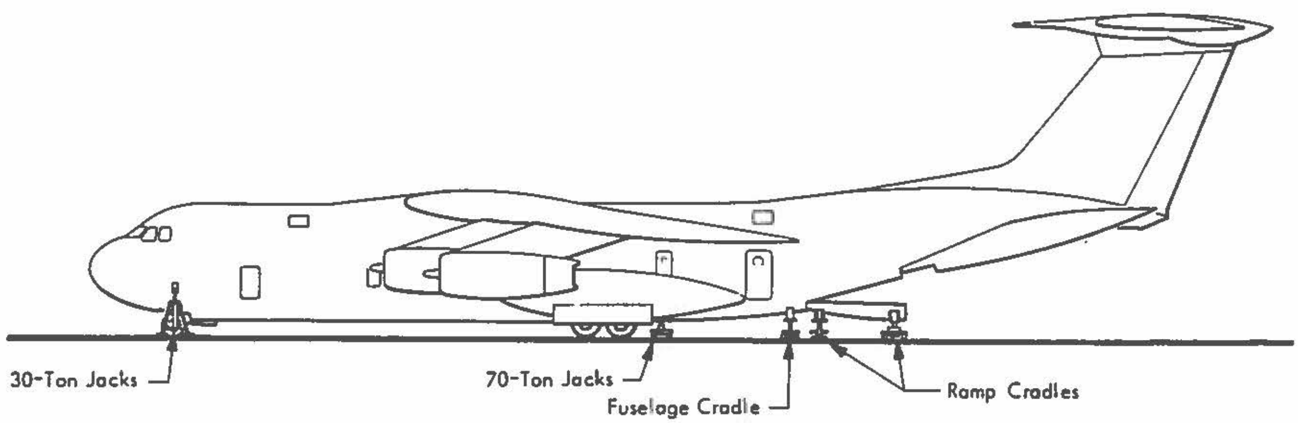

Fig. 5-3 Aircraft Fuselage and Ramp Supports

5-26. The 30-ton jacks support the aircraft through special jack pads on each side of the fuselage near the forward landing gear. The jacks are variable-height, tripod-type units with hydraulic-lift center ram and a mechanical screw extension. A manually operated hydraulic pump, mounted on one leg of the tripod, provides fluid under pressure to the ram. The 70-ton jacks support the aircraft by means of jack pads under the fuselage just aft of the main landing gear. Each jack consists of a horizontal caster-mounted body with a hydraulic ram at one end and a two-speed manual pump at the other. A steering handle allows easy placement of the jack under the fuselage just aft of the main landing gear. Each jack ram has a screw-type mechanical extension. The fuselage cradle serves as a support for the aircraft just forward of the loading ramp hinge. The fuselage cradle conforms to the under-side shape of the aircraft fuselage at this station and is supported at each end by screw-type tripod jacks. A flexible pad inside the cradle protects the fuselage.

5-27. Ramp Supports. During the loading and offloading of the DSRV, two ramp cradles provide support for this portion of the aircraft. They are similar in configuration to the fuselage cradle; each cradle conforms to the ramp contour — one forward and the other aft — and is supported at each end by a screw-type leveling jack. Casters, which compress under load, allow easy positioning of cradles.

5-28. AIRCRAFT NO. 2. After the DSRV is unloaded from the LTV, specific mission and support equipment is transferred from the two flatbed trailers to the LTV. The LTV then is loaded onto Aircraft No. 2. Special equipment required for loading the DSRV onto the LTV is also carried on this aircraft.

5-29. AIRCRAFT NO. 3. Aircraft No. 3 is loaded with the pylons, support van, transfer skirt, 18 crew members, and the remaining equipment from the flatbed trailers.

5-30. AIRCRAFT NO. 4. Aircraft No. 4 carries equipment required for the ship of opportunity.

5-31. SHIPBOARD LOADING AND HANDLING.

5-32. Included in this category are those items of equipment used for loading the DSRV aboard either the ASR, the mother submarine (and, in this case, for supporting the vehicle in the piggyback position), or a ship of opportunity.

5-33. MOTHER SUBMARINE. Loading the DSRV aboard the mother submarine is accomplished with the DSRV lifting sling assembly which attaches to the four lift fittings on the vehicle. The steel rods that make up the sling can be assembled with a single hoisting point or as a double pickup configuration for twin hoists. The two configurations make the sling compatible with a multitude of dockside hoists.

5-34. The DSRV cradle assembly is used to secure the DSRV atop the mother submarine. The DSRV is thus carried piggyback on the mother submarine from the departure port to the rescue area. The cradle assembly provides a means to release the DSRV for the rescue mission, to capture and hold the DSRV during rescuee transfer, and to transport the DSRV back to dockside after mission completion. The cradle assembly system consists of the forward and aft pylons and a control panel with related cable assemblies. The pylons also serve as a shock mitigation device during DSRV recovery. The control panel within the mother submarine activates and monitors the latches that hold the DSRV on the pylons. These elements are carried as a part of the DSRV System and are installed on the mother submarine at dockside prior to loading the DSRV aboard.

5-35. Pylons. The pylons are transported in two subassemblies, one for installation forward and one aft of the mother submarine after rescue hatch. Each assembly includes two support pylons tied together with crossbracing. The DSRV is guided into the pylons by the DSRV pilot, shock mitigation devices within the pylons absorb any contact shock, and the four DSRV support fittings drop into depressions in the top of the pylons. On command from the control subsystem within the mother submarine, the shock mitigation devices are locked and the latch hooks within the pylons engage the DSRV support fittings and firmly secure the vehicle. The foregoing routine is executed in reverse for DSRV release.

5-36. Controls. The control subsystem consists of a control panel plus cable assemblies. The pylon control panel is carried onboard and operated inside the mother submarine. The pylon control panel controls the latching mechanisms within the pylons, navigation lights, and indicates the position of the latches.

5-37. SUBMARINE RESCUE SHIP (ASR). A hoisting sling assembly, provided with the ASR, is used for loading the DSRV aboard the ship. Provisions for handling the DSRV after loading are integral with the ASR system and are described in detail in Section 6.

5-38. SHIP OF OPPORTUNITY. A limited number of mother submarines (SSN) have been modified to support the DSRV rescue mission. The ship of opportunity concept was introduced to expand the operating area of the DSRV. The equipment to be used for ship of opportunity operations constitutes a nearly self-contained and supported system. With this equipment, the DSRV can be installed on the open deck area of any suitable ship. A 50-ton crane is required to lift the DSRV at sea.

5-39. CHECKOUT AND SERVICING.

5-40. Checkout, servicing, and maintenance (both preventive and corrective) procedures are required to maintain the DSRV in a continuing state of mission readiness. The depth and extent of these procedures will depend on the mission status of the vehicle, and will reflect the time and equipment available; i.e., a far more comprehensive checkout can be performed at the home port facilities than during the 50 minutes available on the support vessel between rescue mission dives.

5-41. These procedures fall naturally into two basic categories — those which are performed on a DSRV System while it is in the standby state at the home port, and those which are performed after an alarm has been sounded and the operational phases of a rescue mission are under way. These operational phases consist of the following: 1) at the home port just prior to deployment to the rescue scene, 2) at dockside before being put aboard the support vessel, 3) at sea enroute to the rescue site, 4) after launch from the support vessel but prior to first dive, 5) during the dwell time between rescue dives, and 6) during the return to dockside.

5-42. STANDBY CHECKOUT AND SERVICING. Checkout and servicing of the DSRV, assigned to standby duty at the rescue unit home port, are conducted periodically on systems and critical components to assure conformance to specification requirements. Tests are diagnostic to the component spare level and enable the isolation and replacement of faulty elements. Equipment operation and limits will be checked to determine that each functional item capable of independent operation is performing within specification limits. Included are the following operations: sampling of all stored fluids for required level and contamination; calibration of sensors and readouts; open loop operation of systems; bench testing of selected components; and all other tests necessary to determine that the equipment is operating within the stipulated limits. Out-of-tolerance stimuli are introduced to verify operation of all alarms. Special checkout programs loaded into the central processing computer are used to test the integrated controls and displays. In addition to the vehicle proper and its systems, checkouts and servicing are conducted for all support equipment in the DSRV System.

5-43. Systems included in the standby mode checkout and servicing are main ballast, variable ballast, list and trim ballast, transfer ballast, rescuee ballast, electrical, hydraulic, propulsion and maneuvering, shock mitigation, manipulator, ASR retrieval arms, control and display, life support, emergency jettison, and all support equipment.

5-44. OPERATIONAL CHECKOUT AND SERVICING. All checkouts made during the operational phases of a rescue mission are done to provide status indications for a go/no-go decision. No standard servicing (except for replenishment of life support stores and recharging of main batteries) is done unless a checkout or walkaround inspection reveals an abnormal condition.

5-45. At Home Base Following Rescue Alarm. At this stage in a rescue mission the DSRV is on the support stand, the support equipment trailer is packed and ready to move, all loading and handling equipment is crated or palletized, and crew's personal baggage is ready. No more than an hour is available to determine operation readiness on a go/no-go basis. The DSRV is placed on the LTV or SHV, batteries are given a final check, a visual walkaround inspection of the vehicle is made for leaks and for loose electrical or mechanical connections, and jettison safety devices are installed. The control and display panel together with the central processing computer will be used for status determination.

5-46. At Dockside. Certain variables in the mission deployment pattern will determine the extent of dockside checkout. If the DSRV System has been airlifted from its home port to this point, special care must be taken to determine whether or not any damage has occurred in transit. Likewise, if the support vessel to be used is a mother submarine, checkout emphasis must be placed on systems and equipment that are inaccessible when the DSRV is mounted piggyback on the submarine. In any event, the checkout routine will again serve as a basis for a go/no-go decision, especially with regard to those items removed for transport by air and replaced at dockside.

5-47. Enroute to Rescue Area. This checkout while the DSRV is mated to the mother submarine or onboard the ASR is conducted to further assure that systems are functioning properly. In the event of support by a mother submarine, it will also provide an opportunity to check certain systems that need a submerged environment for indication of proper functioning. Water may be introduced to transfer tanks to expedite transfer skirt flooding during initial demating from the mother submarine. Prior to first dive, the rescuee ballast bags in mid and aft spheres are filled with water from the mother submarine water systems. Checkout time available will depend on transit time to rescue area.

5-48. Prior to Operational Dive. This operational checkout is conducted in the water immediately after demating from the mother submarine or after underwater launch by the ASR. It is a quick check on system operation in the submerged environment and a check of buoyancy and trim before commencing a dive.

5-49. Between Rescue Dives. Total time available for all activities between dives is approximately 50 minutes, the time required for recharging the DSRV main batteries. During this period, rescuees must be transferred to the support vessel and the following servicing operations performed: life support system replenished, rescuee ballast bags refilled, condensate tanks and bilges pumped out, other waste materials removed, rescuee ballast air flask replaced or recharged, and for ASR operations, the main ballast air supply recharged. Again, checkout is limited to a quick status indication for a go/no-go decision.

5-50. PREVENTIVE MAINTENANCE. Preventive maintenance is performed on a periodic basis for all elements in the DSRV System. Schedules are set forth in the Planned Maintenance System Manual, and the associated procedures as given in Maintenance Requirements Cards.

5-51. CORRECTIVE MAINTENANCE. Corrective maintenance is performed as necessary to return the DSRV System to an operational status. Procedures pertaining to corrective maintenance are included with troubleshooting instructions in the appropriate DSRV manuals, which are identified in Section 7.

5-52. SUPPORT AND SERVICING EQUIPMENT.

5-53. Included here are all items of equipment required to support and service the DSRV during its various operational modes. They can be grouped into three general categories: electrical support, servicing support, and life support resupply.

5-54. ELECTRICAL SUPPORT. Electrical support consists of SSN mission support, ASR mission support, and ship of opportunity support.

5-55. SSN Mission. SSN mission electrical support consists of two 0 to 200 ampere Thornton battery chargers. The DSRV shore power is supplied by the SSN.

5-56. ASR Mission. ASR mission electrical support is provided by the ASR for battery charging and shore power. The DSRV support van may be used as an alternative source to supply shore power and battery charging.

5-57. Ship of Opportunity. Ship of opportunity electrical support is provided by the ship of opportunity support equipment. Battery charging and shore power is supplied by the power console. Power is supplied to the power console by the ship of opportunity equipment diesel generator or by the ship of opportunity itself.

5-58. SERVICING SUPPORT. Units of equipment in this category are, in general, used for the replenishment of consumables aboard the DSRV or for the removal of accumulated waste.

5-59. Compensating Fluid Service Units. These portable fluid containers and manual pumps are used to service the fluid-filed pressure compensators that protect such DSRV electrical equipment as the main battery boxes, power distribution boxes, cable junction boxes, power interlock boxes, main propulsion motor, and thruster motors. Operating as force pumps, the three service units top off the fluid in the compensators and connected equipment with the particular type and kind of fluid specified for each. These three types of fluids are used for both pressure compensation and insulation and additionally for transfer of heat from the equipment to the surrounding container.

5-60. Each compensating fluid service unit consists of a hand-operated rotary pump mounted on top of a plastic container with a 0.75 cubic foot capacity. A 6-foot hose terminated with a quick-disconnect fitting provides a connection between the unit and the component being serviced. Pumping rate is approximately 0.1 cubic foot per minute.

5-61. Rescuee Ballast Service Unit. This unit is used to refill with sea water the rescuee ballast bags emptied to maintain neutral buoyancy when rescuees are taken aboard the DSRV. It is transported to the rescue launch port in the support van. It is portable and can be carried aboard the mother submarine when that support vessel is used. It receives sea water under pressure from a supply source on the mother sumbarine. The service unit consists of a pressure regulator, pressure gage, relief valve, manual shutoff valve, and the necessary intake and outlet water hoses. Normal fill time for the ballast bags at a flow rate of 25 gallons per minute is approximately 20 minutes.

5-62. Water Disposal Service Unit. This unit serves as a portable suction pump for draining condensate produced by the air conditioning subsystems in each sphere of the pressure capsule, and for removing liquids from the capsule's bilges. It can be operated in reverse for spraying a liquid from its collection tank. It consists of a hand-operated rotary pump mounted on top of a plastic container with a 0.75 cubic foot capacity. It is equipped with a 6-foot hose, and can be operated at a pumping or spraying rate of approximately 0.1 cubic foot per minute.

5-63. Pyrotechnic Test Simulator. This test unit is used to determine the condition of the pyrotechnic cartridges that actuate the emergency jettison devices in the DSRV. This condition is determined by measuring the cartridges' insulation resistance and bridgewire resistance with a portable test unit that includes a cartridge test chamber, microammeter, circuit selector switch, test switch, batteries, and the necessary electronic package.

5-64. LIFE SUPPORT RESUPPLY. The life support resupply modules provide the equipment required to replenish and service the DSRV life support system.

5-65. The equipment for life support resupply and service is packed in metal carrying cases and carried in the support van. These carrying cases, or modular unit assemblies, are identical, each being approximately 26 × 19 × 14 inches, and are provided with handles for convenient carrying. Individual items for life support resupply and service are described in the following paragraphs. In addition to the DSRV vehicle life support equipment, two dehumidifier canisters are carried in the support van to support SSN missions.

5-66. Oxygen and Nitrogen Tanks. Twenty-one oxygen tanks and three nitrogen tanks are carried in the support van for resupplying the pressure capsule atmosphere. Different type fittings on the oxygen and nitrogen tanks prevent improper installation during replacement.

5-67. Lithium Hydroxide Scrubbing Cartridges. Twenty-five lithium hydroxide cartridges are carried as replacements for units in the DSRV atmosphere conditioning subsystem where they are used to remove carbon dioxide and contaminants. Each cartridge contains a 3-inch layer of lithium hydroxide and a 1/2-inch layer of charcoal.

5-68. Dehumidifier Canisters. Four canisters for the portable dehumidifiers used in the mid and aft spheres are provided as replacements. Each is capable of absorbing approximately 2-1/2 pounds of water.

5-69. Leak Detector. The leak detector is used to check the DSRV atmosphere supply system and the refrigeration unit for leaks of oxygen, nitrogen, and Freon. The unit is a sniffer-type sensing device that compares the thermal conductivity of leaking gas with that of the ambient atmosphere.

5-70. MISCELLANEOUS. Included here are the cables, ducts, and hoses required as umbilicals between support equipment and the DSRV; the tools required for connecting support equipment and for removing and reattaching vehicle components for transit; and various miscellaneous spares and supplies.

Section 6
ANCILLARY SUPPORT SYSTEMS

6-1. GENERAL.

6-2. The DSRV ancillary support systems include those elements necessary for rescue mission accomplishment, but which are not integral in the DSRV System proper. These elements — transport aircraft, support vessels, etc. — were summarized briefly in Section 2 and are described in greater depth in this section. Order of presentation is the same and conforms to the following arrangement:

- AIRCRAFT
  No. 1
  No. 2
  No. 3
  No. 4 (Aircraft for Ship of Opportunity)
- SUPPORT VESSELS
  Submarine Rescue Ship (ASR)
  Mother Submarine
  Ship of Opportunity
- TRUCK-TRACTORS AND TRAILERS
- HOME PORT FACILITIES
- MISCELLANEOUS

6-3. AIRCRAFT.

6-4. Deployment of a DSRV System to a disaster site remote from the rescue unit's home port requires air transportation in the form of three C-141A cargo aircraft. A fourth C-141A cargo aircraft is required when rescue operations involve a ship of opportunity and the ship of opportunity system equipment must be transported. These aircraft are supplied on a high-priority basis by the USAF Military Airlift Command. General loading procedures, together with identification of items carried by each airplane (Fig. 6-1) are given in the following paragraphs.

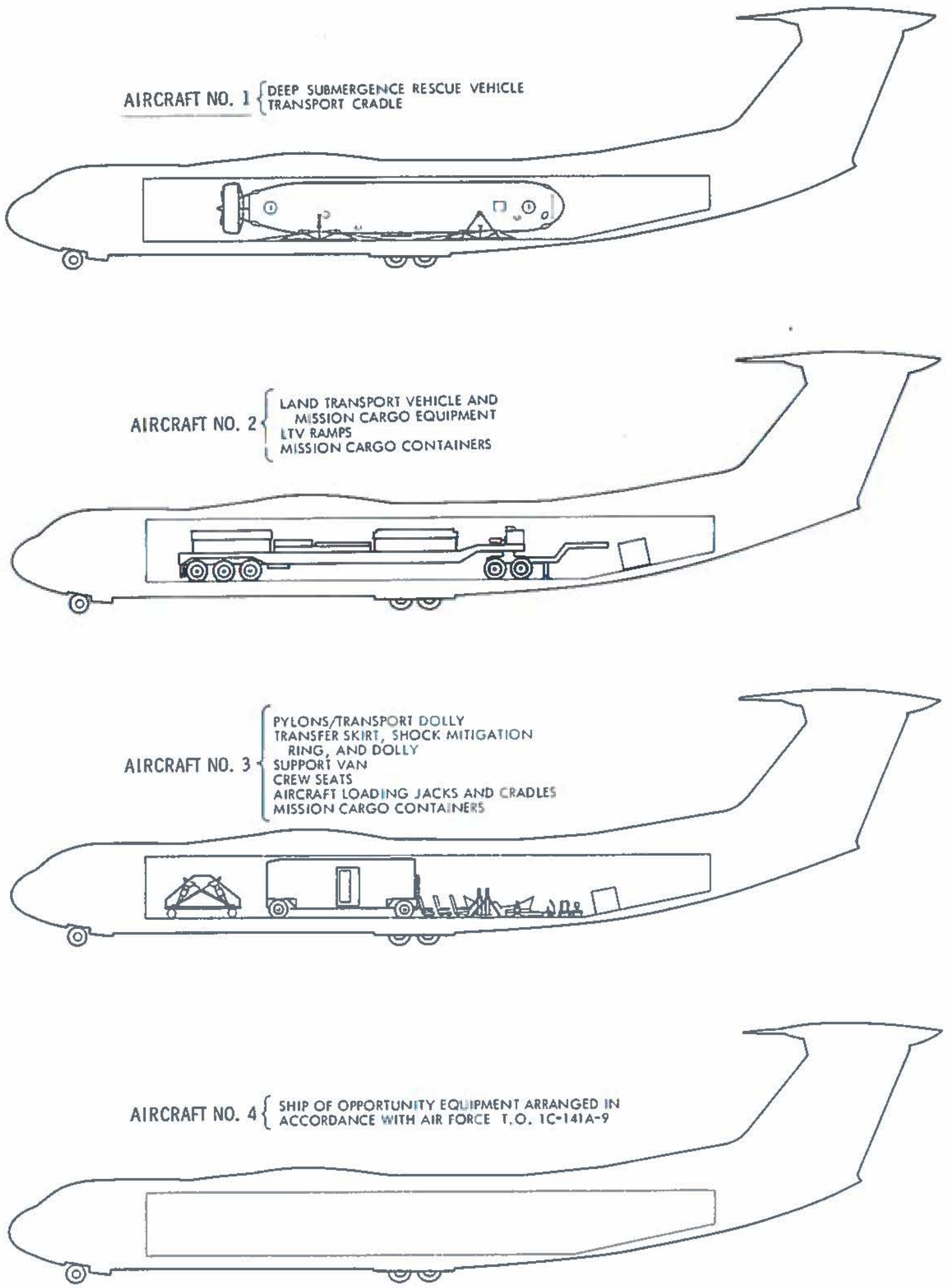

Fig. 6-1 Load Distribution Among Transport Aircraft

6-5. AIRCRAFT NO. 1. The DSRV, supported on its transport cradle, is transported aboard Aircraft No. 1. The transport cradle has restraint devices to secure the DSRV during flight. Nine crew seats and two mission containers are transported at the rear of the aircraft. Loading is accomplished by backing the land transport vehicle into contact with the aircraft loading ramp. The LTV roller system is then aligned with the aircraft roller system in the lateral and vertical planes, and the DSRV is winched aboard with a cable and spreader bar assembly. A second cable and spreader bar assembly is used to restrain the DSRV. During loading, the aircraft is supported by jacks and cradles (supporting equipment for the DSRV System). The supporting equipment is transported in Aircraft No. 3.

6-6. AIRCRAFT NO. 2. Principal item carried on Aircraft No. 2 is the land transport vehicle and its jeep dolly. Prior to placing the LTV on board, the following items are loaded and secured in place on the LTV deck: splitter plate, hoisting sling assembly, and four containers of mission equipment. The jeep dolly is temporarily detached and the LTV is backed into the aircraft by a truck-tractor. The jeep dolly is then hooked to the truck-tractor, backed on board, and reattached to the LTV, which in turn is secured for flight with tiedowns. The special ramps required for loading the DSRV onto the LTV are also carried aboard this aircraft.

6-7. AIRCRAFT NO. 3. Principal item aboard Aircraft No. 3 is the support van, which is loaded by backing to the foot of the ramp and winching aboard. Other items carried on this aircraft include the following: DSRV cradle assembly on a dolly, transfer skirt and shock mitigation ring mounted on transfer skirt dolly, the jacks and cradles that support and stabilize Aircraft No. 1 during loading, and miscellaneous pallets and crates. In addition, seating for 18 DSRV crew members is provided.

6-8. AIRCRAFT NO. 4. Aircraft No. 4 is used to transport the equipment for the ship of opportunity system.

6-9. SUPPORT VESSELS.

6-10. The DSRV is supported during mission deployment by one of three support vessels — an ASR, a mother submarine, or a ship of opportunity. During rescue operations a support vessel transports the DSRV from dockside to the disaster site, launches and recovers the vehicle, replenishes its life support and ballast systems between dives, recharges its batteries as required, assists in any necessary search for the disabled submarine, serves as the on-scene command and control station, and provides accomodations for DSRV crew members and the rescuees evacuated from the disabled submarine.

6-11. The type of support vessel (ASR, mother submarine, or ship of opportunity) selected for a rescue mission will be largely determined by its availability at or near the disaster area, but in the event all are available, the choice will be determined by other factors. In heavy seas or should a submarine be disabled under ice, the mother submarine would be mandatory.

6-12. SUBMARINE RESCUE SHIP (ASR). The ASR is a catamaran-type vessel that is capable of transporting two DSRVs, a support van, and their crew members; however, its normal complement is one DSRV. An overhead bridge crane with twin hoists is used with a vehicle support platform to make subsurface launches and recoveries of the DSRV through a center well.

6-13. Dimensions of the ASR are 251 by 86 feet, with a draft of 24 feet. It has a range of 10,000 miles at a design speed of 13 knots, and is capable of a sustained speed of 15 knots, maximum. Ship's complement consists of 6 officers and 109 enlisted personnel. Accommodations are provided for the DSRV crew members, as well as sufficient workshop, stowage, and service areas for checkout and servicing of the vehicle. During rescue operations, the ASR is capable of supplying all services required by the DSRV including: charging main batteries, providing electrical power, refilling high-pressure air flasks (after an emergency ascent), refilling rescuee ballast bags, providing water for hull cooling and washdown, and supplying decompression facilities and medical attention for rescuees.

6-14. <u>DSRV Support Facilities.</u> The DSRV is loaded aboard the ASR (Fig. 6-2) from off the SHV or LTV at dockside by an overhead bridge crane whose dual hoists have a combined lift capacity of 150,000 pounds. Extension rails for the overhead crane provide sufficient dockside overhang to position the hoists directly over the DSRV for loading. After being hoisted aboard, the DSRV is stowed on a cradle/dolly which in turn is supported by cradle rails that lie athwartship. These rails allow transverse movement for positioning the vehicle over either deck decompression chamber or on the lift platform in the central well. This platform can be raised and lowered by the overhead hoists and is used for subsurface launch and retrieval of the DSRV (Fig. 6-3). TV cameras and lights on the platform aid in positioning the DSRV during recovery.

6-15. The DSRV support van, less its running gear, is stowed aboard the ASR during rescue operations. Additional storage room is available if required for support equipment and supplies. Also available are such support services as high-pressure air, battery recharging and standby electrical power, ballast water, washdown water, and onboard communications.

6-16. Mission operations of the DSRV are monitored in the ASR Rescue Control Center. In the center are facilities for underwater communication, radio communication, data processing and recording, and sonar displays and plotting. A three-dimensional hydrophone array allows the ASR to track the DSRV accurately or to determine its own position relative to an acoustic transponder dropped as a marker.

6-17. <u>Other ASR Facilities.</u> In addition to providing support for the DSRV, the ASR carries two underwater rescue or work systems – two personnel transfer capsules and a submarine rescue chamber. Each of the two personnel transfer capsules is capable of transporting four divers to and from the ocean bottom in either a pressurized or unpressurized condition. Maximum working depth is 850 feet. The submarine rescue chamber (McCann chamber) has the same working depth and can be used to transfer trapped crew members from a disabled submarine to the ASR. Both the transfer capsule and the rescue chamber are normally lowered by cable over the side. Two deck decompression chambers, each with a 40-man capacity, are available for compressing or decompressing divers and rescuees.

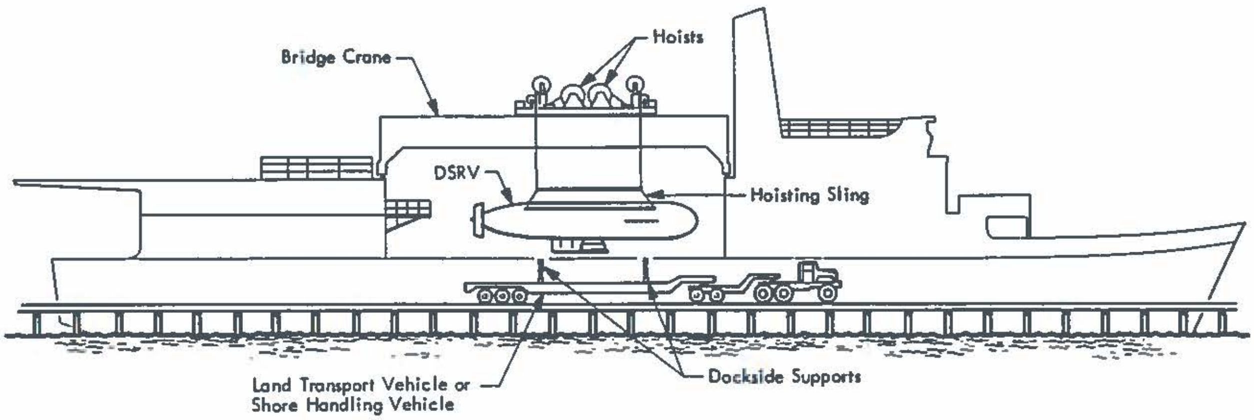

Fig. 6-2 Loading DSRV Aboard ASR

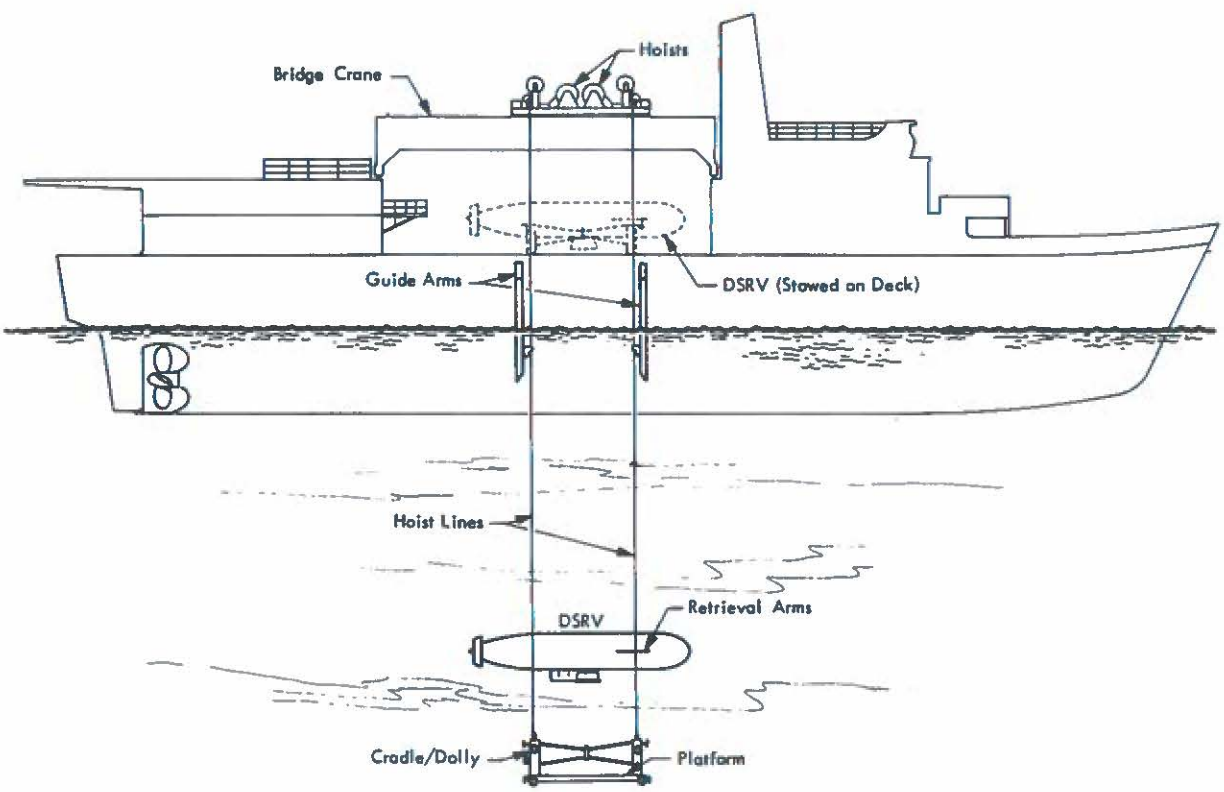

Fig. 6-3 Underwater Recovery of DSRV by ASR

6-18. MOTHER SUBMARINE (FIGS. 6-4 AND 6-5). Several nuclear-powered attack submarines will be specially equipped in order to support the DSRV as mother submarines during rescue missions. They are capable of transporting, supporting, launching, and recovering the vehicle while submerged, and because all these operations are done while submerged, rescue operations can be accomplished under ice and despite adverse weather conditions. The mother submarine can transport the DSRV at speeds up to 15 knots while submerged.

6-19. The mating aids, piggyback support pylons, monitoring equipment, and servicing units required by a mother submarine to support a rescue mission are integral with the DSRV System and are carried in transportable containers along with the vehicle. This equipment is installed at dockside and the servicing units loaded on board the mother submarine. Included are the following.

6-20. Cradle. The forward and aft pylon assemblies are attached to permanent mounting plates on the submarine hull. These assemblies serve as a cradle to support the DSRV in a piggyback position on the mother submarine, and ensure proper alignment with the aft escape hatch. Hydraulically operated latches lock and unlock the DSRV from the four pylons.

6-21. Other Launch and Recovery Aids. Two TV camera subsystems, with mercury vapor lights and a tilt mount, are attached to outer hull foundations near the aft and forward hatches to monitor the launch and recovery operations. An acoustic transponder mounted on the submarine fairwater or sail, helps guide the DSRV in remating. Reflective tape and paint mark all obstructions on the mother submarine and highlight both hatch areas.

6-22. Monitor and Service Units. The following equipment is stowed or installed in designated areas aboard the mother submarine: battery charging system, high voltage detectors, pylon control panel, television monitor, rescuee ballast service unit, life support resupply modules, various mission spares, and crew baggage.

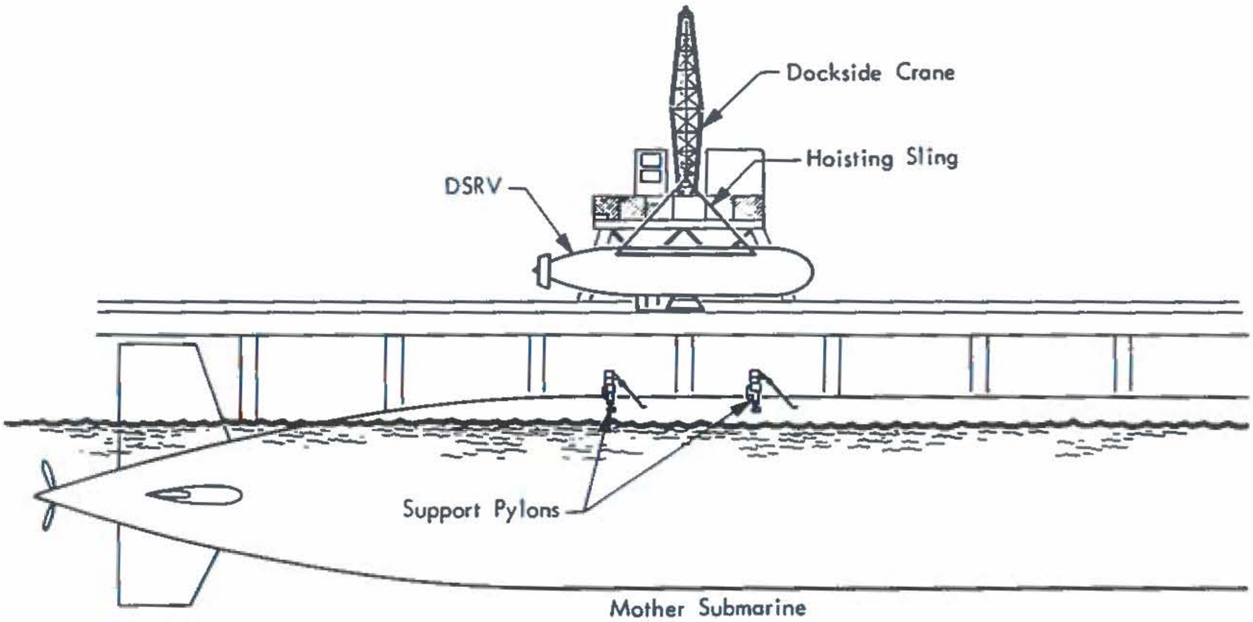

Fig. 6-4 Loading DSRV Aboard Mother Submarine

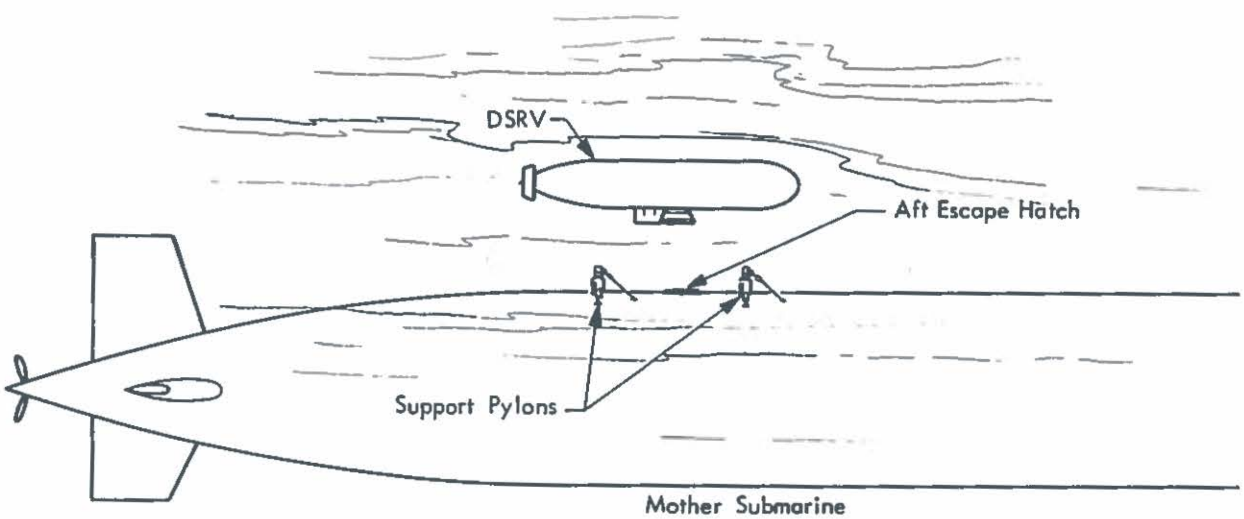

Fig. 6-5 Underwater Capture of DSRV by Mother Submarine

6-23. Ordinarily, all mating between DSRV and the mother submarine is at the aft hatch where the DSRV pylons are located. However, when decompression of crew and rescuees is required(crew for last trip must be decompressed in the DSRV after landing at aft hatch), mating must be done at the forward hatch which provides access to a forward compartment capable of being pressurized to 5 atmospheres. The DSRV must be moved to the aft hatch (after offloading rescuees and the mid sphere crewman) to recharge batteries, replenish the life support system, and perform other servicing operations.

6-24. SHIP OF OPPORTUNITY. In addition to either carrying or towing the DSRV itself, the ship of opportunity selected for a given rescue mission will need to be provided the following special equipment (refer to NAVSHIPS 0900-051-7010):

- Flotation beams
- Towline and bridle
- Special launching sling (with quick-release devices) and stand for deck transport of the DSRV
- Battery charging equipment
- Source of shore power for DSRV
- Source of main ballast air replenishment
- Umbilical bundle for above three items
- Source of water for rescuee ballast replenishment, and an umbilical hose
- Life support resupply (O_2, N_2, LiOH)
- Umbilical for topside sound powered telephone jack (so that deck of the ship of opportunity can communicate with the DSRV pilot)
- Underwater telephone for DSRV communication
- Underwater tracking equipment for tracking the DSRV
- Oil for replenishment of main battery compensation fluid
- Boats (preferably rubber) for DSRV operations
- Bumper gear (to protect DSRV from side of ship)
- DSRV handling and securing lines

6-25. TRUCK-TRACTORS AND TRAILERS.

6-26. During land transport operations, truck-tractors are required as prime movers for the land transport vehicle and the support van. In addition, a flatbed semitrailer and truck-tractor are required for approximately 20,000 pounds of mission equipment. Prime mover for the LTV must have a towing capacity of approximately 120,000 pounds, a standard commercial fifth wheel, sufficient airbrake capacity for the LTV, and a standard commercial connector to provide 12-volt electrical power for vehicle lights. The truck-tractor required for towing the support van must have a capacity of approximately 25,000 pounds and be capable of accepting a lunette eye towbar. A bus or other personnel carrier is needed for crew transportation. All of the vehicles identified here will be obtained from a local motor pool or a commercial source.

6-27. HOME PORT FACILITIES.

6-28. A permanent base facility supporting a Rescue Unit of two complete DSRV Systems is located at the North Island Naval Air Station, San Diego, Calif. A second ASR is located at Norfolk, Va. During normal operations, one DSRV System will be maintained in a standby status ready for immediate deployment on a rescue mission, while the second DSRV System is in a maintenance status, or deployed on a work or training mission.

6-29. The Rescue Unit is housed in a standby and maintenance building consisting of a high-bay center section flanked by two-story wings, one of which contains offices, workshops, personnel facilities, storage, and housekeeping areas. In the center bay are areas for standby and checkout, and for maintenance and disassembly. A 100,000-pound capacity overhead bridge crane is located in the main bay.

6-30. Maintenance and repair shops for sonar, optics, and electronic equipment, and for battery charging, painting, cleaning, and general maintenance services are provided. Storage areas are available for spares and for mercury, hydraulic fluids, oxygen, and nitrogen. Also provided are offices, personnel lockers, conference and classrooms, sleeping quarters for personnel on standby duty, a lounge, and limited mess facilities for both officers and enlisted personnel.

6-31. Paved areas around the building provide vehicle maneuvering space, parking space, and a suitable location to washdown and clean equipment returning from operational missions.

6-32. MISCELLANEOUS.

6-33. Forklifts are required for handling crated and palletized equipment. A dockside crane of at least 80,000 pounds capacity must be available for loading the DSRV onto the mother submarine, or when launching it directly for surface towing.

Section 7
DSRV SYSTEM TECHNICAL PUBLICATIONS

(To be supplied)

INDEX

☆U.S. GOVERNMENT PRINTING OFFICE: 1990 - 504-024/40032

(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:**

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing this form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION.
2. BLOCKS MARKED WITH "*" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1E FOR MAILING CLASSIFIED TMDERS.)
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 360-4805/5084 OR COMMERCIAL 805-982-4805/5084.

1. NAVSEA NO. *	2. VOL. PART *	3. TITLE *

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7. USER'S EVALUATION OF MANUAL (*Check Appropriate blocks*)

	A. EXCEL-LENT		B. GOOD		C. FAIR		D. POOR		E. COM-PLETE		F. INCOM-PLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARA-GRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED
13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO.	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

NAVSEA 9086/10 (REV. 6-85)
(REPLACES 4-84 EDITION & NAVSEA 4160/1 - DESTROY STOCK)

CLASSIFICATION:

PLEASE CLOSE WITH TAPE - DO NOT STAPLE - THANK YOU

DEPARTMENT OF THE NAVY

Official Business
PENALTY FOR PRIVATE USE, $300

PLACE
POSTAGE
HERE

FIRST CLASS MAIL

COMMANDING OFFICER
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)
PORT HUENEME, CA 93043-5007

FOLD HERE

(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:**

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing this form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION.
2. BLOCKS MARKED WITH "★" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1E FOR MAILING CLASSIFIED TMDERS.)
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 360-4805/5084 OR COMMERCIAL 805-982-4805/5084.

1. NAVSEA NO. ★	2. VOL. PART ★	3. TITLE ★

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7. USER'S EVALUATION OF MANUAL (*Check Appropriate blocks*)

	A. EXCELLENT		B. GOOD		C. FAIR		D. POOR		E. COMPLETE		F. INCOMPLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARAGRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED
13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO.	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

NAVSEA 9086/10 (REV.6-85)
(REPLACES 4-84 EDITION & NAVSEA 4160/1 - DESTROY STOCK)

CLASSIFICATION:

PLEASE CLOSE WITH TAPE - DO NOT STAPLE - THANK YOU

DEPARTMENT OF THE NAVY

Official Business
PENALTY FOR PRIVATE USE, $300

PLACE
POSTAGE
HERE

FIRST CLASS MAIL

COMMANDING OFFICER
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)
PORT HUENEME, CA 93043-5007

FOLD HERE

(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:**

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing this form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION.
2. BLOCKS MARKED WITH "★" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1E FOR MAILING CLASSIFIED TMDERS'.)
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 360-4805/5084 OR COMMERCIAL 805 982-4805/5084

1. NAVSEA NO. ★	2. VOL. PART ★	3. TITLE ★

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7. USER'S EVALUATION OF MANUAL (*Check Appropriate blocks*)

	A. EXCELLENT		B. GOOD		C. FAIR		D. POOR		E. COMPLETE		F. INCOMPLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARAGRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED
13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO.	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

NAVSEA 9086/10 (REV.6-85)
(REPLACES 4-84 EDITION & NAVSEA 4160/1 - DESTROY STOCK)

CLASSIFICATION:

PLEASE CLOSE WITH TAPE · DO NOT STAPLE · THANK YOU

DEPARTMENT OF THE NAVY

PLACE
POSTAGE
HERE

Official Business
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL

COMMANDING OFFICER
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)
PORT HUENEME, CA 93043-5007

FOLD HERE