S0600-AA-PRO-080

REVISION 1

UNDERWATER SHIP HUSBANDRY MANUAL

CHAPTER 8
SECONDARY PROPULSION MOTORS

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iii through vii	1
viii blank	1
8-1 through 8-13	0
8-14 blank	0
8-15 through 8-17	0
8-18 through 8-18A	1
8-18B blank	1
8-19 through 8-28	0
8-29 through 8-32	1
8-33 through 8-40	0
8-41	1
8-42	0
8-42A	1
8-42B blank	1
8-43 through 8-52	0
8-53 through 8-55	1
8-56 through 8-57	0
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8-59	0
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1	8-15-99	Add Chain Hoist Caution Correct sub paragraph numbering in paragraph 8-3.5	

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SAFETY SUMMARY

GENERAL SAFETY PRECAUTIONS. The following general safety precautions supplement the specific warnings and cautions throughout this chapter. These general precautions are related to the task of secondary propulsion motors. They are precautions that must be understood and applied before and during work on the SRD. In addition to the following precautions, personnel must be familiar with and observe safety precautions set forth in the following publications:

a. *Navy Occupational Safety and Health Program Manual for Forces Afloat*, OPNAVINST 5000.19 (Series)

b. *Naval Ships' Technical Manual* (NSTM)

c. Technical/operating manuals for equipment

e. *U.S. Navy Diving Manual*, Volume I, NAVSEA-0944-LP-001-9010.

WARNING

Rotation of propellers or operation of underwater electrical equipment while divers are in the vicinity can cause serious injury or death. Ensure that ship's equipment, including the SPM system, is de-energized and tagged out as required by reference (h) prior to beginning underwater operations. (pages 8-15 and 8-33)

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained. (Page 8-16, 8-32, 8-34, 8-35, 8-39, and 8-55)

All divers must be out of the water when megger testing is being conducted. (pages 8-22, 8-30 and 8-54))

CAUTION

It is essential that all tools and materials brought to the underwater job site are accounted for and removed at the completion of the job. Tools and materials inadvertently left at the job site can generate unacceptable noise and possibly cause severe damage to shipboard components. Locally generated work packages shall ensure that a general tool and material log sheet is prepared and maintained during all UWSH operations. (pages 8-15 and 8-33).

Shut and tag out the vent valves for the main ballast tanks 4A, 4B, 5A, and 5B. Ensure that the vent valve cover is installed on ballast tank 4A. (page 8-16).

Chain twist in the working chain loops of manual chain hoists and chain falls will cause chain failure. Chain twist in the working chain loop occurs when the chain has an improper reeve through the chain sprockets OR (more often) the running block has flipped up and through any of the chain loops (see figures 8-6A and 8-16A).

All chain hoists and chain falls issued with NAVSEA SUPSALV Underwater Ship Husbandry equipment kits have been checked for chain twist

and the chain hoist/fall has been loosely two-blocked so that the running block can not flip over into the working chain loops during shipment.

OPERATORS must ensure that the running block is not flipped over into the chain loops creating chain twist while deploying and rigging the chain hoists/falls.

To check for chain twist in the chain loop:

Hang the hoist from the top hook in a safe, accessible location. Tighten the hoist until less then one foot of separation exists between the hoist body and the running block. The short throw allows for much easier visual detection of twist in the individual chain reeves. Confirm that none of the chain lengths running from the working chain sprocket to the running chain sprocket (chain reeves) have any twist caused by the running block being flipped over and through the loop of the chain. If ANY chain twist is detected, flip the running block back through the chain loop until the twist is removed. If ANY twist can not be removed by flipping the running block, the hoist chain MUST be removed from the hoist body and re-reeve exercising care not to twist the chain during installation (pages 8-18, 8-42A, and 8-53).

Ensure that the SPM does not bottom out on the seabed when lowering it from the SPM cavity. (pages 8-22 and 8-43).

Water contacting the electrical

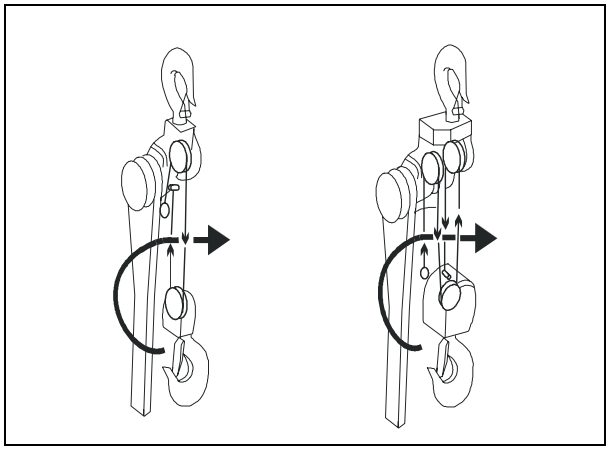

Fig. 8-6A & 8-16A Typical Running Block Flip (one or two part chain reeve)

cable connectors can damage insulation and prevent proper electrical connection. Use extreme care when packaging and transporting electrical cables to the cofferdam. Use connector caps as directed (ensuring proper o-ring compression) to prevent water from making contact with the cables. (page 8-27).

Ensure that there is clear communication between the divers and the crane operator to prevent the SPM from bottoming out on the seabed. (pages 8-29 and 8-53).

An adapter or extension used on a torque wrench increases the torque value. (page 8-29).

Shut and tag out the vent valves for the main ballast tanks 5A, 5B, 6A and 6B for SSN 640 class submarines and 4A, 4B, 5A and 5B for SSN 637 class submarines. (page 8-34).

Water contacting the electrical cables can damage insulation and prevent proper electrical connection. Use extreme care when packaging and transport-

ing electrical cables to the cofferdam. (page 8-51).

Improper alignment of the flange surfaces could dislodge the o-ring and prevent a proper seal when the flange is tightened. Ensure that o-ring (item 65) on the support column flange has not been dislodged. (page 8-54).

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CHAPTER 8
SECONDARY PROPULSION MOTORS

SECTION 1. INTRODUCTION

8-1.1 GENERAL INFORMATION

Underwater ship husbandry provides operational and maintenance advantages by allowing removal and replacement of secondary propulsion motors (SPM) and SPM system components while the submarine is waterborne. The most obvious advantages are the elimination of costly dry docking and the expeditious return of the submarine to operational status. Another advantage is that the SPM system components can be replaced virtually anywhere the submarine is berthed, provided there is underwater clearance of at least ten feet below the bottom edge of the cofferdam when it is attached to the hull. Adherence to the procedures contained within this manual will significantly increase the quality of underwater SPM maintenance operations.

8-1.2 PURPOSE

This chapter describes the Naval Sea Systems Command (NAVSEA) approved procedures for the underwater removal and replacement of SPMs on submarines (with the exception of SSBN 726 Class submarine procedures, which are currently under development). These procedures provide detailed, standardized instructions for cofferdam installation and removal, SPM replacement, and electrical cable replacement. A listing of required tools, materials, and equipment is included. These procedures have been used and validated at various Navy ship maintenance facilities. The proper use of these procedures will result in a permanent repair and will eliminate the need for emergency or unscheduled dry docking.

8-1.3 SYSTEM DESCRIPTION

8-1.3.1 SSN 688 Class. The secondary propulsion system in the SSN 688 Class submarine consists of one SPM located on the starboard side of the center line on the bottom of the submarine between frames 127 and 131. This SPM has four major components: the motor, the electrical power system, the training and retracting mechanism, and the SPM controls. The SPM general location is shown in Figure 8-1. The controls are located within the ship and are not discussed in this chapter. The SPM drives a propeller which operates in a Kort nozzle attached to the motor housing. The electrical power system consists of the electrical hull fitting (EHF), the power cables (with a motor connector on one end and an EHF connector on the other end), and the electrical console (located inside the submarine). The training and retracting mechanism consists of a main support column, a hydraulic training motor for rotating the unit, and a retracting hoist cylinder for raising and lowering the SPM. The SPM can provide thrust at any relative heading of 0 degrees to 200 degrees and will operate at angles up to 60 degrees from the horizontal plane. The SPM training and retracting mechanism is shown in Figure 8-2. When not in use, the SPM is retracted to a stored position within a free-flooding enclosure in a main ballast tank. The enclosure opening in the shell plating is covered by a faired plate attached to the underside of the SPM. This enclosure in designed so that the motor is completely immersed in sea water except when the ballast tanks are fully blown. Interlocks prevent SPM operation while it is in the stored position. The SPM may be raised, lowered, started, stopped, and trained from its own local control box. A remote control panel provides for starting, stopping and training only. The unit is designed to be trained and retracted manually in the event of electrical failure. NAVSEA S6260-CB-MMO-010, Secondary Propulsion Submersible Motor technical manual, and NAVSEA S9238-AB-MMA-

010, Secondary Propulsion Motor technical manual, provide details on the configuration, operation, and maintenance of "wet winding" SPMs and "dry winding" (canned) SPMs, respectively. "Wet winding" SPMs allow seawater to fill the motor and circulate through the bearings, windings, and the gap between the rotor and stator. "Dry winding" SPMs use a rotor and stator which are sealed in an Inconel lining (canned) which isolates the windings from seawater. Consult the technical manual ship applicability list and the submarine's onboard technical manual to confirm the type of SPM used by a particular submarine.

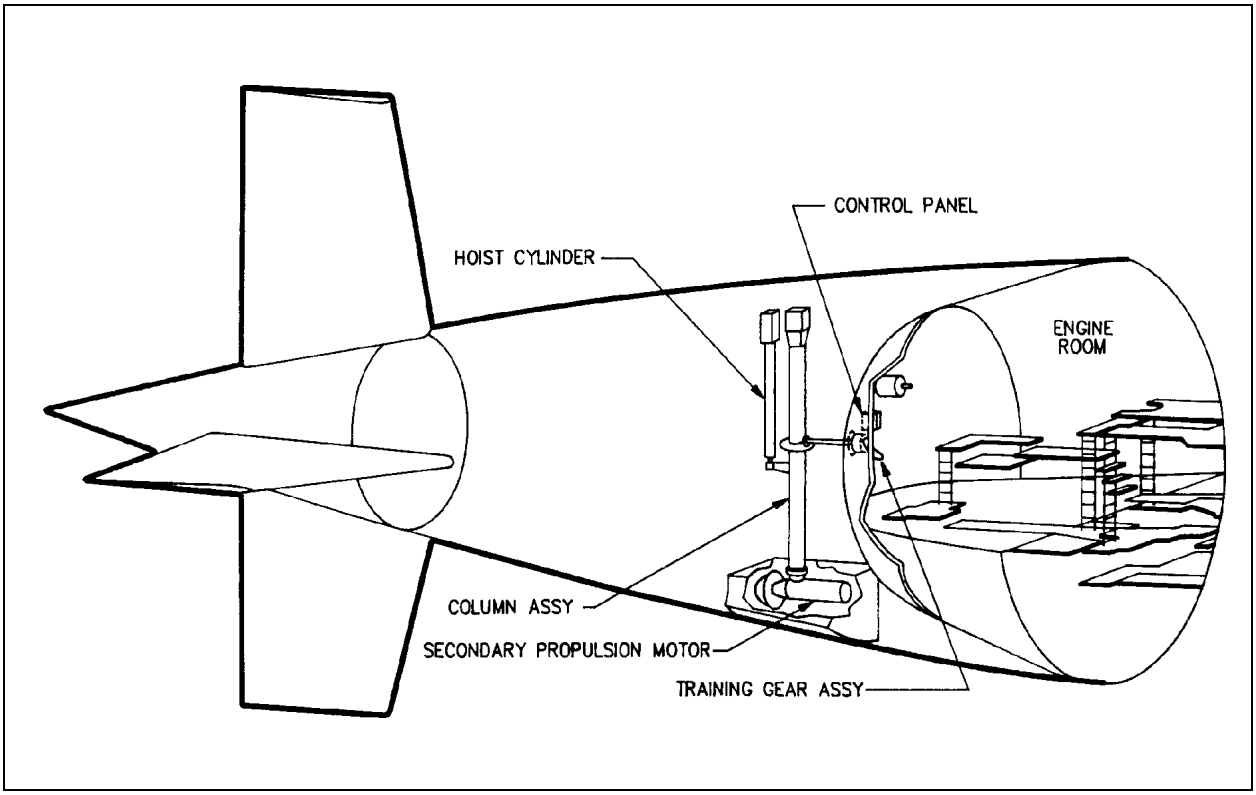

Figure 8-1. SPM Location in SSN 688 Class Submarine.

8-1.3.2 SSN 640 Class. The secondary propulsion system in the SSN 640 Class submarine consists of one SPM located along the center line on the bottom of the submarine between frames 112 and 117. The training and retracting mechanisms are electrically and hydraulically powered. The support structure for the training and retracting devices are mounted inside the pressure hull of the submarine. The support structure actually forms part of the pressure hull. The hydraulic cylinders, which are bolted to the hull insert and structural support, provide the means of raising and lowering the main column, which is attached to the carriage. The SPM is mounted at the base of the column and outside the pressure hull. The carriage contains the mounting of the training motor and gear assembly. The training motor provides the electrical training of the SPM to any desired location through 360 degrees. The SPM training and retracting mechanism is shown in Figure 8-3. When not in use, the SPM is retracted to a stored position within a free-flooding enclosure in a main ballast tank. The enclosure opening in the shell plating is covered by a faired plate attached to the underside of the SPM. This enclosure in designed so that the motor is completely immersed in sea water except when the ballast tanks are fully blown. Interlocks prevent SPM operation while it is in the stored position. The SPM may be raised, lowered, started, stopped, and trained from its own local control box. A remote control panel

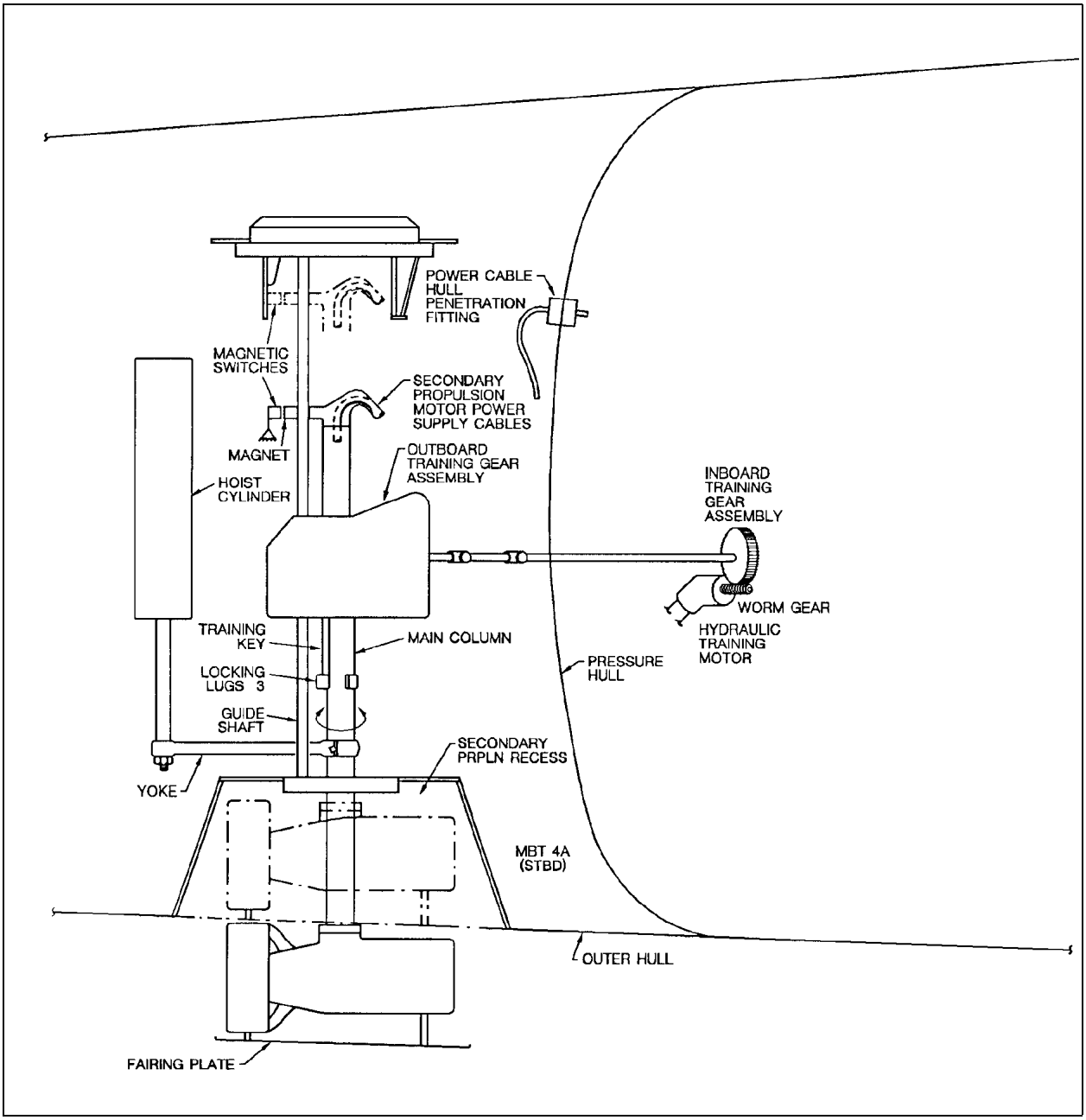

Figure 8-2. Secondary Propulsion Motor and Associated Components (SSN 688)

provides for starting, stopping and training only. The unit is designed to be trained and retracted manually in the event of electrical failure. NAVSEA 0363-LP-100-3002, SSBN 627 Class Secondary Propulsion Motor technical manual, provides details on the configuration, operation, and maintenance of SPMs for SSN 640 Class submarines.

8-1.3.3 SSN 637 Class The secondary propulsion system in the SSN 637 Class submarine consists of one SPM located along the center line on the bottom of the submarine between frames 72 and 76. The components of the training and retracting mechanism include the main column, upper yoke, two ball screw assemblies, training and retracting

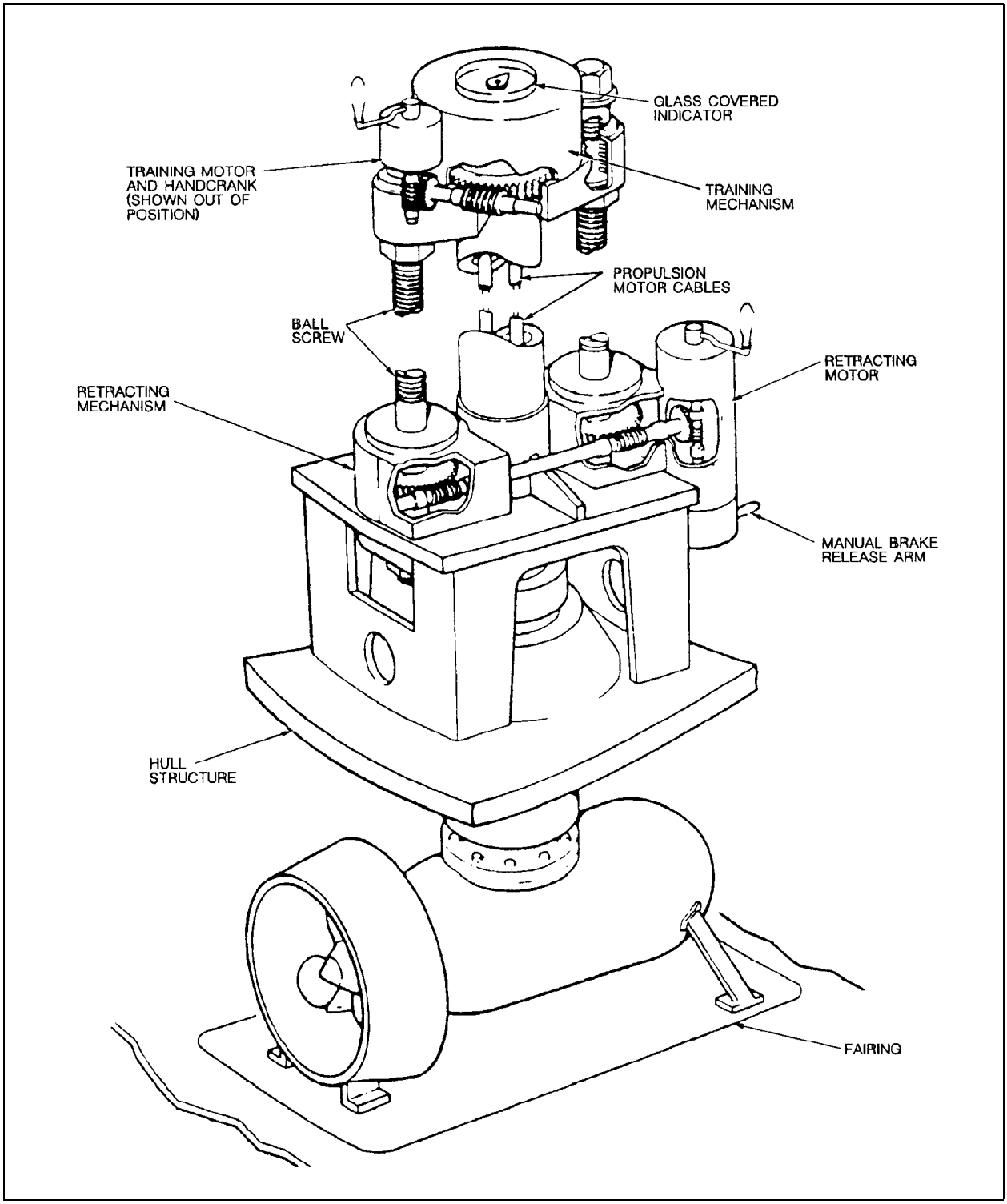

Figure 8-3. Secondary Propulsion Motor and Associated Components (SSN 640)

motors and gear assemblies. The SPM is mounted at the base of the main column and outside the pressure hull. The upper yoke contains the mounting of the training motor, training gear assembly and ball screw assemblies. The training motor provides the electrical training of the SPM to any desired location through 360 degrees. The ball screw assemblies pro-

vide the means of raising or lowering the main column. The retracting motor and brake with the associated gear reduction units are attached to the top of the hull insert. The gear reduction units operate in tandem to rotate the ball screws and extend or retract the upper yoke. The electric brake is connected to the retracting motor and is mechanically set to stop and hold the yoke in any position. The SPM training and retracting mechanism is shown in Figure 8-4. When not in use, the SPM is retracted to a stored position within a free-flooding enclosure in a main ballast tank. The enclosure opening in the shell plating is covered by a faired plate attached to the underside of the SPM. This enclosure in designed so that the motor is completely immersed in sea water except when the ballast tanks are fully blown. Interlocks prevent SPM operation while it is in the stored position. The SPM may be raised, lowered, started, stopped, and trained from its own local control box. A remote control panel provides for starting, stopping and training only. The unit is designed to be trained and retracted manually in the event of electrical failure. NAVSEA 0963-LP-007-6000, Secondary Propulsion System, Submersible Motor, Submarine technical manual, provides details on the configuration, operation, and maintenance of "wet winding" SPMs for SSN 637 Class submarines.

8-1.3.4 SSBN 726 Class. The secondary propulsion motors on the SSBN 726 Class submarines are located on both sides of the center line on the bottom of the submarine. The SPMs can only be extended or retracted, they cannot be trained. The SPMs are mounted at the base of the main column located outside of the pressure hull. The SPMs can be independently operated, and each has its own extend/retract mechanism. The extend/retract mechanism consists of a hydraulic control valve, a hydraulic hoisting motor, an inboard gear box, an outboard gear box, and a mechanical screw assembly. The SPM extend/retract mechanism is shown in Figure 8-5. When not in use, the SPM is retracted to a stored position within a free-flooding enclosure in a main ballast tank. The enclosure opening in the shell plating is covered by a faired plate attached to the underside of the SPM. This enclosure in designed so that the motor is completely immersed in sea water except when the ballast tanks are fully blown. Interlocks prevent operation while it is in the stored position. The SPMs can only be raised, lowered, started and stopped from their local control panel. The SPMs have no remote operating capability. The units are designed to be operated manually in the event of a power failure. NAVSEA S9238-AB-MMA-010, Secondary Propulsion Motor technical manual, provides details on the configuration, operation, and maintenance of "dry winding" SPMs for SSBN 726 Class submarines. Consult the technical manual ship applicability list to confirm the proper technical manual for a particular submarine. These waterborne replacement procedures are currently under development.

8-1.4 REFERENCE DOCUMENTS

The documents listed below contain the technical information required for the planning, preparation and execution of an SPM replacement operation for various submarine classes, with the exception of SSBN 726 Class submarines. Care should be taken to obtain and use the most current version of these documents. They must be used during the planning phase and shall be available on site during the conduct of waterborne replacement operations. NAVSEA S0600-AA-PRO-020, Underwater Ship Husbandry Manual: General Information and Safety Precautions, provides information on obtaining and using technical documents.

(a) Ship's Drawing Index: a thorough review and understanding of the following NAVSEA drawings are required for successful SPM replacement operations:

- 1197260 (Rev B or later) , Electrical Hull Fitting: contains all necessary information concerning SPM cable/EHF connector and cable/motor

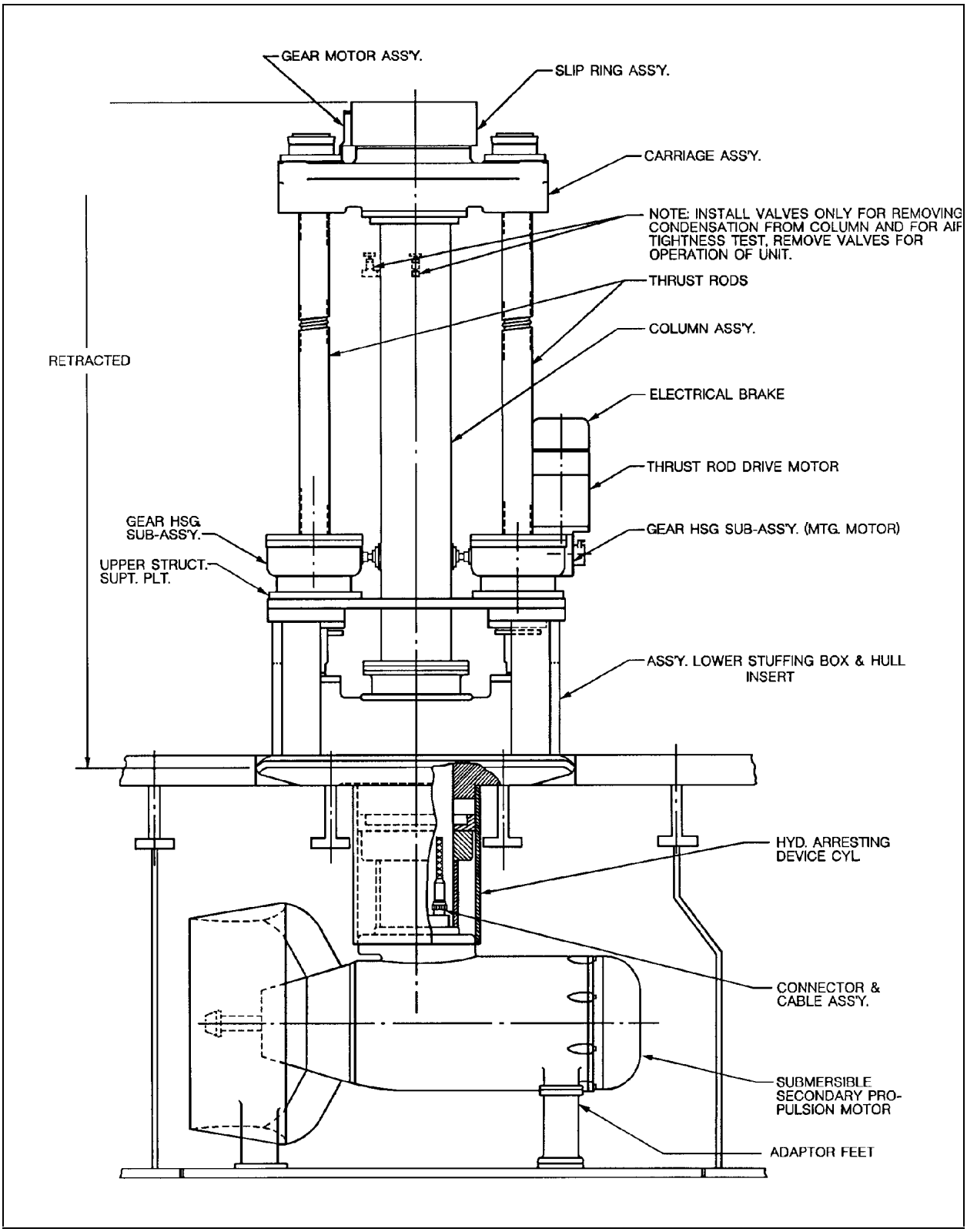

Figure 8-4. Secondary Propulsion Motor and Associated Components (SSN 637)

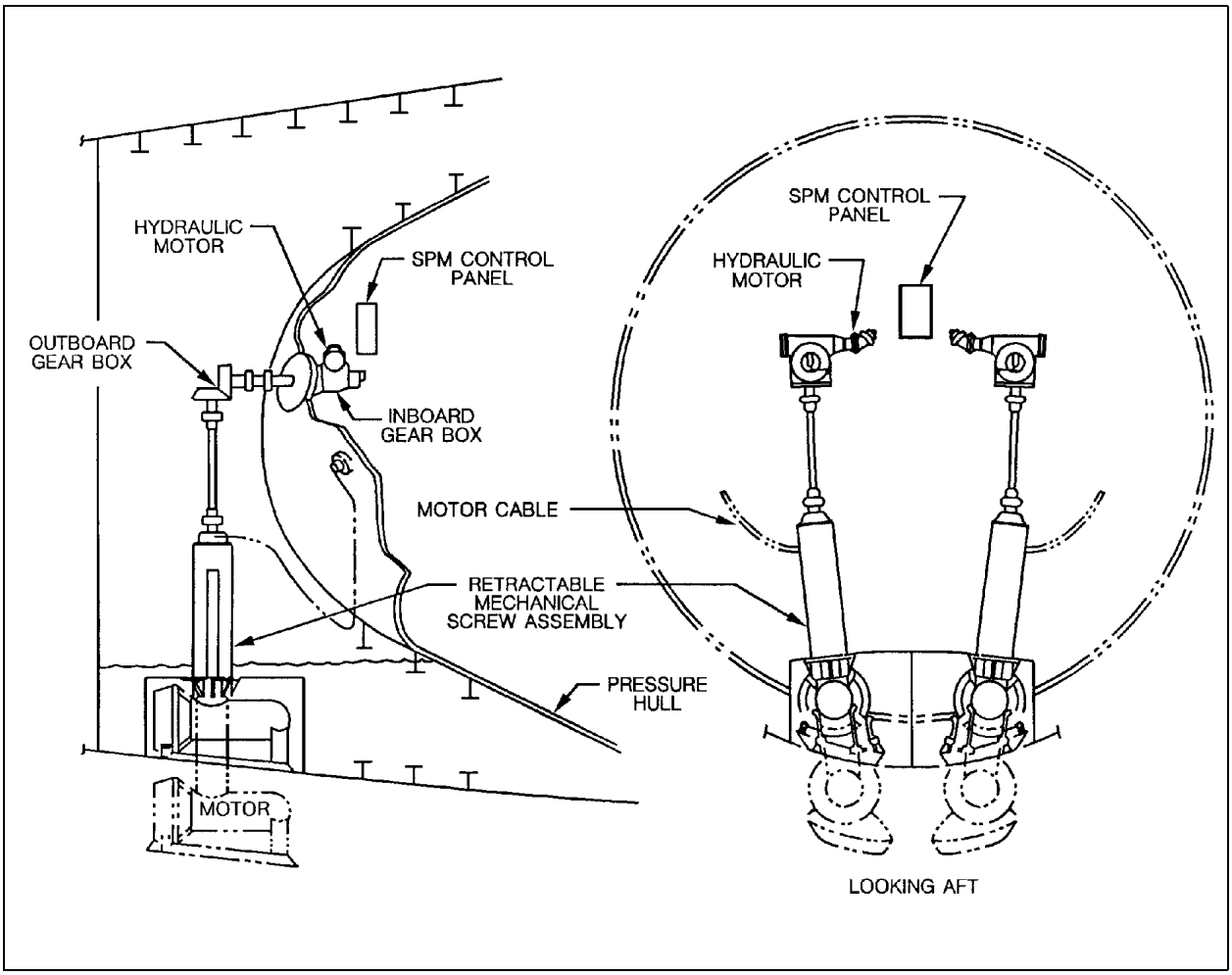

Figure 8-5. Secondary Propulsion Motor and Associated Components (SSBN 726).

connector installations, O-ring specifications, hydrostatic testing requirements, and minimum megaohm requirements for resistance testing. SPM replacement should not be attempted without use of this drawing.

- 4454547, SPM Cables: includes hydrostatic testing requirements and installation requirements.
- 4494057 and 5942057, SSN 688 Class Fairing Plate.
- 5006590, SSN 688 Class Outboard Penetrations.
- 2012206, SSN 640 Class Fairing Plate.
- 2140608, SSN 637 Class Fairing Plate

(b) NAVSEA S6260-CB-MMO-010, Secondary Propulsion Submersible Motor Technical Manual and NAVSEA S9238-AB-MMA-010, Secondary Propulsion Motor Technical Manual (SSN 688 Class submarines).

(c) NAVSEA 0363-LP-100-3002, Technical Manual, SSBN 627/SSN 640 Class Secondary Propulsion Motor.

(d) NAVSEA 0963-LP-007-6000, Technical Manual, Secondary Propulsion System, Submersible Motor, Submarine (SSN 637 Class submarines).

(e) NAVSEA S9086-KC-STM-000, NSTM CH 300, Electric Plant General.

(f) NAVSEA S9086-CQ-STM-010, NSTM CH 081, Waterborne Underwater Hull Cleaning of Navy Ships.

(g) NAVSEA S9505-AM-GYD-010, Submarine Fastening Criteria (Non Nuclear).

(h) NAVSEA 0994-LP-001-9110 / 0927-LP-001-9110, U.S. Navy Diving Manual.

PLANNING AND PREPARATION
SECTION 2

8-2.1 GENERAL INFORMATION

Planning is essential to the successful completion of any underwater ship husbandry task. Proper planning should begin at the earliest possible time, involve all concerned parties, and result in a written operational plan. General planning guidelines are presented in NAVSEA S0600-AA-PRO-020, Underwater Ship Husbandry Manual: General Information and Safety Precautions.

8-2.2 PLANNING

In planning an underwater SPM replacement operation, consideration must be given not only to general planning guidelines but also to those aspects which are unique to the task, such as fabrication of an SPM cofferdam. The scope of work may vary from a partial removal of the SPM for the purpose of conducting electrical tests to a complete SPM replacement. The ship's mooring position and depth of water under the center line on the bottom of the submarine are extremely important. When working on SSN 688 Class SPMs, the submarine is required to be moored starboard side to. However, since their SPMs are located on centerline, SSN 637 and SSN 640 Class submarines may be moored either port or starboard side to. Also, when working on the SPM, water depth should allow a minimum of ten feet of clearance below the bottom edge of the cofferdam when it is attached to the hull. Scheduling and personnel requirements depend greatly on the ship's operating schedule and the time available to complete the task. Coordination between divers, surface support personnel, and ship's force engineering personnel is mandatory and must be reflected in the operational plan.

8-2.3 PREPARATION

Preparation for the task consists of assembling all necessary material and personnel identified in the planning phase and properly arranging those resources on site. Table 8-1 provides a listing of the tools, materials, and equipment required to perform the task. Appendices F through I depict the various class hull penetrations.

8-2.4 TOOLS, MATERIALS, AND EQUIPMENT

Removal and replacement of the SPM and the electrical cables require special equipment and tools. The items listed in Table 8-1 represent the minimum requirements necessary for SPM replacement. Many items have been designed especially for SPM replacement operations. Their functions are described in the following paragraphs. These items are also available as a kit from NAVSEA 00C5.

NOTE

All tools transferred into submarine spaces (main ballast tanks, SPM enclosure, etc) shall be documented in a tool check-in sheet in order to avoid leaving tools in these spaces and creating mechanical and/or noise problems.

8-2.4.1 Cofferdam. The cofferdam is manufactured to conform specifically to the submarine's hull configuration. The cofferdams provide a dry environment which prevents contact between electrical components and the water. Ensure that the required cofferdam is available during the planning stage. The

cofferdam may be fabricated in accordance with NAVSEA drawings: 6699589 for SSN 688 Class submarines, 6697897 for SSN 637 Class submarines, and 6697889 for SSN 640 Class submarines.

8-2.4.2 Sealing Caps. During the removal and replacement of the SPM, sealing caps are required to be placed on the SPM electrical connections to prevent contact with moisture. These items may be fabricated in accordance with NAVSEA drawings 6697894 and 6697891.

8-2.4.3 Special Tools. Specially configured cable connector tools may have to be constructed and used during the removal of the SPM electrical connector. See NAVSEA drawing 1197260, revision B.

8-2.4.4 Portsmouth Fitting Tool. A Portsmouth fitting tool is required for the removal of the portsmouth electrical connectors from the Electrical Hull Fitting (EHF) on SSN 688 Class submarines. See NAVSEA drawing 1197260 (Rev B or later).

8-2.4.5 SPM Alignment Fixture. The SPM alignment fixture is designed to measure distances between the SPM and the fairing plate to ensure proper fit-up. The alignment fixture may be fabricated in accordance with NAVSEA drawing 6697988.

8-2.4.6 Cable Support Replacement Tool. The cable support replacement tool is used to remove and replace the cable support for the SSN 688 Class submarine. The cable support replacement tool may be fabricated in accordance with NAVSEA drawing 6697989.

8-2.4.7 Portsmouth Connector Caps. During the removal and replacement of the SPM, portsmouth connector caps are required to be placed on the portsmouth connectors on the SPM cable to prevent contact with moisture. These items may be fabricated in accordance with NAVSEA drawing 6697892.

Table 8-1. Tools, Materials, and Equipment for SPM Replacement.

Item No.	Quantity	Component Description	Technical Specifications	Class Application
1	18	3/4-inch shackle, anchor[5]	9-ton SWL, screw pin, galvanized	All
2	2	Eyeslings, two-ply polyester, 2-inch wide x 45 feet[5]	3-ton SWL	All
3	4	1/2-ton come-along[5]	Commercial	All
4	1	Crane, mobile (pierside or floating)	10-ton minimum	All
5	12	3/4 inch x 12-inch turnbuckle with J-Hook[5]	NAVSEA Dwg. 6697835	637/640
6	12	3/4 inch x 18 inch turnbuckle with J-Hook[5]	NAVSEA Dwg. 6697835	637/640
7	10	3-ton beam clamps[5]	Commercial	All
8	8	2-inch expandable plugs[5]	Commercial	All
9	8	1-inch expandable plugs[5]	Commercial	All
10	10	Plastic bags, 36 by 54 inches	Commercial	All
11	1 roll	Duct tape	Commercial	All
12	100 feet	Air hose: 250 psig, 3/8-inch diam, 1/4 inch NPT fittings[2, 5]	Commercial	All
13	as needed	Bintsuke	See Appendix A	All
14	1	Pipe wrench, 11 inch[5]	Commercial	688
15	4	3-ton beam clamps[2, 5]	Super Clamp, Model S3A	All
16	4	18-inch polyester roundsling[2, 5]	3-ton SWL	All
17	6	10 1/2-inch Masterlink [5]	Campbell, PT NO. C0-5	All
18	2	7/8 inch shackle, anchor[2, 5]	12-ton SWL, screw pin, galvanized	All
19	2	3-ton chain hoist[2, 5] (manual or hydraulic[6])	30-ft minimum throw, w/ safety latches	All
20	1	13-ft polyester roundsling[2, 5]	3-ton SWL	All
21	2	1-inch shackle, anchor[2, 5]	16 ton SWL, screw pin, galvanized	All
22	2	3-ft polyester roundsling[2, 5]	3-ton SWL	All
23	1	11-ft polyester roundsling[2, 5]	3-ton SWL	All
24	as needed	12-inch tie wraps	NSN: 5975-01-243-2102	All
25	3	Brass sealing caps[5]	NAVSEA Dwg. 6697894	All
26	3	Delrin sealing caps[5]	NAVSEA Dwg. 6697891	All
27	1 set	Standard mechanic's tools	Commercial	All
28	1	SPM Alignment Fixture[5]	NAVSEA Dwg. 6697988	All

Table 8-1. Tools, Materials, and Equipment for SPM Replacement.

Item No.	Quantity	Component Description	Technical Specifications	Class Application
29	1	Torpedo Level, 9 inch or smaller[5]	Commercial	All
30	1	Torque wrench[5] (100 ft-lbs and 250 ft-lbs, calibrated), manual or hydraulic[6]	Commercial	All
31	8	Lock nuts, 1/2-13 UNC-3B	Mil Spec: 17828-8C NSN: 5310-00-245-3504	All
32	8	Lock nuts, 3/4-10 UNC-3B	Mil Spec: 17828-12 NSN: 5310-01-160-2035	All
33	2 bottles	Dry nitrogen w/fittings, hoses & regulator	Commercial	All
34	as needed	Sealant[2, 5]	Bostich 920 fast set, marine use	All
35	8 or 16	1 5/8-inch self-locking nuts (8 for SSN 640 and SSN 637, 16 for SSN 688), 1-8 UNC-2B Heavy	Ni-Cu (QQ-N-281) Magnatek Louis Allis, part # 50P03012-0001	All
36	1	Chain wrench[2, 5]	KD Tools, part # 2595	All
37	as needed	Silicone Compound	NSN: 6850-00-702-4297	All
38	1	Lockwire pliers, 9 inch[5]	Commercial	688
39	75 feet	Water Hose[5]	Commercial	688
40	1	5/8-inch Expandable Plug[5]	Commercial	688
41	2	Cable Support Replacement Tool[5]	NAVSEA Dwg. 6697989	688
42	1	Portsmouth Fitting Tool[5]		688
43	1	2 3/8-inch cable connector tool1, 4,5		688
44	1	1 15/16-inch cable connector tool[1, 4, 5]		688
45	3	Portsmouth Connector Caps[5]	NAVSEA Dwg. 6697892	688
46	2	1/2 inch O.D. expandable plugs or 1/2 inch IPT plugs[2, 3]	Expand-O-Seal, part # SP30760050N or NSN: 1560-00-959-2059	688
47	1	Hydrostatic test fixture[5]	NAVSEA Dwg. 6697893	688
48	75 feet	Hydrostatic test tubing[2, 5]	Gates, part # 4C3, 1/4 inch SAE 100R3 G04198	688
49	1	Hydrostatic test pump[2, 5]	Haskell, part # 26817	688
50	2	0 to 15 psig hydraulic pressure gauge[5] (calibrated)	Commercial	688
51	2	0 to 500 psig hydraulic pressure gauge[5] (calibrated)	Commercial	688

Table 8-1. Tools, Materials, and Equipment for SPM Replacement.

Item No.	Quantity	Component Description	Technical Specifications	Class Application
52	as needed	Lockwire (.051 inch dia.)	Ni-Cu (QQ-N-281)	688
53	1	Cofferdam[5]	NAVSEA Dwg. 6697898	688
54	1	Cofferdam[5]	NAVSEA Dwg. 6697897 NAVSEA Dwg. 6697889	637 640
55	1	Column Vent & Drain Valve Assy 1 Valve 1 Air Inlet Fitting, 3/8 inch 1 Nipple, pipe 1 O-ring, 7/8 inch I.D. x 1 inch O.D.	Conbraco, part # 1040A-3/8 NSN: 4820-01-076-6436 Hoffman Eng., part # MPB-3 Coltec Ind., part # 92008302 NSN:4730-01-075-6960 Mil-R-25897C Parker Seal part # 2-20	637/640
56	1	0-50 psig air gauge (calibrated)	Commercial	637/640
57	1	Support column cover[5]	NAVSEA Dwg. 6697895	637/640
58	1	Gasket, cover[5]	NAVSEA Dwg. 6697895	637/640
59	1	Boat winch, 500 pound minimum with 1/4 inch x 15 ft wire rope[5]	McMaster-Carr, part # 3196T26. See Figure 8-18	637/640
60	1	Eyebolt, 3/8-13 UNC	Commercial (200 lbs capacity)	637/640
61	1	3/8-inch shackle, anchor	Commercial	637/640
62	1	Closure plate, gasket and accessories[5]	NAVSEA Dwg. 6697896	637/640
63	6	Screws, hex head 5/16-18 UN-2A x 1-1/16 inch	Steel	637/640
64	1	Vacuum pump w/ vacuum hose[2]	DAYTON, part # 4ZS77	637/640
65	1	O-ring 10-inch I.D. – 10 1/2-inch O.D	Buna-N, part # 2-449 NSN: 5330-01-205-3173	637/640
66	1	O-ring 8-inch I.D. – 8 1/2-inch O.D.	Buna-N, part # 2-445 NSN: 5330-00-599-0974	637/640
67	1	Wrench, 2 1/2-inch crow's foot[2] (typical)[4]	Snap-On, part # AN8508-40A NSN: 5120-00-184-8389	637/640
68	1	Wrench, 2 3/4-inch crow's foot[2] (typical) [4]	Snap-On, part # AN8508-44A NSN: 5120-00-184-8393	637/640
69	2	Blanking Flanges Forward Flange Port & Stbd Flange	NAVSEA Drawing 6697899	637/640

1. Special item that may be used
2 . Or suitable substitute
3 . May be used if the drain plugs on the SPM column are tapped
4. SPM locknut and coupling sizes vary. If items 67 and 68 do not fit, use appropriate size crows foot.
5. Item available in NAVSEA SPM kit.
6. Hydraulic hoist and hydraulic torque wrench are available through NAVSEA.

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PROCEDURES FOR REMOVAL AND REPLACEMENTOF SSN 688 CLASS SPM AND ELECTRICAL CABLES

SECTION 3

WARNING

Rotation of propellers or operation of underwater electrical equipment while divers are in the vicinity can cause serious injury or death. Ensure that ship's equipment, including the SPM system, is de-energized and tagged out as required by reference (h) prior to beginning underwater operations.

CAUTION

It is essential that all tools and materials brought to the underwater job site are accounted for and removed at the completion of the job. Tools and materials inadvertently left at the job site can generate unacceptable noise and possibly cause severe damage to shipboard components. Locally generated work packages shall ensure that a general tool and material log sheet is prepared and maintained during all UWSH operations.

8-3.1 GENERAL: SSN 688 CLASS SUBMARINES

NOTE

Before beginning these procedures, ship's force shall isolate all SPM electrical system components inside the submarine (console, EHF) and megger these components separately in accordance with reference (e) in order to ensure that the problem is located outside the pressure hull. If any internal system component is faulty, it should be repaired and the system should be reconnected and meggered to see if the fault has been corrected before any action is taken on the external components of the SPM system.

This section provides detailed procedures for removal and replacement of an SPM on a waterborne SSN 688 Class submarine. A separate set of procedures is included for removal and replacement of faulty electrical cables. If an electrical problem exists within the SPM system, reference (b) provides test procedures down to the SPM. If tests reveal that the fault is beyond the SPM cable connections, divers must disconnect the power cables from the SPM to further isolate the fault. When this has been accomplished and the cables and SPM terminals are known to be dry, ship's force personnel may conduct additional electrical tests to further isolate the fault. When the results of this additional testing have been evaluated, the cognizant repair activity representative must determine the appropriate course of action to correct the fault. Electrical problems may be caused by faulty cables, a faulty motor, or moisture on the terminal connections.

NOTE

While the following procedures require that topside personnel and divers work closely together, certain steps must be carried out by particular personnel. To clarify these steps,

abbreviations are placed at the beginning of each step where the specific party needs to be identified: (DV) represents diver; (TOP) represents topside personnel or ship's force, and (SHOP) represents the machine shop personnel.

8-3.1.1 Removal of the SPM requires the use of a cofferdam. Procedures for cofferdam installation and SPM replacement are provided in the following paragraphs.

8-3.2 SECONDARY PROPULSION MOTOR REMOVAL PROCEDURE (SSN 688)

8-3.2.1 (TOP) Tag out the SPM system and all sources of high pressure air associated with the SPM.

8-3.2.2 (DV) Measure and record the fairing plate vertical alignment with the hull (Figure 8-6). Measurements shall be taken forward, aft, port, and starboard. Each measurement shall be recorded as positive if the outside surface of the plate is outside the hull outer surface, and negative if the fairing plate outer surface is inside of the hull outer surface. The fairing plate vertical alignment inside or outside the hull shall not exceed tolerances specified in NAVSEA drawing 4494057 or 5942057. For measurement charts, see Appendix E.

8-3.2.3 (DV) Measure the transverse gap between the fairing plate and the hull. Measurements should be taken forward, aft, port, and starboard. The transverse gap between the fairing plate and the hull should be within local repair activity QA criteria, but shall not exceed 1 inch at any point around the perimeter. For measurement charts, see Appendix E.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

NOTE

Ensure that all tag out procedures are in accordance with the current shipboard instructions.

CAUTION

Shut and tag out the vent valves for the main ballast tanks 4A, 4B, 5A, and 5B. Ensure that the vent valve cover is installed on ballast tank 4A.

8-3.3 COFFERDAM RIGGING, INSTALLATION, AND SPM REMOVAL (SSN 688)

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-3.3.1 (TOP) Remove tags necessary to lower the SPM and fully lower the SPM.

8-3.3.2 (TOP) Tag out the SPM system to ensure that it is not raised, lowered, or trained.

8-3.3.3 (DV) Lower the ballast tank 4A grate just forward of the SPM cavity.

8-3.3.4 (DV) Enter ballast tank 4A and locate the cable cover guide at the top of the SPM support column. Cut the lock wires and remove the four bolts holding the two cable clamps. Cut the lock wires and remove the eight 3/8-inch allen head screws on the top of the cable cover guide. Using a pipe wrench (item 14), remove the 1- 1/4-inch shaft which aligns the cable guide by turning the shaft counter-clockwise. The end of the shaft is threaded and will disconnect at the bottom. Remove the guide and shaft from the support column by sliding it up the cables. Inspect the cables inside the column for any twisting, kink-

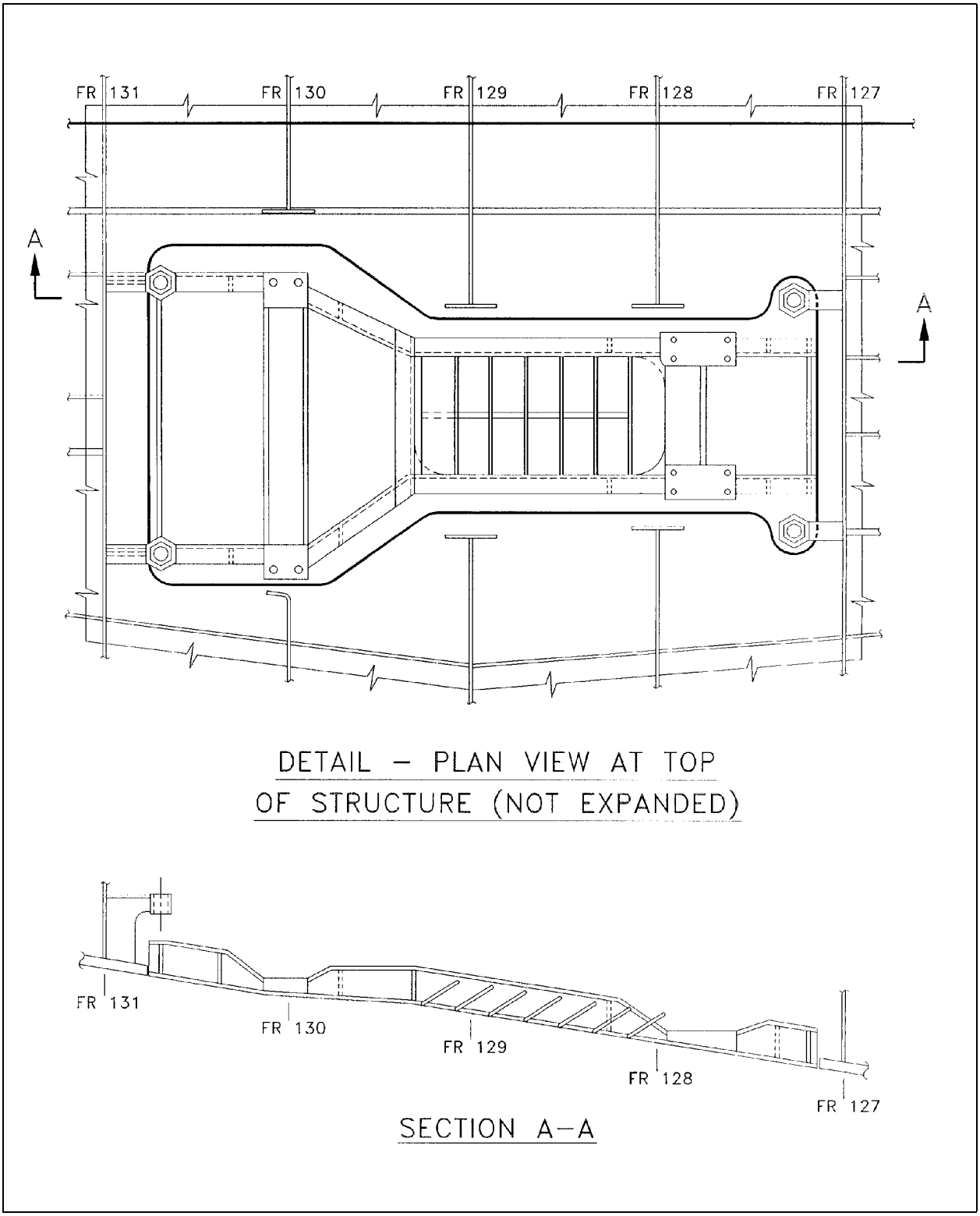

Figure 8-6. Submarine Fairing Plate (SSN 688)

ing, or other abnormalities which may prevent the cables from passing through the cable support at the bottom of the support column (Figure 8-7). Feed approximately two feet of cable into the support column to allow for slack when removing the SPM from the column.

NOTE

Each submarine has a different I-beam configuration within the SPM cavity. Rigging attachment points will vary. The following are typical steps for rigging and placement of I-beam clamps and chain hoists.

8-3.3.5 (DV) Install two I-beam clamps (item 15) as close to center as possible on the forward I-beam above the SPM. Depending on the I-beam configuration, install a 18-inch long 3-ton SWL roundsling (item 16) or a 10 1/2-inch link (item 17) to each beam clamp using a 3/4-inch shackle and join the roundslings or links together with a 7/8-inch shackle (item 18). Install two other beam clamps as close to center as possible on the aft I-beam above the SPM in the same manner as the forward beam clamps. Install a 18-inch long, 3-ton SWL roundsling or a 10 1/2-inch link to each beam clamp using a 3/4-inch shackle and join the roundslings or links together with a 7/8-inch shackle. If I-beam configuration permits, one beam clamp forward and aft may be used instead of two beam clamps forward and aft. Also, chain hoists may be attached directly to the beam clamps.

NOTE

Ensure a minimum of 48 inches clearance between the SPM and the overhead I-beams within the SPM cavity.

CAUTION

Chain twist in the working chain loops of manual chain hoists and chain falls will cause chain failure. Chain twist in the working chain loop occurs when the chain has an improper reeve through the chain sprockets OR (more often) the running block has flipped up and through any of the chain loops (see figure 8-6A)

All chain hoists and chain falls issued with NAVSEA SUPSALV Underwater Ship Husbandry equipment kits have been checked for chain twist and the chain hoist/fall has been loosely two-blocked so that the running block can not flip over into the working chain loops during shipment.

OPERATORS must ensure that the running block is not flipped over into the chain loops creating chain twist while deploying and rigging the chain hoists/falls.

To check for chain twist in the chain loop:

Hang the hoist from the top hook in a safe, accessible location. Tighten the hoist until less then one foot of separation exists between the hoist body and the running block. The short throw allows for much easier visual detection of twist in the individual chain reeves. Confirm that none of the chain lengths running from the working chain sprocket to the run-

ning chain sprocket (chain reeves) have any twist caused by the running block being flipped over and through the loop of the chain. If ANY chain twist is detected, flip the running block back through the chain loop until the twist is removed. If ANY twist can not be removed by flipping the running block, the hoist chain MUST be removed from the hoist body and re-reeve exercising care not to twist the chain during installation.

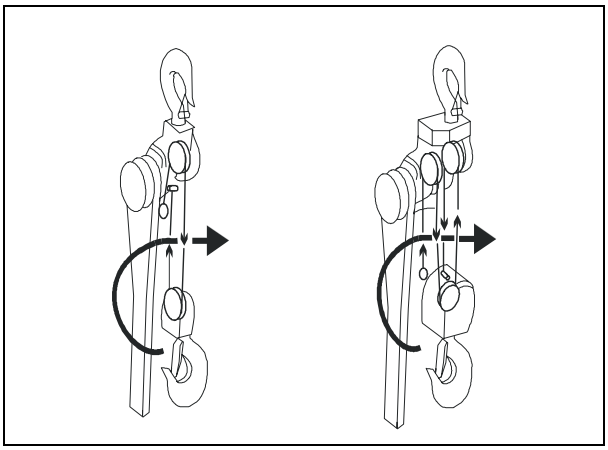

Fig. 8-6A Typical Running Block Flip (one or two part chain reeve)

8-3.3.6 (DV) Attach a 3-ton chain hoist (item 19) to the forward and aft 7/8-inch shackles.

8-3.3.7 (DV) Double wrap a 13-foot, 3-ton SWL polyester roundsling (item 20) in a basket configuration around the forward end of the SPM. Make sure that the roundsling does not lie in the groove between the SPM and the forward shroud. Connect the roundsling to the forward chain hoist using a 1-inch shackle (item 21). Connect a 3-foot long, 3-ton SWL roundsling (item 22) as a lazy pendant in the 1-inch shackle (see Figure 8-8) on top of the SPM, and drape the pendants on the starboard side of the SPM.

8-3.3.8 (DV) Double wrap an 11-foot, 3-ton SWL polyester roundsling (item 23) in a basket configuration around the aft end of the SPM, forward of the Kort nozzle. Do not rig through or allow the roundsling to rest on the Kort nozzle. Connect the roundsling to the aft chain hoist using a 1-inch shackle. Connect a 3-foot long, 3-ton SWL roundsling as a lazy pendant in the 1-inch shackle (see Figure 8-8) on top of the SPM, and drape the pendants on the starboard side of the SPM.

8-3.3.9 (DV) Remove all slack from the chain hoists and roundsling rigging so that they are able to take the weight of the SPM as the flange bolts are loosened.

8-3.3.10 (DV) Scribe a match mark on both the SPM flange and the support column flange.

8-3.3.11 (DV) Sequentially remove each of the sixteen 1-5/8-inch self-locking nuts on the main column flange.

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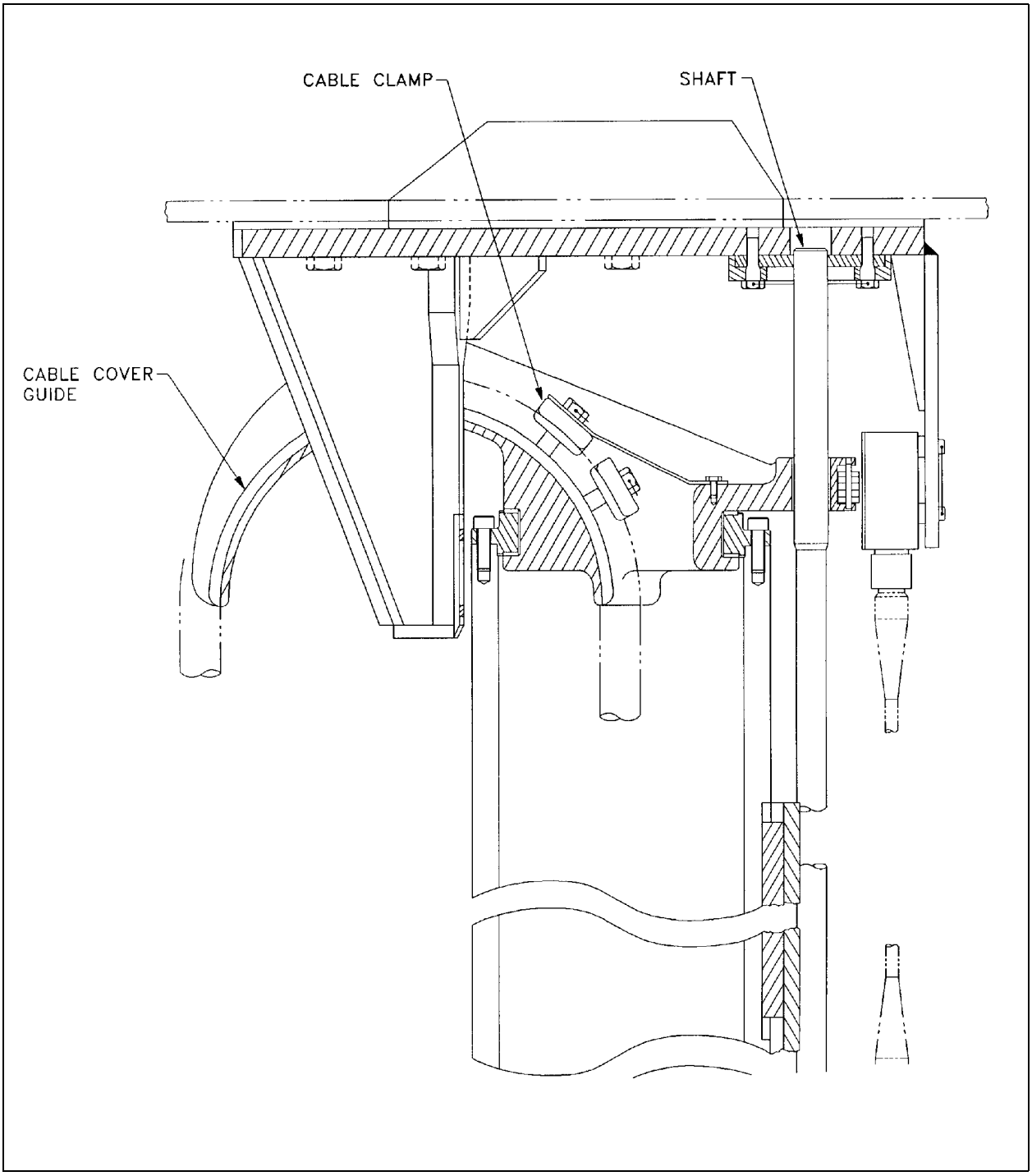

Figure 8-7. Upper SPM Column Assembly (SSN 688).

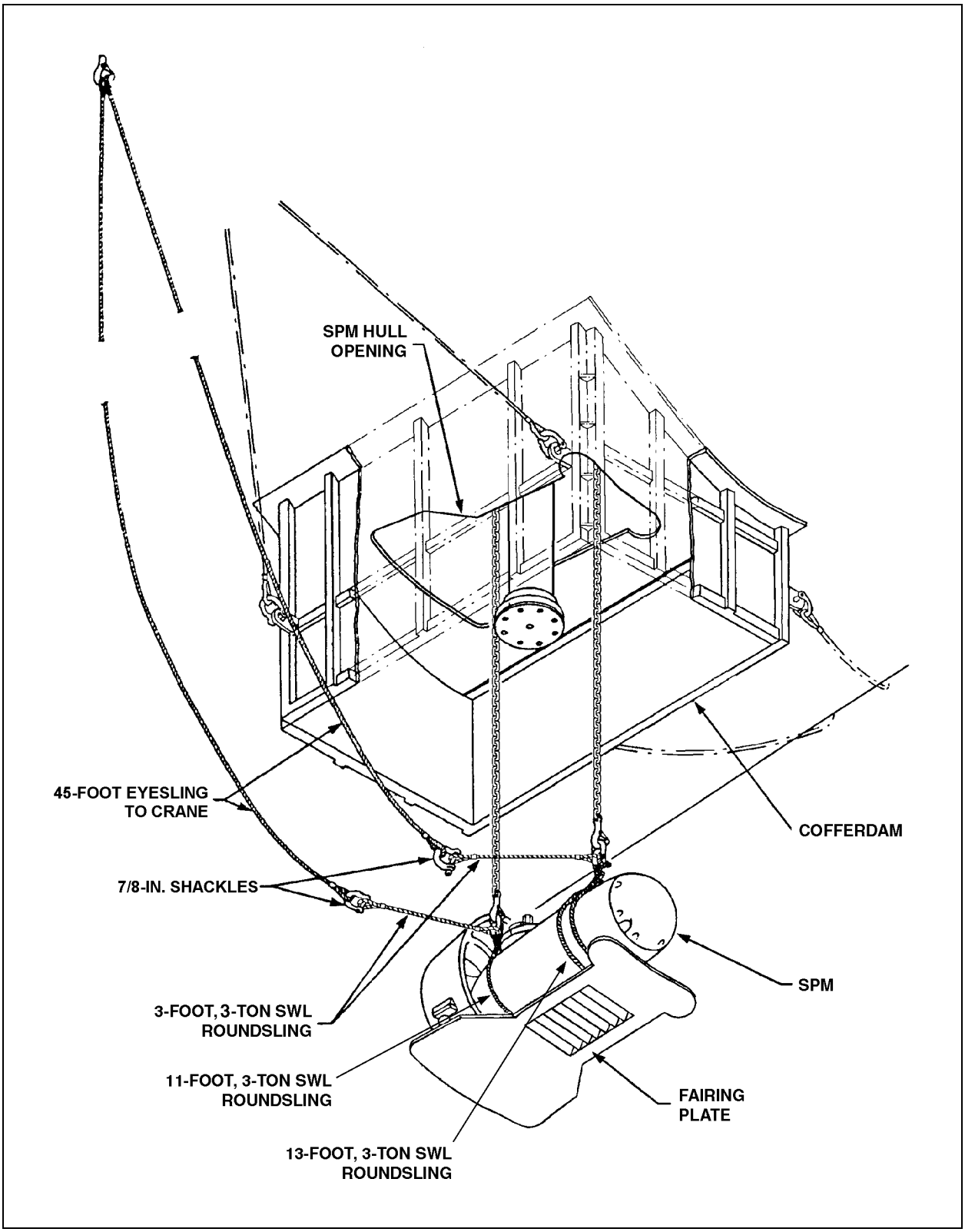

Figure 8-8. SPM Rigged for Transfer to Crane.

3.3.12 (DV) Upon receiving authorization from the dive supervisor, use the forward and aft chain hoists to lower the SPM as much as possible (approximately 30 inches) to gain access to the electrical connectors, but no lower than the slack in the electrical cables will allow.

8-3.3.13 (DV) Attach a beam clamp (item 7) and a 1/2-ton come-along (item 3) to the ceiling on the port side of the SPM cavity. Attach another beam clamp and 1/2-ton come-along to the starboard side of the ceiling.

NOTE

Ensure that there is clear communication between the divers and the crane operator to prevent the cofferdam from bottoming out on the seabed.

8-3.3.14 (DV) Enter the SPM cavity and install standard wooden DC plugs or expandable plugs (items 8 and 9) into the 1-inch drain holes in the SPM cavity.

8-3.3.15 (DV) Install a 5/8-inch expandable plug (item 40) on the bottom of the AN/BQN-13A distress beacon drain pipe. The drain pipe is located on the starboard side as you enter ballast tank 4A through the aft grate (refer to NAVSEA drawing 5006590, section A-A, item F-2).

8-3.3.16 (DV) Wrap a plastic bag (item 10) around the perforated end of the equalization pipe that runs between ballast tanks 4A and 5A, and secure the bag with duct tape (item 11). The perforated end of the pipe is located on the topside of the SPM housing and runs down the center of the bulkhead that divides ballast tank 4A and 4B.

8-3.3.17 (DV) Ensure that cables and motor connecting terminals are positively identified. If no positive identification is apparent, mark the cables with tie wraps (item 24, one tie wrap for T1, two tie wraps for T2, etc.).

8-3.3.18 (TOP) Apply a liberal amount of marine sealant (item 34) to the entire mating surface of the forward and aft halves of the mounting ring assembly (Figure 8-9), including the cable penetration holes. Ensure that O-ring stock is in place and secure.

8-3.3.19 (DV) Install aft half of mounting ring assembly and gasket to SPM column flange by placing mounting ring assembly all-thread rods thru column flange and securing using 1-inch washers and nuts on the all-thread rods.

8-3.3.20 (DV) Place appropriate SPM cable in its place in the aft mounting ring assembly and bolt the forward half of mounting ring (with O-ring stock installed) to aft half of mounting ring using 3/8-inch nuts, bolts, and washers, taking care not to damage SPM cable jackets during installation.

8-3.3.21 (TOP/DV) Install a shackle in the top padeye of the port half of the cofferdam (the half with the 45 degree protrusion) and transfer the port half to the 1/2-ton come-along previously rigged on the port side of the SPM enclosure ceiling.

8-3.3.22 (DV) Install the port side of the cofferdam by placing cofferdam all-thread rods thru the mounting ring assembly and the column flange and securing using 1 inch nuts and washers on the all-thread rods.

8-3.3.23 (DV) Repeat the process for the starboard half of the cofferdam.

8-3.3.24 (DV) Bolt cofferdam halves together using 1/2 inch bolts, nuts, and washers.

8-3.3.25 (DV) After the cofferdam is tightly in place with cofferdam gasket compressed, connect an LP air hose (item 12) to the air supply fitting on the cofferdam. Dewater the cofferdam. Check for leakage of air around the cofferdam gasket and seal leaks as necessary. Maintain a constant air flow into the cofferdam at a rate which will maintain the lowest water level possible.

8-3.3.26 (DV) Depending on the type of cable motor connector, use either the chain wrench (item 36) for a Joy type (imbedded O-ring) connector or cable connector tools (items 43 and 44) for ITT Cannon type (three O-ring) connector to disconnect the electrical connections (Figure 8-10).

NOTE

Cables associated with SSBN 726 motors (which are sometimes used on SSN 688 Class submarines) and SSN 688 dry winding motors require a slightly larger coupling nut wrench than a SSN 688 wet winding motor. Refer to NAVSEA drawing 1197260, Rev B or later, for wrench dimensional details.

8-3.3.27 (DV) Install brass sealing caps (item 25) on top of the SPM motor terminals. Install Delrin sealing caps (item 26) on the cable motor connectors. Ensure all sealing caps are properly installed so that they compress their associated sealing surfaces in order to make a waterproof seal.

8-3.3.28 (DV) Lower the SPM until there is sufficient clearance for removal.

CAUTION

Ensure that the SPM does not bottom out on the seabed when lowering it from the SPM cavity.

NOTE

Some SPM installations utilize a spacer between the SPM and the support column. In order to guarantee a good fit-up of the new SPM with the fairing plate and the hull, any spacers must be reinstalled on the new SPM in the same configuration in which they were found on the old unit.

8-3.3.29 (DV) Using the 7/8-inch shackles on the 45-foot eyeslings, connect the two 45-foot eyeslings from the pier crane to the two 3-foot "lazy" roundslings on the SPM (see Figure 8-8).

8-3.3.30 (TOP) Following direction from divers, take up the slack on the pier crane until it begins to support the weight of the SPM.

8-3.3.31 (DV/TOP) Slowly raise the pier crane while lowering the chain hoist until the SPM clears the ship and cofferdam.

8-3.3.32 (DV) Disconnect the chain hoists from the SPM, leaving the shackles on the SPM.

8-3.3.33 (TOP) Remove the SPM from the water using the pier crane and place it in a safe working area.

8-3.3.34 (DV) Remove any dowel pins from the support column flange.

WARNING

All divers must be out of the water when megger testing is being conducted.

8-3.3.35 (TOP) Megger test SPM cables in accordance with NSTM CH 300, Section 300-4 to determine if cables are good, and record the test results in the work package. Refer to NAVSEA drawing 1197260 (Rev B or later) for acceptable component resistance values.

8-3.3.36 (SHOP) Ensure that the SPM alignment fixture legs are fully retracted. Place the SPM alignment fixture (item 28) on top of the old SPM (include any spacer present on existing installation) and snugly fasten the fixture to the SPM using four of the sixteen used nuts at 90 degree separation.

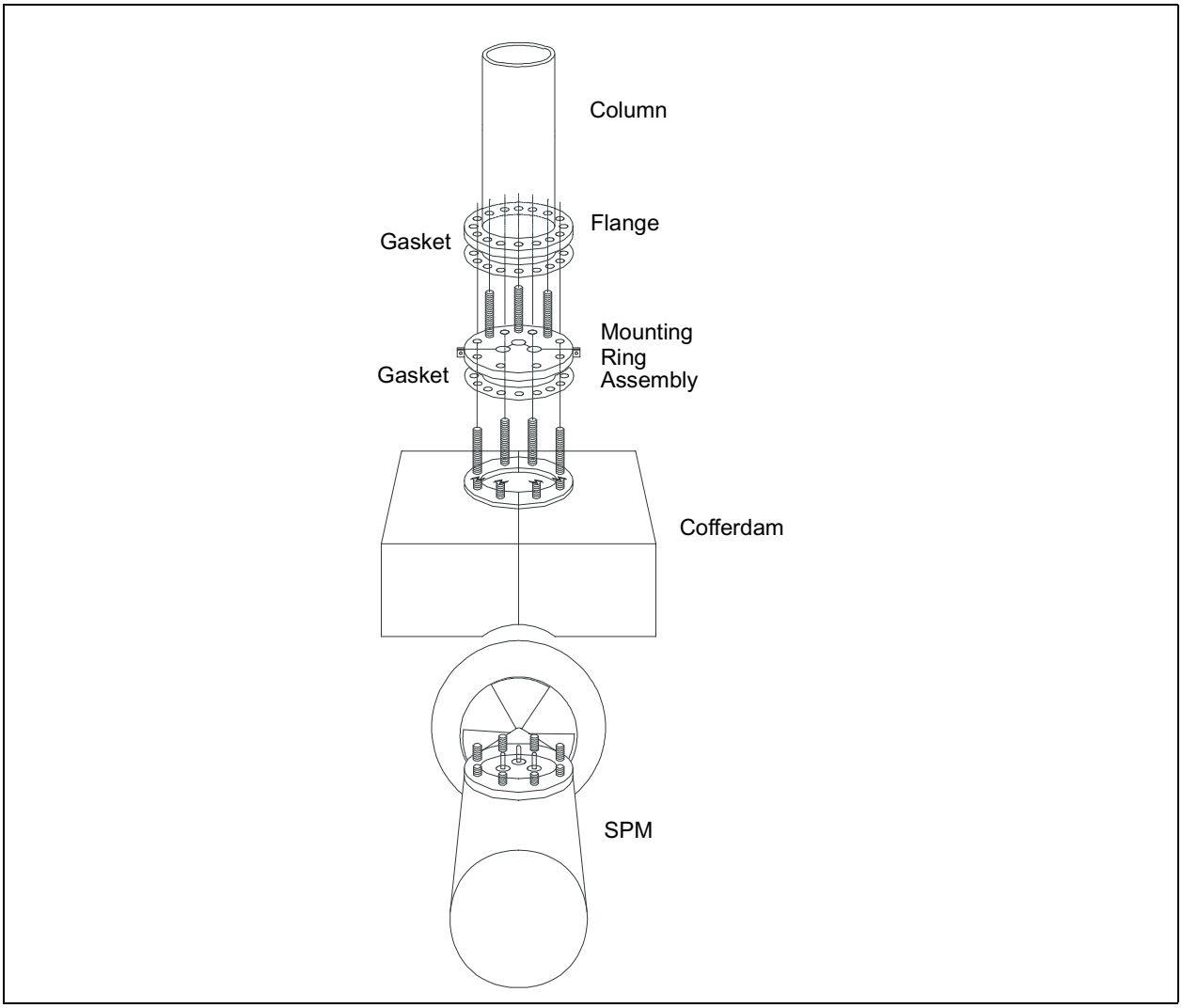

Figure 8-9. Configuration of SSN 688 Cofferdam.

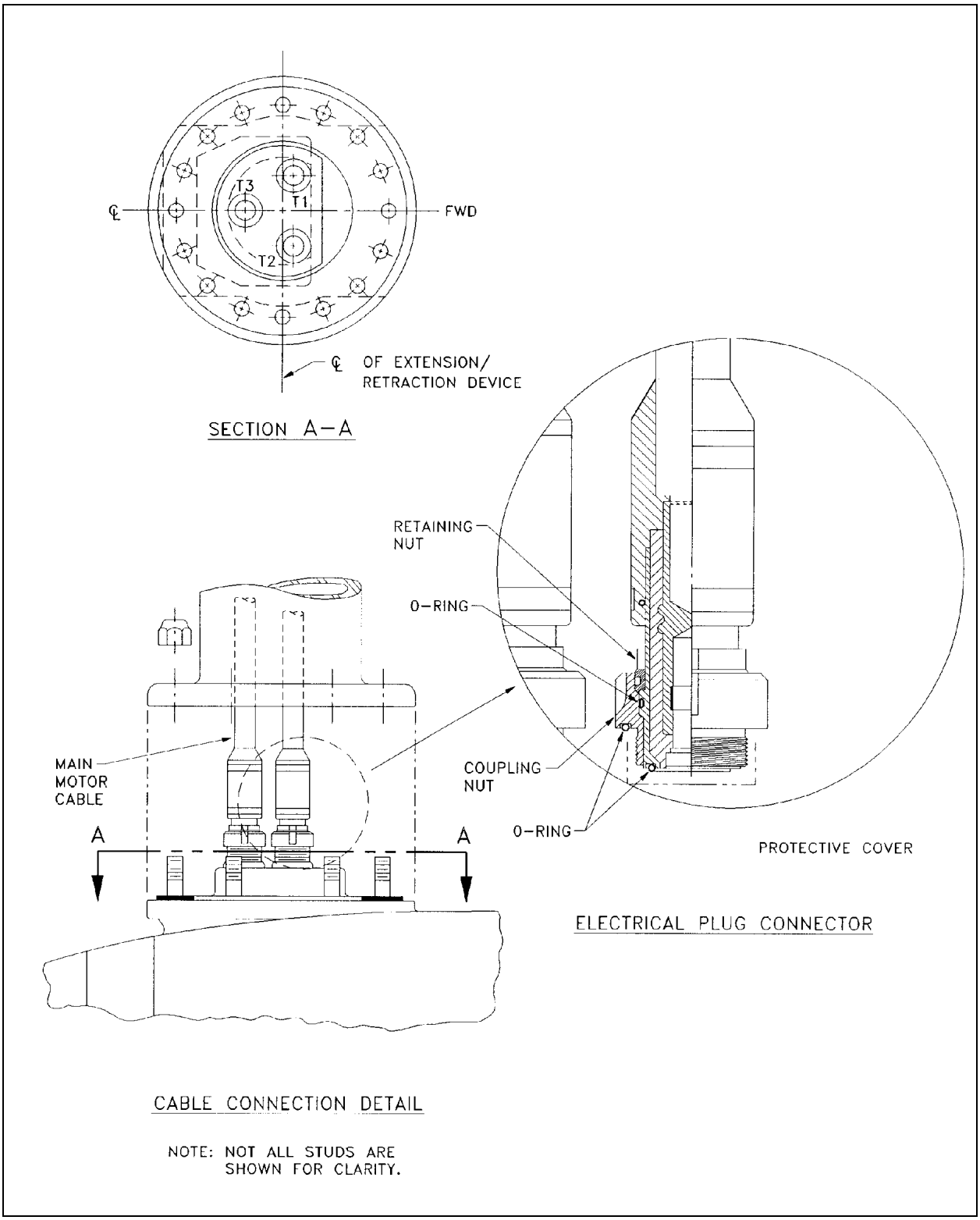

Figure 8-10. Typical SPM Cable Connection.

8-3.3.37 (SHOP) Turn the adjustment screw to bring the longitudinal cross arm level with the SPM using a torpedo level (item 29). Adjust and lock the adjustment screw on the longitudinal cross arm.

8-3.3.38 (SHOP) With the SPM alignment fixture level with the SPM, lower the retractable legs until the tips of each leg are in contact with the fairing plate.

8-3.3.39 (SHOP) Lock the legs in position and mark points with chalk on the fairing plate where the legs make contact.

8-3.3.40 (SHOP) Remove and place the alignment fixture in a safe working area.

NOTE

After the SPM alignment fixture has been adjusted it is important that the fixture is not disturbed.

8-3.3.41 (SHOP) Disconnect and transfer the fairing plate to the new SPM. This is most easily accomplished if legs are loosened on the new SPM body so they can be aligned with existing fairing plate bolt holes. Using a torque wrench (item 30) and new lock nuts (items 31 and 32), tighten all leg threaded connectors and all other loosened threaded connectors in accordance with torque values calculated from reference (g). Final torque values shall equal calculated torque values plus lock nut running torques. See NAVSEA drawing 4494057 or 5942057 for additional fairing plate details.

NOTE

If studs have to be installed or replaced, do so in accordance with reference (g).

8-3.3.42 (SHOP) Carefully place the SPM alignment fixture onto the new SPM (with spacer, if present in original installation) without applying any force on the alignment fixture legs. The SPM to fairing plate height must be equal to the previous height as measured by the SPM alignment fixture.

8-3.3.43 (SHOP) Add or remove shim material as necessary for the SPM and fairing assembly to be within tolerance when fully retracted into the ship.

NOTE

Corrections can be calculated using dimensions taken from paragraph 8-3.2.2 and 8-3.2.3.

8-3.4 ELECTRICAL CABLE REMOVAL AND REPLACEMENT PROCEDURES (SSN 688)

The underwater removal and replacement of the SPM electrical cables can be accomplished only after the following conditions are met:

a. Cofferdam installed and dewatered.

b. SPM separated from the support column, cables disconnected, SPM properly capped, cable motor connectors properly capped, triple-bagged, and taped.

c. Cofferdam flooded, disassembled, and removed.

8-3.4.1 (DV) Remove the three cable support set screws. These are 5/16-inch Allen screws located 21 inches above the SPM support column flange.

8-3.4.2 (DV) Insert the cable support replacement tools (item 41) into the 1-inch drains opposite each other in the cable support and tighten them into place (see Figure 8-11).

8-3.4.3 (DV) Using the cable support replacement tools, evenly pull the cable support out through the bottom of the support column.

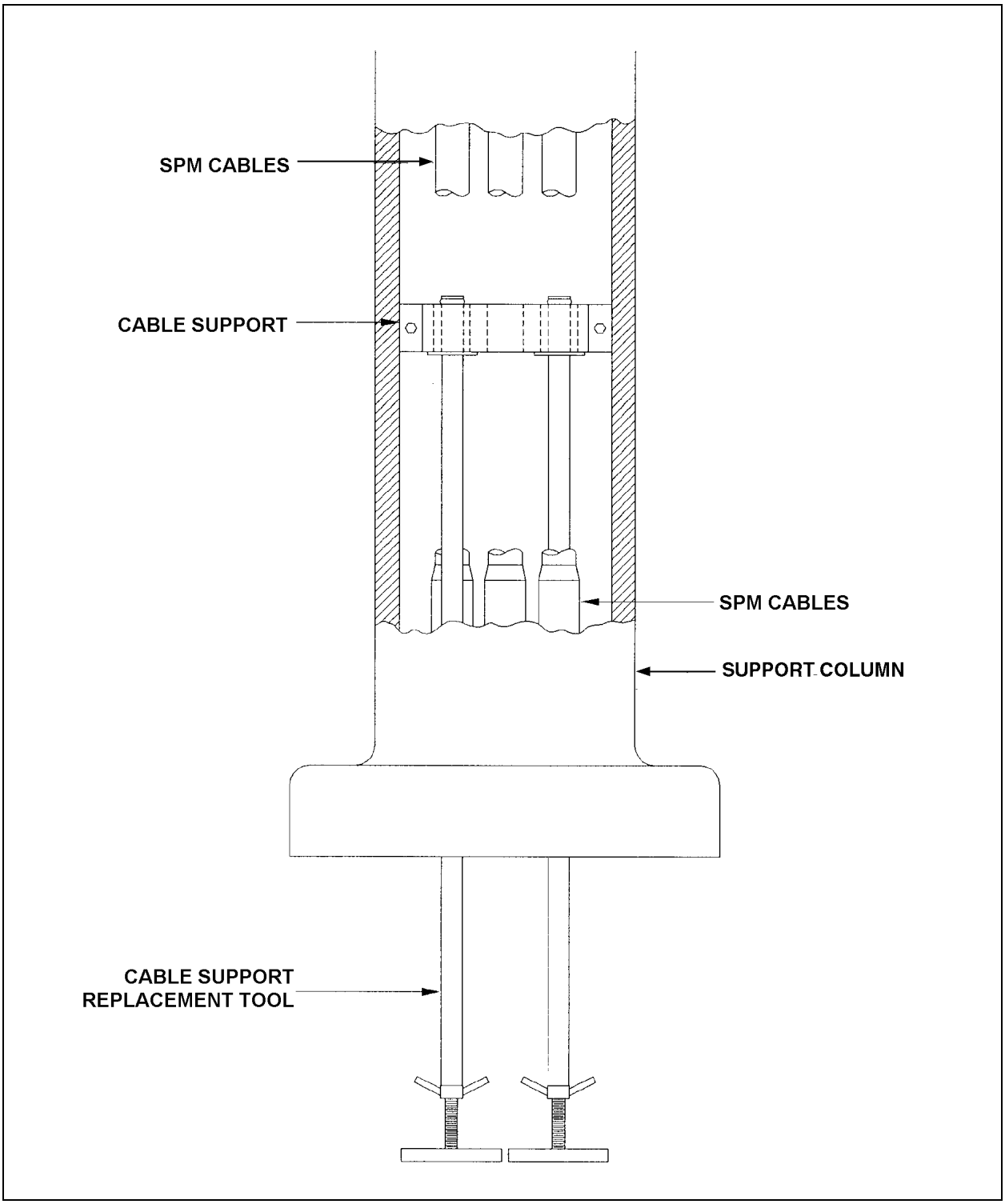

Figure 8-11. Typical Cable Support Removal Technique.

8-3.4.4 (DV) Remove the cable support replacement tool and the nut and bolt assembly from the cable support, remove the two cable support halves, and send them topside.

8-3.4.5 (DV) Remove the grate on the top of the electrical hull fitting (EHF) by loosening and removing the six 9/16-inch bolts.

8-3.4.6 (DV) Remove the 3/4-inch nuts from the cable bracket studs.

8-3.4.7 (DV) Remove the 3/16-inch set screws from the EHF connector.

8-3.4.8 (DV) If the hydrostatic test fitting plugs in the cable connector interfere with the portsmouth fitting tool (item 42), remove the plugs.

8-3.4.9 (DV) Disconnect the bad cables(s) from the EHF using the portsmouth fitting tool and place the portsmouth connector cap(s) (item 45) onto the cable EHF connector. Ensure that all sealing caps are properly installed so that they compress their associated O-rings in order to make a waterproof seal.

8-3.4.10 (DV) Remove the banding from the cable tray.

8-3.4.11 (DV) Remove the bad cable(s) from the group and remove the cable(s) through the top of the SPM column. Triple bag and tape the EHF end of the cable(s).

NOTE

Ensure that new cable(s) have been machined in accordance with note 25 on NAVSEA drawing 4454547.

Ensure that the cable insulation on new cables is not damaged during installation.

8-3.4.12 (TOP) Mark motor connector ends of each new electrical cable to be installed (T1-T1, T2-T2, and T3-T3) to match the markings on the connectors. Inspect the EHF connector end of each new cable to ensure that dimensions and configurations are the same.

8-3.4.13 (TOP) Megger new cables in accordance with NSTM CH 300, Section 300-3.60 to determine if cables are good, and record the test results in the work package. Refer to NAVSEA drawing 1197260 (Rev B or later) for acceptable component resistance criteria. Install dried caps on both ends of new cable, ensuring proper O-ring compression. Triple bag and tape both ends of the cable.

CAUTION

Water contacting the electrical cable connectors can damage insulation and prevent proper electrical connection. Use extreme care when packaging and transporting electrical cables to the cofferdam. Use connector caps as directed (ensuring proper O-ring compression) to prevent water from making contact with the cables.

8-3.4.14 (DV) Enter ballast tank grate 4A with the SPM cable(s) in hand.

NOTE

Ensure that the motor connector ends of the new cables enter the ballast tank first.

8-3.4.15 (DV) Lower the new cable(s) down through the top of the SPM column beginning with the motor connector.

8-3.4.16 (DV) Blow dry the EHF terminals and cable EHF connectors with dry nitrogen (item 33). Ensure that all electrical conductor surfaces are clean and dry.

8-3.4.17 (DV) Connect the new cable(s) to the EHF in accordance with NAVSEA drawing

1197260 (Rev B or later), "Outboard Cable Installation" procedure.

8-3.4.18 (TOP) Hydrostatically test the EHF cable connection(s) in accordance with NAVSEA drawing 1197260 (revision B), "Post Installation Tests Penetrator And Outboard Cables" procedure.

8-3.4.19 (DV) Reinstall hydrostatic test fitting plugs in the EHF cable connector.

8-3.4.20 (DV) Reinstall the set screws into the EHF cable connector.

8-3.4.21 (DV) Reinstall the cable bracket.

8-3.4.22 (DV/TOP) Scribe a line around the center of the edge of the cable support and reinstall the cable support around the cables.

8-3.4.23 (DV) Using the cable support removal tools, evenly push the cable support into place.

NOTE

Before installing, vertically align the set screw holes in the support with the set screw holes in the support column.

8-3.4.24 (DV) Align the scribed line with the set screw holes in the column and then align the holes as required. Install set screws.

8-3.4.25 (DV) Reinstall the grate over the EHF.

8-3.4.26 (DV) Band the cable on the cable tray.

8-3.5 SPM REPLACEMENT (SSN 688)

The underwater replacement of the SPM can only be accomplished if the following conditions are met:

a. Cofferdam installed and dewatered.

b. Column lowered, cable motor connector caps in place.

c. Old SPM removed.

d. Fairing plate and spacer (if present) transferred to new SPM and is within fit-up tolerance.

e. All shipping protection removed from new SPM.

NOTE

SHIPALT 4018-D allows the use of older SPMs (manufactured before 1974) which only have fourteen holes in the SPM flange instead of the standard sixteen holes. Mounting these motors with fourteen studs meets the shock requirements for the system. Bolt spacing patterns are the same for both installations. DO NOT ATTEMPT TO INSTALL ADDITIONAL STUDS IN THESE MOTORS. Drilling may break into the dry winding cavity of these motors, thereby causing a leak path and shorting out the motor.

8-3.5.1 (SHOP) Transfer cable markings from the old SPM to the new SPM.

8-3.5.2 (SHOP) Transfer flange marks from the old SPM to the new SPM.

8-3.5.3 (SHOP) Thoroughly clean the three motor terminal pins on the new SPM. Megger test the new SPM.

8-3.5.4 (SHOP) Apply a very light film of silicone compound (item 37) to the rubber seals of the motor connectors. Ensure that all electrical contact surfaces are clean and dry. Install brass sealing caps (item 25), ensuring proper compression of rubber seals.

8-3.5.5 (TOP) Double wrap a 13-foot, 3-ton SWL polyester roundsling (item 20) in a basket configuration around the forward end of the SPM. Make sure that the roundsling does not lie in the groove between the SPM and the forward shroud. Connect the roundsling to a 3-foot long, 3-ton SWL "lazy" roundsling using a 1-inch shackle on top of the SPM, and drape the roundsling on the starboard side of the SPM.

8-3.5.6 (TOP) Double wrap a 11-foot, 3-ton SWL polyester roundsling (item 23) in a basket configuration around the aft end of the SPM, forward of the Kort nozzle. Do not rig through or allow the roundsling to rest on the Kort nozzle. Connect the roundsling to a 3-foot long, 3-ton SWL "lazy" roundsling using a 1-inch shackle on top of the SPM, and drape the roundsling on the starboard side of the SPM.

CAUTION

Ensure that there is clear communication between the divers and the crane operator to prevent the SPM from bottoming out on the seabed.

8-3.5.7 (TOP) Using the 7/8-inch shackles, connect the two 45-foot eyeslings from the pier crane to the two 3-foot roundslings on the SPM, and lower the new SPM into the water to a point where the SPM will clear the ship and cofferdam when raised by the chain hoists.

CAUTION

Refer to the CAUTION immediately before paragraph 8-3.3.6.

8-3.5.8 (DV) Connect the chain hoists to the 1-inch shackles on the "lazy" roundslings on the SPM and take up all slack.

8-3.5.9 (DV/TOP) Slowly raise the SPM with the chain hoists while lowering the pier crane until the SPM has cleared the ship and the full weight of the SPM is supported by the chain hoists.

8-3.5.10 (TOP) Remove the 45-foot eyeslings from the 3-foot roundslings on the SPM.

NOTE

Ensure that the shackles remain on the 45-foot eyesling.

8-3.5.11 (DV) Raise the SPM until it contacts the bottom edge of the cofferdam. This position should allow the electrical cables to be connected.

8-3.5.12 (DV) Remove the caps from the motor terminals on the SPM and from the cable motor connectors.

8-3.5.13 (DV) Blow dry the cable motor connectors and motor terminals with dry nitrogen (item 33). Ensure that all electrical conductor surfaces are clean and dry.

8-3.5.14 (DV) Conduct O-ring contact check in accordance with NAVSEA drawing 1197260 (Rev B or later), "Motor End Connector Installation Procedure".

8-3.5.15 (DV) Depending on the type of cable motor connector, use either the chain wrench (item 36) for Joy type (imbedded O-ring) connectors or a torque wrench with the cable connector tools (items 43 and 44) for ITT Cannon type (three O-ring) connectors to connect the cable motor connectors to their proper terminals on the SPM. Installation shall be in accordance with NAVSEA drawing 1197260 (Rev B or later), "Motor End Connector Installation" procedures and Appendix B.

CAUTION

An adapter or extension used on a torque wrench increases the torque value.

WARNING

All divers must be out of the water when megger testing is being conducted.

8-3.5.16 (TOP) With the divers out of the water, megger test the cables from inside the ship and record the results to ensure proper installation in accordance with the electrical test procedures as described references (b) and (e). Refer to NAVSEA drawing 1197260 (revision B) for acceptable component resistance criteria.

8-3.5.17 (DV) Apply marine sealant (item 34) to the SPM flange, around the base of the studs, around the spacer (if present), and anywhere else there could be a leak path during the hydrostatic test. Allow sealant to cure for at least one hour.

8-3.5.18 (DV) Secure LP air to the cofferdam and vent the cofferdam.

8-3.5.19 (DV) Disassemble and remove cofferdam.

8-3.5.20 (DV) Mate the SPM with the column flange using new self-locking nuts (item 35). Sequentially torque the nuts to torque values calculated in accordance with reference (g). Final torque values shall equal calculated torque values plus lock nut running torques.

8-3.6 SPM SUPPORT COLUMN HYDROSTATIC TEST PROCEDURES (SSN 688)

8-3.6.1 (DV) Install two 1/2-inch O. D. expandable plugs (item 46) into the two drain holes at the bottom of the SPM column (or 1/2-inch IPT plugs if drain holes are tapped).

8-3.6.2 (DV) Using a water hose (item 39), fill the SPM column with water to within a foot of the top.

NOTE

Apply marine sealant liberally and evenly to all holes and sealing surfaces of the hydrostatic test fixture (item 47) and SPM column before installing the test fixture on top of the column.

8-3.6.3 (DV) Install the hydrostatic test fixture on the top of the SPM column using the eight 3/8-inch allen cap screws used to secure the cable guide to the support column. Ensure that O-ring stock is in place between the halves of the test fixture. Ensure that packing material is installed in the test fixture's cable penetrations before cable clamps are installed and drawn down.

8-3.6.4 (DV) Open the vent valve on the hydrostatic test fixture.

8-3.6.5 (DV) Connect the water hose (item 39) to the hydrostatic test fixture fill valve and fill the SPM column with water. When water issues from the vent valve, stop filling.

8-3.6.6 (DV) Disconnect the water hose and shut the vent valve.

8-3.6.7 (DV/TOP) Using a minimum of 75 feet of hydrostatic test tubing (item 48), connect the tubing from the hydrostatic pump (item 49) to the hydrostatic test fixture fill valve.

WARNING

All divers must be out of the water when megger testing is being conducted.

8-3.6.8 (DV) With the proper gauges (items 50 and 51) attached to the hydrostatic pump and while simultaneously meggering the SPM cables, perform hydrostatic tests of the SPM motor connectors in accordance with NAVSEA drawing 1197260 (Rev B or later) (this proce-

dure does not test the SPM column; the column is used as a pressure vessel in order to hydrostatically test the motor connectors):

(a) Pressurize to 100 psig for 10 minutes

(b) Record megger readings

(c) Reduce pressure to 0 psig

(d) Pressurize to 500 psig for 15 minutes

(e) Record megger readings

(f) Reduce pressure to 0 psig

(g) Repeat steps (d) thru (f) for a total of three 0-500 psig test cycles

NOTE

Megger each cable in accordance with references (b) and (e) during each hydrostatic cycle.

8-3.6.9 (TOP) Perform a final megger test on the SPM after it has been submerged in the water for at least 24 hours.

8-3.6.10 (DV) Open the vent valve on the hydrostatic test fixture and disconnect the hydrostatic test tubing from the test fixture.

8-3.6.11 (DV) Remove the hydrostatic test fixture and clean off all marine sealant on the test fixture and SPM column.

8-3.6.12 (DV) Pull the slack out of the electrical cables and reinstall both the cable cover guide and the shaft which aligns the cable cover guide. Tighten the 3/8-inch Allen head bolts and the four bolts on the cable clamps to 48 ft-lbs above running torque and lockwire (item 52) them in place using lockwire pliers (item 38) in accordance with reference (g).

8-3.6.13 (DV) Remove the two expandable plugs (or 1/2-inch IPT plugs) from the SPM column drain holes.

8-3.6.14 (DV) Remove rigging gear. Return gear to the surface.

8-3.6.15 (DV) Remove all tools and connector caps from the SPM cavity and clear the tool log. Thoroughly inspect the SPM cavity for any loose gear.

8-3.6.16 (DV) Apply a handfull of grease to the fairing plate bumper stops.

NOTE

Ensure that the SPM is in the zero degree relative bearing position.

8-3.5.17 (TOP) Upon receiving authorization from the dive supervisor, remove tags from the SPM system and proceed to fully raise the SPM. Tag out SPM system after SPM is raised.

8-3.6.18 (DV) Measure and record the vertical fairing plate alignment with the hull. Measurements shall be taken forward, aft, port, and starboard (see Appendix E). Each measurement shall be recorded as positive if the outside surface of the plate is outside the hull outer surface, and negative if the fairing plate outer surface is inside of the hull outer surface. The fairing plate vertical alignment inside or outside the hull shall not exceed tolerances specified in NAVSEA drawing 4494057 or 5942057.

8-3.6.19 (DV) Measure the transverse gap between the fairing plate and the hull. Measurements should be taken forward, aft, port, and starboard (see Appendix E). The transverse gap between the fairing plate and the hull should be within local repair activity QA criteria, but shall not exceed 1 inch at any point around the perimeter.

8-3.6.20 (TOP) Upon receiving authorization from the dive supervisor, remove all tags.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-3.6.21 (TOP) Lower and train the SPM.

8-3.6.22 (TOP) Perform propeller rotation test on SPM to ensure proper cable hookup.

8-3.6.23 (TOP) Tag out the SPM system.

8-3.6.24 (DV) Inspect the fairing plate bumper stops to ensure that the fairing plate is properly seated in place within the hull of the ship (even transfer of grease on bumper stops). If not, adjust stops. Inspect the cable at the top of the column for sufficient slack.

8-3.6.25 (TOP) Upon receiving authorization from the diving supervisor, remove the tags from the SPM system. Prepare to raise the SPM.

NOTE

Ensure that the SPM is in the zero relative bearing position.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-3.6.26 (TOP) Raise the SPM.

8-3.6.27 (TOP) Inform the ship's force or cognizant repair activity representative that SPM related underwater work has been completed.

8-3.7 DEBRIEF SHIP'S FORCE

(TOP) The lead dive supervisor should debrief the proper ship’s officers on the final status of the SPM and/or cable replacement.

8-3.8 PREPARE FINAL REPORT

(TOP) Prepare a final report documenting the accomplished repair. Documentation should consist of inspection reports, data sheets, photographs, and video logs. The final report shall include details regarding any problems encountered, new or special tools needed, or modifications to tools or procedures found to facilitate the SPM and/or cable replacement. Send copy of final report to NAVSEA 00C5.

PROCEDURES FOR REMOVAL AND REPLACEMENT OF SPM AND ELECTRICAL CABLES SSN 637 and SSN 640 CLASS

SECTION 4

WARNING

Rotation of propellers or operation of underwater electrical equipment while divers are in the vicinity can cause serious injury or death. Ensure that ship's equipment, including the SPM system, is de-energized and tagged out as required by reference (h) prior to beginning underwater operations.

CAUTION

It is essential that all tools and materials brought to the underwater job site are accounted for and removed at the completion of the job. Tools and materials inadvertently left at the job site can generate unacceptable noise and possibly cause severe damage to shipboard components. Locally generated work packages shall ensure that a general tool and material log sheet is prepared and maintained during all UWSH operations.

8-4.1 GENERAL: SSN 637 AND SSN 640 CLASS SUBMARINES

NOTE

Before beginning these procedures, ship's force shall isolate all SPM electrical system components inside the submarine (console, slip ring, secondary seal) and megger these components separately in accordance with reference (e) in order to ensure that the problem is located outside the pressure hull. If any internal system component is faulty, it should be repaired and the system should be reconnected and meggered to see if the fault has been corrected before any action is taken on the external components of the SPM system.

This section provides detailed procedures for removal and replacement of an SPM on a waterborne SSN 637 and SSN 640 Class submarine. A separate set of procedures is included for removal and replacement of faulty electrical cables. If an electrical problem exists within the SPM system, references (c) and (d) provide test procedures down to the secondary seal. If tests reveal that the fault is beyond the SPM cable connections, divers must disconnect the power cables from the SPM to further isolate the fault. When this has been accomplished and the cables and SPM terminals are known to be dry, ship's force personnel may conduct additional electrical tests to further isolate the fault. When the results of this additional testing have been evaluated, the cognizant repair activity representative must determine the appropriate course of action to correct the fault. Electrical problems may be caused by faulty cables, a faulty motor, or moisture on the terminal connections.

NOTE

While the following procedures require that topside personnel and divers work closely together, certain steps must be carried out by particular personnel. To clarify these steps, abbreviations are placed at the beginning of each step where the specific party needs to be identified: (DV) represents diver; (TOP) represents topside personnel or ship's force, and (SHOP) represents the machine shop personnel.

8-4.1.1 Removal of the SPM requires the use of a cofferdam. Procedures for cofferdam installation and SPM replacement are provided in the following paragraphs.

8-4.2 SPM REMOVAL PROCEDURES (SSN 637 and SSN 640)

8-4.2.1 (TOP) Tag out the SPM system and all sources of high pressure air in the main ballast tank related to the SPM.

8-4.2.2 (DV) Clean the area around the SPM opening (see Figures 8-13 and 8-14) in accordance with Naval Ship's Technical Manual S9086-CQ-STM-010 Chapter 081, Waterborne Underwater Hull Cleaning of Navy Ships. Inspect the area for any obstructions that might interfere with the cofferdam seal.

8-4.2.3 (DV) Measure and record the fairing plate vertical alignment with the hull. Measurements shall be taken forward, aft, port, and starboard. Each measurement shall be recorded as positive if the outside surface of the plate is outside the hull outer surface, and negative if the fairing plate outer surface is inside of the hull outer surface. The fairing plate vertical alignment inside or outside the hull shall not exceed tolerances specified in NAVSEA drawing 2012206 (SSN 640 Class) or 2140608 (SSN 637 Class). For measurement charts, see Appendix C for SSN 640 and Appendix D for SSN 637 Class submarines.

8-4.2.4 (DV) Measure the transverse gap between the fairing plate and the hull. Measurements shall be taken forward, aft, port, and starboard. The transverse gap between the fairing plate and the hull should be within local repair activity QA criteria, but shall not exceed 1 inch at any point around the perimeter. For measurement charts, see Appendix C for SSN 640 and Appendix D for SSN 637 Class submarines.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

NOTE

Ensure that all tag out procedures are in accordance with the current shipboard instructions.

CAUTION

Shut and tag out the vent valves for the main ballast tanks 5A, 5B, 6A and 6B for SSN 640 class submarines and 4A, 4B, 5A and 5B for SSN 637 class submarines.

8-4.3 RECOMMENDED COFFERDAM RIGGING AND INSTALLATION

8-4.3.1 SSN 640 Class Submarines

8-4.3.1.1 (DV) Attach a 1/2-ton come-along (item 3) to the aft grate of ballast tank 5B. Attach another 1/2-ton come-along to the forward grate of ballast tank 6B (port).

8-4.3.1.2 (TOP) Using a 3/4-inch shackle (item 1), attach a 1/2-inch by 45-foot eyesling (item 2) to each of the two padeyes on the starboard outboard side of the cofferdam (Figure 8-12).

8-4.3.1.3 (TOP) Utilizing a pierside crane (item 4), lift and train the cofferdam using the 45-foot eyeslings, over to the starboard side of the submarine between frames 111 and 116.

8-4.3.1.4 (TOP) Lower the cofferdam (item 54) into the water until it is even with the bottom of the ship.

8-4.3.1.5 (DV) Using a 3/4-inch shackle, attach the outboard padeye on the forward-port side of the cofferdam to the come-along on ballast tank 5B (port side).

8-4.3.1.6 (DV) Using a 3/4-inch shackle, attach the outboard padeye on the aft-port side of the cofferdam to the come-along at ballast tank 6B (port).

8-4.3.1.7 (TOP/DV) Yard and stay the cofferdam using the come-alongs and the pier crane to position the cofferdam under the SPM opening.

8-4.3.1.8 (DV) Using two 3/4-inch shackles, attach a 1/2 ton come-along between the most aft grate of ballast tank 5A (stbd) and the outboard forward-starboard padeye on the cofferdam.

8-4.3.1.9 (DV) Using two 3/4-inch shackles, attach a 1/2 ton come-along between the most forward grate of ballast tank 6A (stbd) and the outboard aft-starboard padeye on the cofferdam.

8-4.3.1.10 (DV) Evenly take up tension on all the come-alongs until the cofferdam is seated on the hull of the ship and clear of the SPM opening.

8-4.3.1.11 (DV) Remove the two 45-foot eyeslings from the starboard side of the cofferdam leaving the shackles attached to the eyeslings.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-4.3.1.12 (TOP) Remove tags necessary to lower the SPM, and fully lower the SPM.

8-4.3.1.13 (TOP) Tag out the SPM system to ensure that it is not raised, lowered, or trained.

8-4.3.1.14 (DV) Attach turnbuckles with the clamp attached (items 5, 6 and 7), approximately 10 turnbuckles and clamps, evenly spaced, from the bottom of the cofferdam to the lip of the SPM opening.

8-4.3.1.15 (DV) Gradually and evenly, take up the tension in each of the turnbuckles until the cofferdam seal is compressed with the hull. Do not overtighten the turnbuckles.

8-4.3.1.16 (DV) Enter the SPM cavity and install expandable plugs or standard wooden DC plugs (items 8 and 9) into the 1-inch drain holes in the SPM cavity. If there is an equalization tube in the SPM cavity wrap it with a plastic bag (item 10) and secure with duct tape (item 11).

8-4.3.1.17 (DV) After the cofferdam is tightly in place with the cofferdam gasket compressed all around, connect an LP air hose (item 12) to the air supply fitting on the cofferdam. Dewater the SPM cavity and the cofferdam. Check for gross leakage of air around the cofferdam gasket and seal leaks as necessary. Maintain a constant air flow into the cofferdam at a rate which will maintain the lowest water level possible.

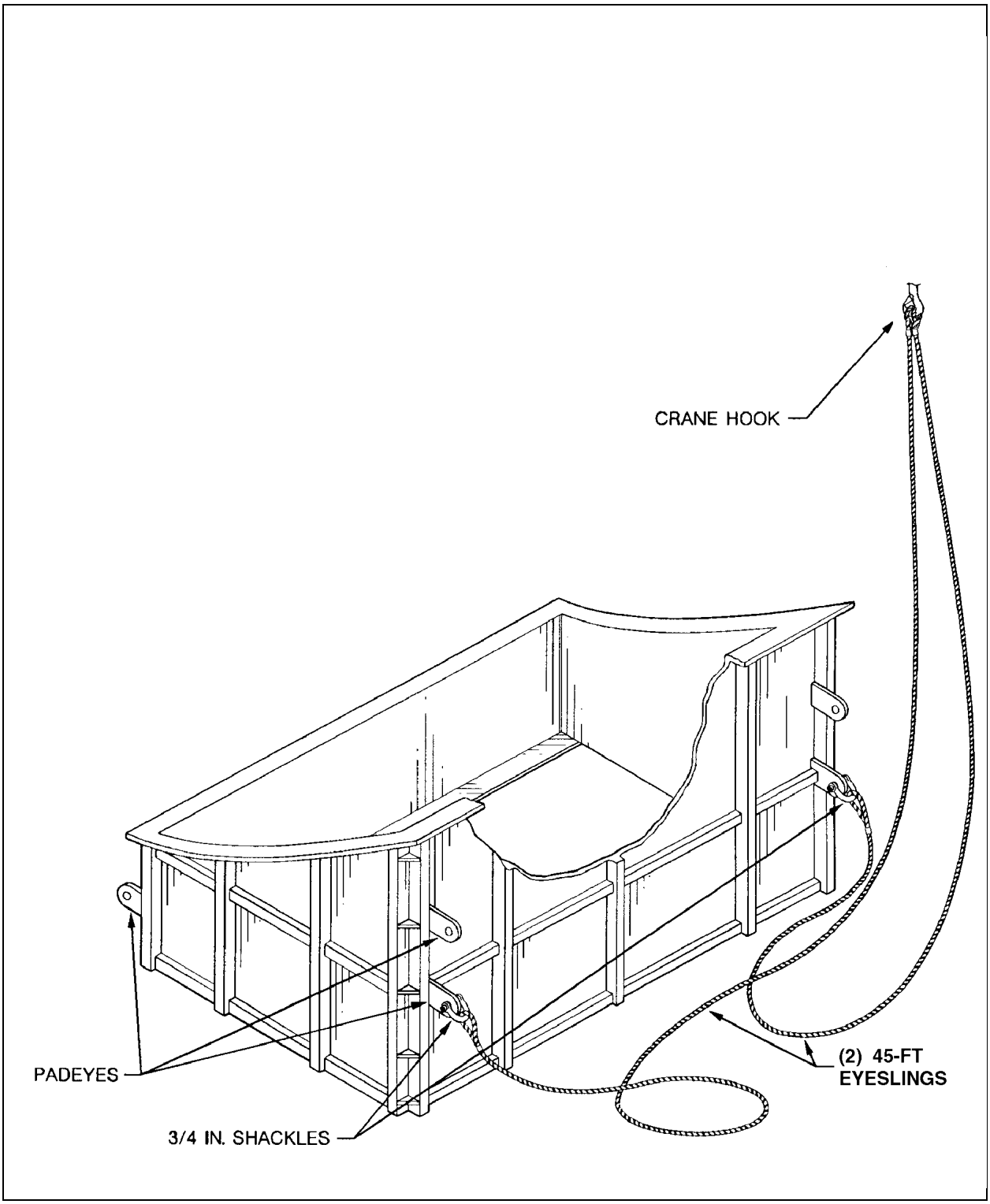

Figure 8-12. Typical Rigging of SSN 637 and SSN 640 Cofferdam.

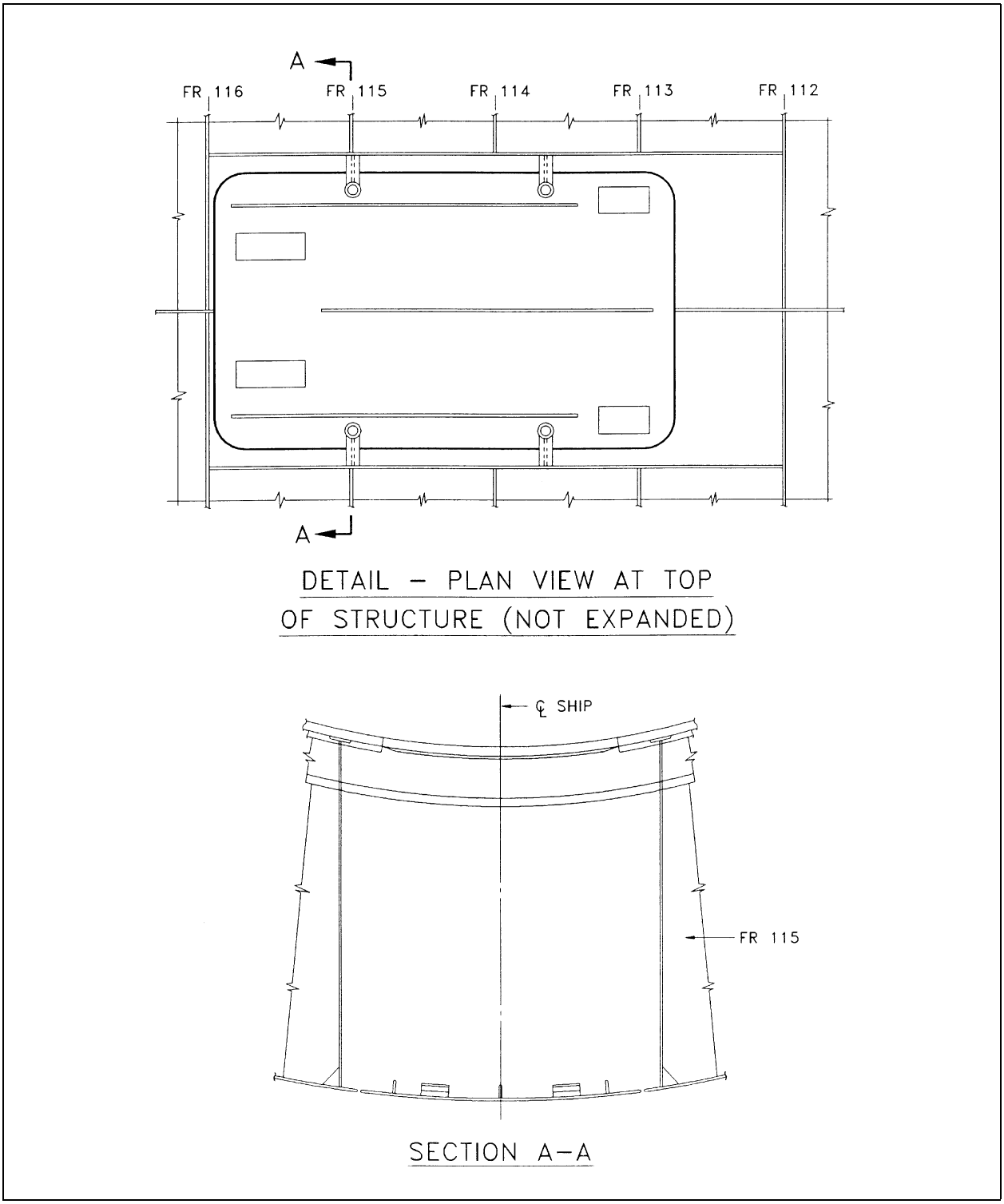

Figure 8-13. Submarine Fairing Plate (SSN 640)

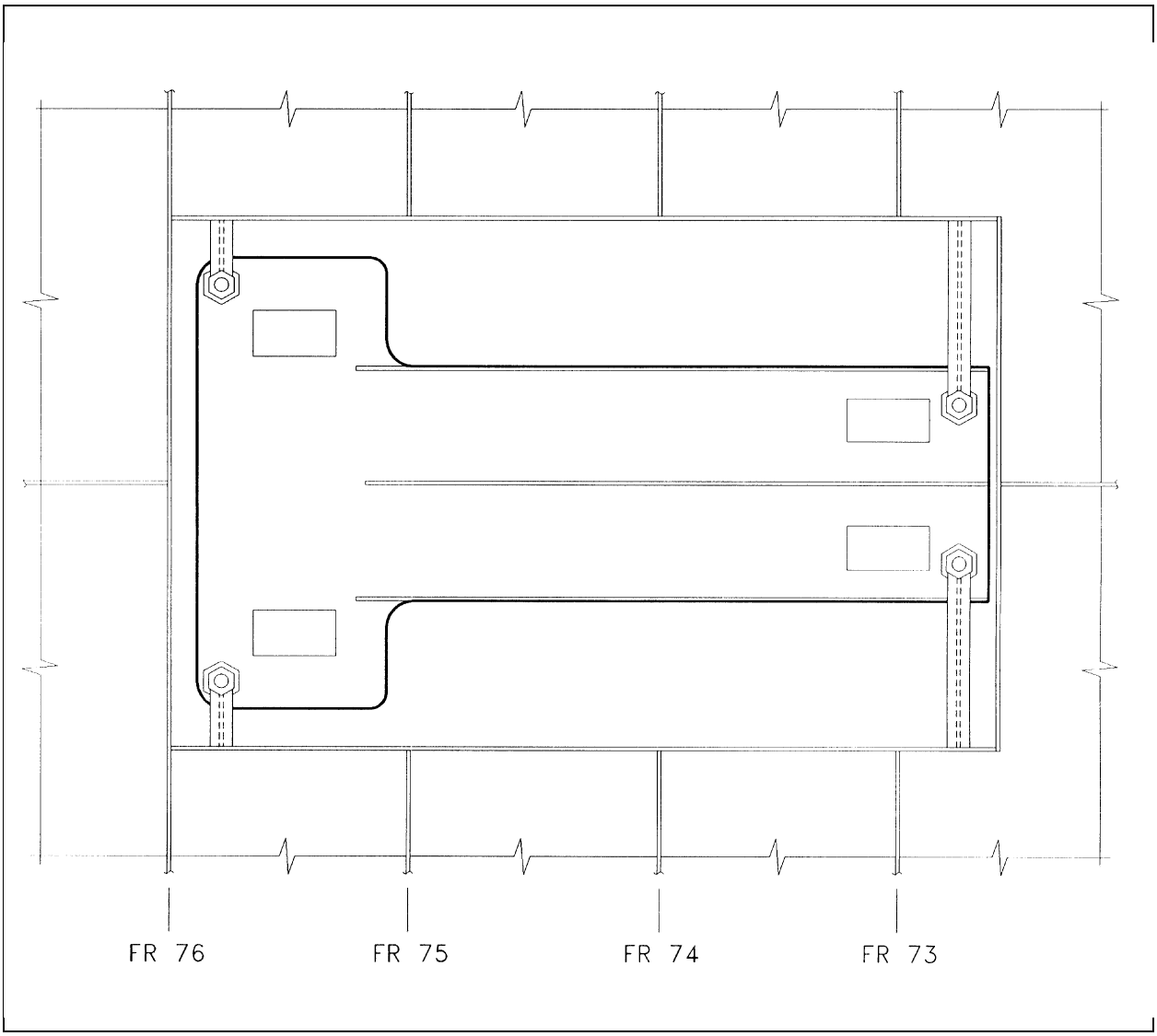

Figure 8-14. Submarine Fairing Plate (SSN 637)

NOTE

An effective sealant to fill gaps between the cofferdam gasket and the submarine hull is Bintsuke (item 13).

8-4.3.2 SSN 637 Class Submarines

8-4.3.2.1 (DV) Attach a 1/2-ton come-along (item 3) to the most forward grate of ballast tank 5B (port). Attach another 1/2-ton come-along to the aft grate of ballast tank 5B (port).

8-4.3.2.2 (TOP) Using a 3/4-inch shackle (item 1), attach a 1/2-inch by 45-foot eyesling (item 2) to each of the two padeyes on the starboard outboard side of the cofferdam (Figure 8-12).

8-4.3.2.3 (TOP) Using a pierside crane (item 4), lift and train the cofferdam using the 45-foot eyeslings, over to the starboard side of the submarine between frames 72 and 77.

8-4.3.2.4 (TOP) Lower the cofferdam (item 54) into the water until it is even with the bottom of the ship.

8-4.3.2.5 (DV) Using a 3/4-inch shackle, attach the padeye on the forward port side of the cofferdam to the come-along on the forward grate on 5B.

8-4.3.2.6 (DV) Using a 3/4-inch shackle, attach the padeye on the center-port side of the cofferdam to the come-along on the aft grate on 5B.

8-4.3.2.7 (TOP/DV) Yard and stay the cofferdam using the come-alongs and the pierside crane to position the cofferdam under the SPM opening.

8-4.3.2.8 (DV) Using two 3/4-inch shackles, attach a 1/2-ton come-along between the forward starboard flood hole in the SPM cavity and the inboard forward-starboard padeye on the cofferdam.

8-4.3.2.9 (DV) Using two 3/4-inch shackles, attach a 1/2-ton come-along between the aft starboard flood hole in the SPM cavity and the inboard center-starboard padeye on the cofferdam.

8-4.3.2.10 (DV) Evenly take up tension on all the come-alongs until the cofferdam is seated on the hull of the ship.

NOTE

Make certain that the cofferdam seal is between the SPM cavity flood holes and the ballast tank grates and does not interfere with the SPM fairing plate.

8-4.3.2.11 (DV) Remove the two 45-foot eyeslings from the starboard side of the cofferdam leaving the shackles attached to the eyeslings.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-4.3.2.12 (TOP) Remove tags necessary to lower the SPM, and fully lower the SPM.

8-4.3.2.13 (TOP) Tag out the SPM system to ensure that it is not raised, lowered, or trained.

8-4.3.2.14 (DV) Attach turnbuckles (items 5, 6, and 7) with the clamp attached (approximately 10 turn buckles and clamps) evenly spaced, from the bottom of the cofferdam to the lip of the SPM opening.

8-4.3.2.15 (DV) Gradually and evenly, take up the tension in each of the turnbuckles until the cofferdam seal is compressed on the hull. Do not overtighten the turnbuckles.

8-4.3.2.16 (DV) Enter the SPM cavity and install expandable plugs or standard DC plugs (items 8 and 9) into the 1-inch drain holes in

the SPM cavity and the 1-1/2-inch vent holes. In accordance with NAVSEA drawing 6697899, measure to fit blanking flanges (item 69) on the forward and port & starboard flood holes (four places) (Figure 8-15) and install blanking flanges.

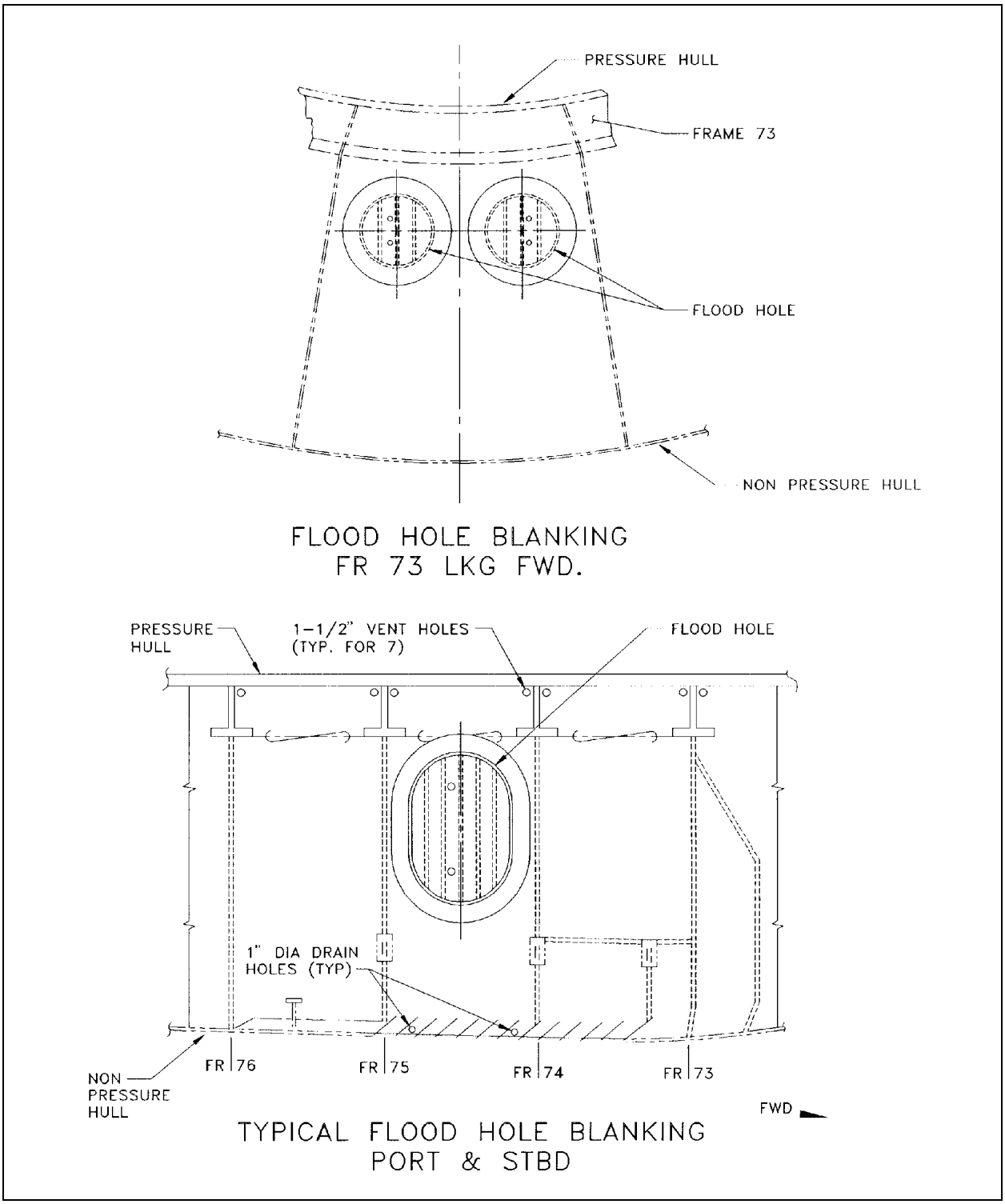

Figure 8-15. SPM Flood Holes (SSN 637)

8-4.3.2.17 (DV) After the cofferdam is tightly in place with the cofferdam gasket compressed all around, connect an LP air hose to the air supply fitting on the cofferdam. Dewater the SPM cavity and the cofferdam. Check for gross leakage of air around the cofferdam gasket and seal leaks as necessary. Maintain a constant air flow in to the cofferdam at a rate which will maintain the lowest water level possible.

NOTE

An effective sealant to fill gaps between the cofferdam gasket and submarine hull is Bintsuke (item 13).

8-4.4 SPM REMOVAL (SSN 637 AND SSN 640)

8-4.4.1 (TOP) Test the tightness of the SPM main column internal seals by installing the column vent and drain valve assembly (item 55) (Figure 8-17).

8-4.4.2 (TOP) Install a calibrated 0-50 psig air gauge (item 56) in the assembly vent valve.

8-4.4.3 (TOP) Attach an LP air source to the assembly valve air inlet fitting.

8-4.4.4 (TOP) Ensure the valve to the pressure gauge is open, and pressurize the column to 35 psig.

8-4.4.5 (TOP) Close the valve used to introduce the compressed air, but leave the valve to the pressure gauge open and let pressure stabilize.

8-4.4.6 (TOP) Monitor the pressure for 15 minutes.

8-4.4.7 (DV/SF) If any air leakage is detected by the loss of pressure in the column, investigate for the cause and correct the problem before proceeding.

NOTE

If the leakage is at the SPM motor flange, investigate for cause after the removal of the motor.

8-4.4.8 (TOP) After completion of the initial pressure test, decrease pressure inside the main column to the same pressure inside the cofferdam air cavity (air cavity pressure (psig) equals 0.445 times the depth in feet to the bottom edge of the cofferdam).

NOTE

Each submarine has a different I-beam configuration within the SPM cavity. Rigging attachment points will vary. The following steps are typical for rigging and placement of come-alongs and chain hoists.

8-4.4.9 (DV) Install two beam clamps (item 15) as close to center as possible on the forward I-beam above the SPM. Install a 18-inch long, 3-ton SWL roundsling (item 16) to each beam clamp using a 3/4-inch shackle and join the roundslings together with a 7/8-inch shackle (item 18). Install two other beam clamps as close to center as possible on the aft I-beam above the SPM in the same manner as the forward beam clamps. Install a 18-inch long, 3-ton SWL roundsling to each beam clamp using a 3/4-inch shackle and join the roundslings together with a 7/8-inch shackle.

NOTE

Ensure a minimum of 48 inches clearance between the SPM and the overhead I-beams within the SPM cavity.

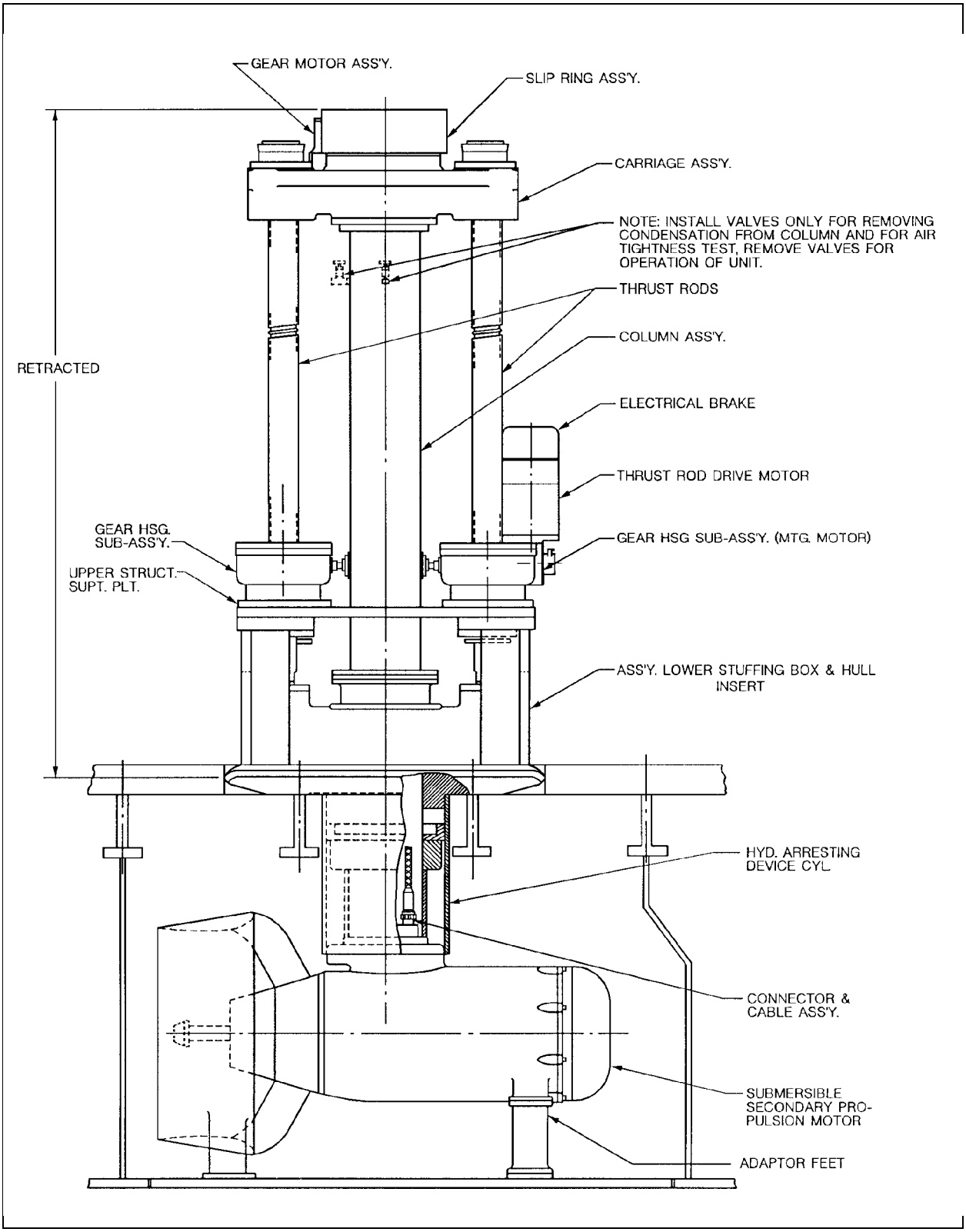

Figure 8-16. Installation of Column Vent & Drain Valves (SSN 640 and SSN 637)

CAUTION

Chain twist in the working chain loops of manual chain hoists and chain falls will cause chain failure. Chain twist in the working chain loop occurs when the chain has an improper reeve through the chain sprockets OR (more often) the running block has flipped up and through any of the chain loops (see figure 8-16A).

All chain hoists and chain falls issued with NAVSEA SUPSALV Underwater Ship Husbandry equipment kits have been checked for chain twist and the chain hoist/fall has been loosely two-blocked so that the running block can not flip over into the working chain loops during shipment.

OPERATORS must ensure that the running block is not flipped over into the chain loops creating chain twist while deploying and rigging the chain hoists/falls.

To check for chain twist in the chain loop:

Hang the hoist from the top hook in a safe, accessible location. Tighten the hoist until less then one foot of separation exists between the hoist body and the running block. The short throw allows for much easier visual detection of twist in the individual chain reeves. Confirm that none of the chain lengths running from the working chain sprocket to the running chain sprocket (chain reeves) have any twist caused by the running block being flipped over and through the loop of the chain. If ANY chain twist is detected, flip the running block back through the chain loop until the twist is removed. If ANY twist can not be removed by flipping the running block, the hoist chain MUST be removed from the hoist body and re-reeve exercising care not to twist the chain during installation.

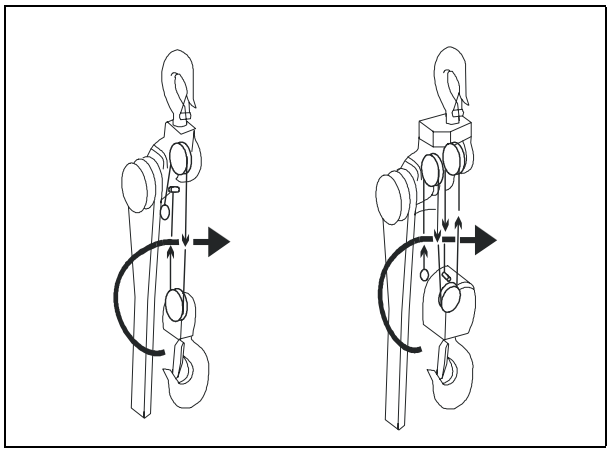

Fig. 8-16A Typical Running Block Flip (one or two part chain reeve)

8-4.4.10 (DV) Attach a 3-ton chain hoist (item 19) to the forward and aft 7/8-inch shackles.

8-4.4.11 (DV) Double wrap a 13-foot, 3-ton SWL polyester roundsling (item 20) in a bas-

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ket configuration around the forward end of the SPM. Make sure that the roundsling does not lie in the groove between the SPM and the forward shroud. Connect the roundsling to the forward chain hoist using a 1-inch shackle (item 21). Connect a 3-foot long, 3-ton SWL roundsling (item 22) as a "lazy" pendant in the 1-inch shackle (see Figure 8-8) on top of the SPM, and drape the roundslings on the starboard side of the SPM.

8-4.4.12 (DV) Double wrap an 11-foot, 3-ton SWL polyester roundsling (item 23) in a basket configuration around the aft end of the SPM, forward of the Kort nozzle. Do not rig through or allow the roundsling to rest on the Kort nozzle. Connect the roundsling to the aft chain hoist using a 1-inch shackle. Connect a 3-foot long, 3-ton SWL roundsling as a "lazy" pendant in the 1-inch shackle (see Figure 8-8) on top of the SPM, and drape the roundslings on the starboard side of the SPM.

8-4.4.13 (DV) Remove all slack from the chain hoists and roundsling rigging so that they are able to take the weight of the SPM as the flange bolts are loosened.

8-4.4.14 (DV) Scribe a match mark on both the SPM flange and the column flange.

8-4.4.15 (DV) Sequentially remove each of the eight 1 5/8-inch self-locking nuts on the column flange.

8-4.4.16 (DV) Upon receiving authorization from the dive supervisor, use the forward and aft chain hoists to lower the SPM enough to expose the electrical connectors, but no lower than the slack in the electrical cables will allow (approximately 8 inches).

8-4.4.17 (DV) Ensure that cables and motor connecting terminals are positively identified. If positive identification is not apparent, mark the cables with tie wraps (item 24, one tie wrap for T1, two tie wraps for T2, etc.). Disconnect the electrical connections using the 2-1/2-inch and 2-3/4-inch crow's foot (items 67 and 68).

8-4.4.18 (DV) Install brass sealing caps (item 25) on top of the SPM motor terminals. Install Delrin sealing caps (item 26) on the cable motor connectors. Ensure all sealing caps are properly installed so that their sealing surfaces are compressed in order to make a waterproof seal.

8-4.4.18 (DV) Install the lower column cover (item 57) and gasket (item 58). Ensure that the lower column cover vent valve is in the closed position (Figure 8-17).

8-4.4.19 (TOP) Ensure the valve to the pressure gauge is open, pressurize the column to approximately 35 psig.

8-4.4.20 (TOP) Close the valve used to introduce the compressed air, but leave the valve to the air gauge open.

8-4.4.21 (TOP) Monitor the pressure for 15 minutes.

8-4.4.22 (DV/SF) If any leakage is detected by the loss of pressure, investigate for the cause and correct the problem before proceeding.

8-4.4.23 (DV) Lower the SPM until there is sufficient clearance between it and the walls of the cofferdam when raised by the pier crane.

CAUTION

Ensure that the SPM does not bottom out on the seabed when lowering it from the SPM cavity.

8-4.4.24 (DV) Using the 7/8-inch shackles on the 45-foot pendants, connect the two 45-foot pendants from the pier crane to the two 3-foot lazy pendants on the SPM (see Figure 8-8).

8-4.4.25 (TOP) Following direction from divers, take up the slack on the pier crane until it begins to support the weight of the SPM.

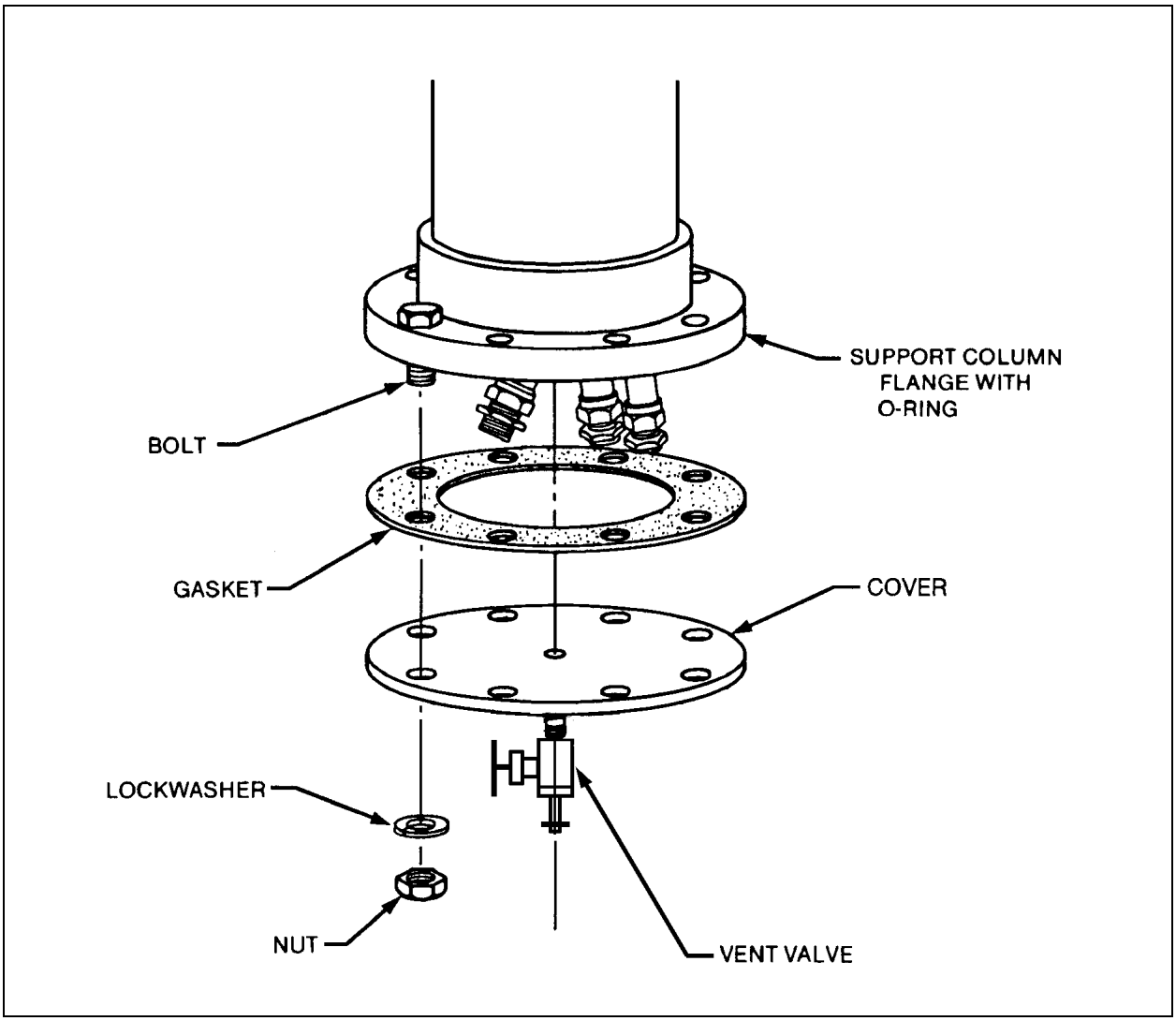

Figure 8-17. Installation of Cover on Support Column Flange.

8-4.4.26 (DV/TOP) Slowly raise the pier crane while lowering the chain hoist until the SPM clears the ship and cofferdam.

8-4.4.27 (DV) Disconnect the chain hoists from the SPM, leaving the shackles on the SPM.

8-4.4.28 (TOP) Remove the SPM from the water using the pier crane and place it in a safe working area.

8-4.4.29 (DV) Remove any dowel pins from the support column flange.

8-4.4.30 (SHOP) Ensure that the SPM alignment fixture legs are fully retracted. Place the SPM alignment fixture (item 28) on top of the old SPM and snugly fasten the fixture to the SPM using four of the eight used nuts at 90 degree separation.

8-4.4.31 (SHOP) Turn the adjustment screw to bring the longitudinal cross arm level with the SPM using a torpedo level (item 29). Adjust and lock the adjustment screw on the longitudinal cross arm.

8-4.4.32 (SHOP) With the SPM alignment fixture level with the SPM, lower the retractable legs until the tips of each leg are in contact with the fairing plate.

8-4.4.33 (SHOP) Lock the legs in position and mark points with chalk on the fairing plate where the legs make contact.

8-4.4.34 (SHOP) Remove and place the alignment fixture in a safe working area.

NOTE

After the SPM alignment fixture has been adjusted it is important that the fixture is not disturbed.

8-4.4.35 (SHOP) Disconnect and transfer the fairing plate to the new SPM. This is most easily accomplished if legs are loosened at the SPM body so they can be aligned with existing fairing plate bolt holes. Using a torque wrench (item 30) and new lock nuts (items 31 and 32), tighten all leg threaded connectors and all other loosened threaded connectors in accordance with torque values calculated from reference (g). Final torque values shall equal calculated torque values plus lock nut running torques. For additional fairing plate details for SSN 640 Class see NAVSEA drawing 2012206; for SSN 637 Class see NAVSEA drawing 2140608.

NOTE

If studs have to be installed or replaced, do so in accordance reference (g).

8-4.4.36 (SHOP) Carefully place the SPM alignment fixture onto the new SPM without applying any force on the legs. The SPM to fairing plate height must be equal to the previous height as measured by the SPM alignment fixture.

8-4.4.37 (SHOP) Add or remove shim material as necessary for the SPM and fairing assembly to be within tolerance when fully retracted into the ship.

NOTE

Corrections can be calculated using dimensions taken from paragraph 8-4.2.3 and 8-4.2.4.

8-4.5 ELECTRICAL CABLE REMOVAL AND REPLACEMENT PROCEDURES (SSN 637 and SSN 640)

The underwater removal and replacement of the SPM electrical cables can be accomplished only after the following conditions are met:

a. Cofferdam is installed and dewatered.

b. Column vent and drain assembly installed.

c. SPM separated from the support column, cables disconnected, SPM terminals properly capped, cable motor connectors properly capped, triple-bagged, and taped.

d. Column lowered, lower column cover in place, vent valve closed.

8-4.5.1 (TOP) Mount a hand-operated boat winch (item 59) between the two ball screw assemblies (Figure 8-18).

8-4.5.2 (TOP) With a scribe, benchmark the support ring for the slip ring, the column, and the secondary seal disk (Figure 8-19).

8-4.5.3 (TOP) Remove the six 1/2-inch 13 UNC hex nuts and lock washers from the stud for the secondary seal.

8-4.5.4 (TOP) Remove the support ring for the slip ring from the support column.

8-4.5.5 (TOP) Install a 3/8-inch eyebolt in the secondary seal disk (Figure 8-20), (item 60).

8-4.5.6 (TOP) Attach the soft eye of a 1/4-inch by 15 foot wire rope to the secondary seal disk eyebolt with a 3/8-inch shackle (Figure 8-20, (item 61).

8-4.5.7 (TOP) Thread the bitter end of the 1/4-inch wire rope through the bottom of the stuffing tube of the upper column closure plate (item 62).

8-4.5.8 (TOP) Install the upper column closure plate and gasket to the top of the support column with six hex head screws (item 63) (Figure 8-21) and attach the bitter end of the wire rope to the boat winch, reeving it around. Do not put tension on the wire rope attached to the secondary seal disc.

8-4.5.9 (TOP) Tighten the stuffing tube packing gland in the upper column closure plate.

8-4.5.10 (DV) Close the vent valve in the lower column cover.

8-4.5.11 (TOP) Install a calibrated 0-50 psig air gauge in the upper column closure plate (see Figure 8-21).

8-4.5.12 (TOP) Attach an LP air source to the upper column closure plate vent valve.

8-4.5.13 (TOP) Ensure the valve to the pressure gauge is open, and pressurize the column to approximately 35 psig.

8-4.5.14 (TOP) Close the valve used to introduce the compressed air, but leave the valve to the air gauge open.

8-4.5.15 (TOP) Monitor the pressure for 15 minutes.

8-4.5.16 (DV/SF) If any leakage is detected by the loss of pressure, investigate for the cause and correct the problem before proceeding.

NOTE

Air escaping around the upper column closure plate indicates an improper seal. It may be necessary to tighten the hex head screws on the closure plate, or to remove the closure plate, clean all surfaces and reinstall the closure plate.

8-4.5.17 (DV/TOP) Pass the vacuum hose (item 64) into the cofferdam.

8-4.5.18 (DV) Connect the hose to the vent valve in the lower column cover.

8-4.5.19 (DV) Open the vent valve in the lower column cover.

8-4.5.20 (TOP) Using the vacuum pump, draw a vacuum on the support column to unseat the secondary seal disk.

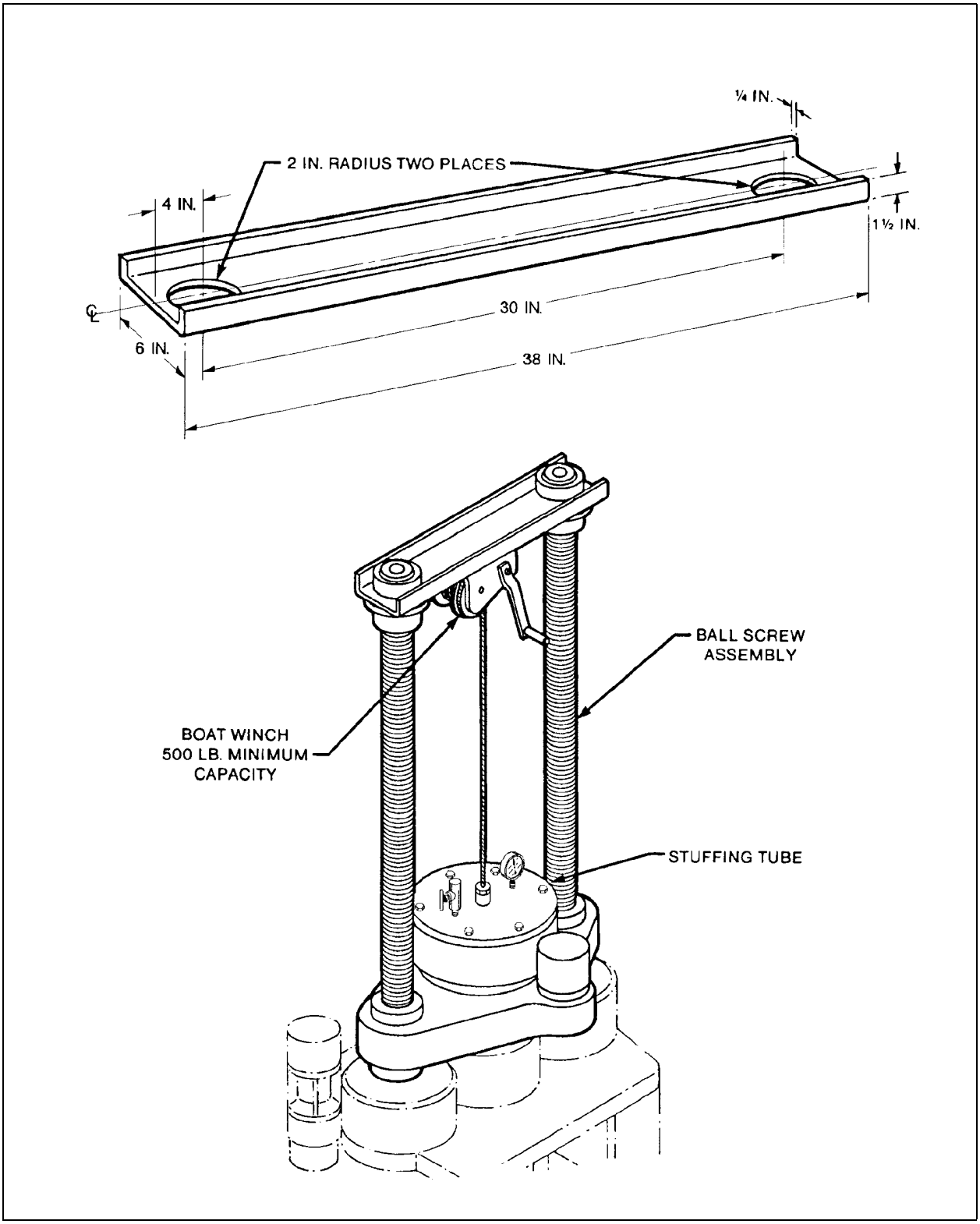

Figure 8-18. Boat Winch Installed.

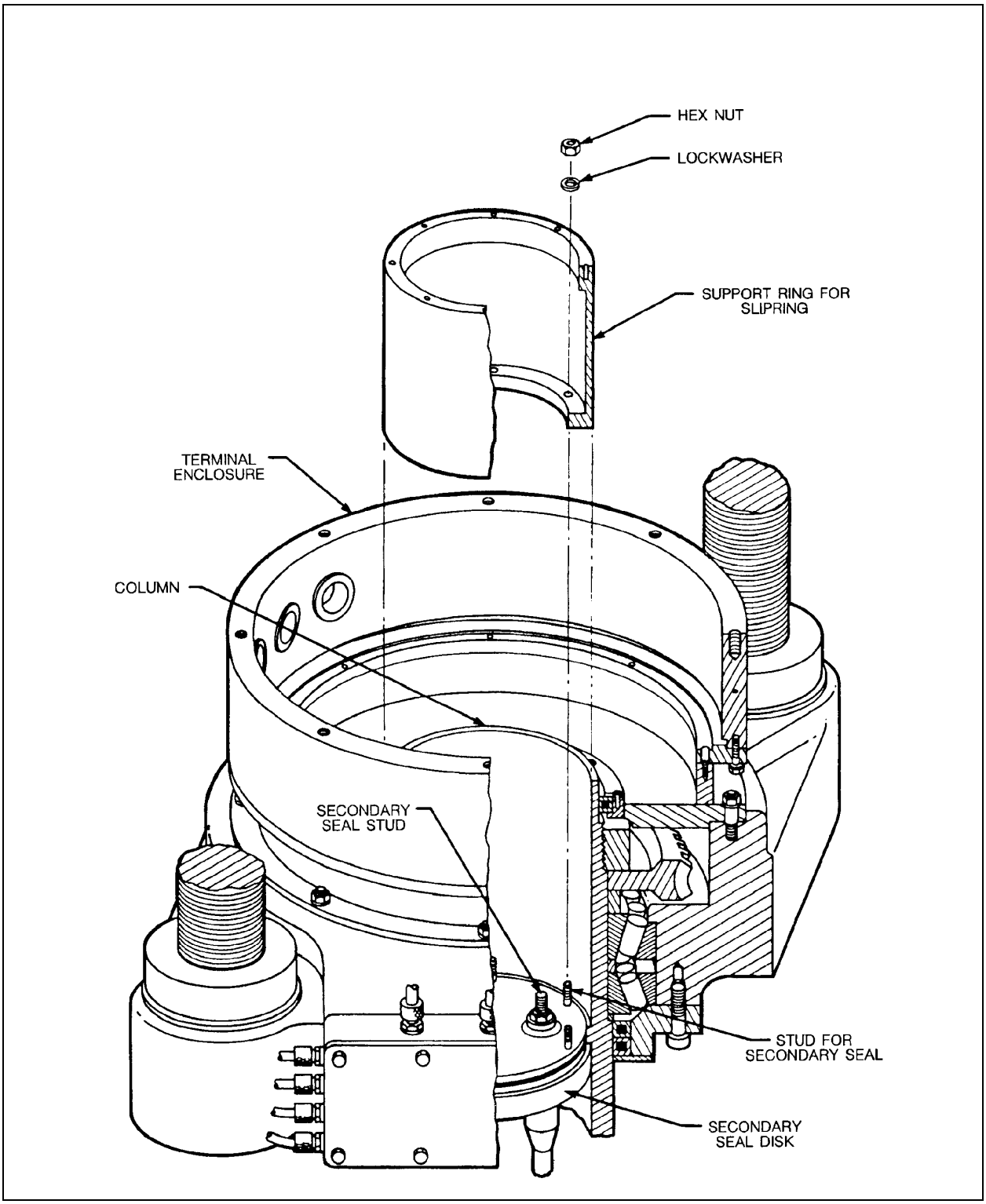

Figure 8-19. Removal of Support Ring for Slip Ring.

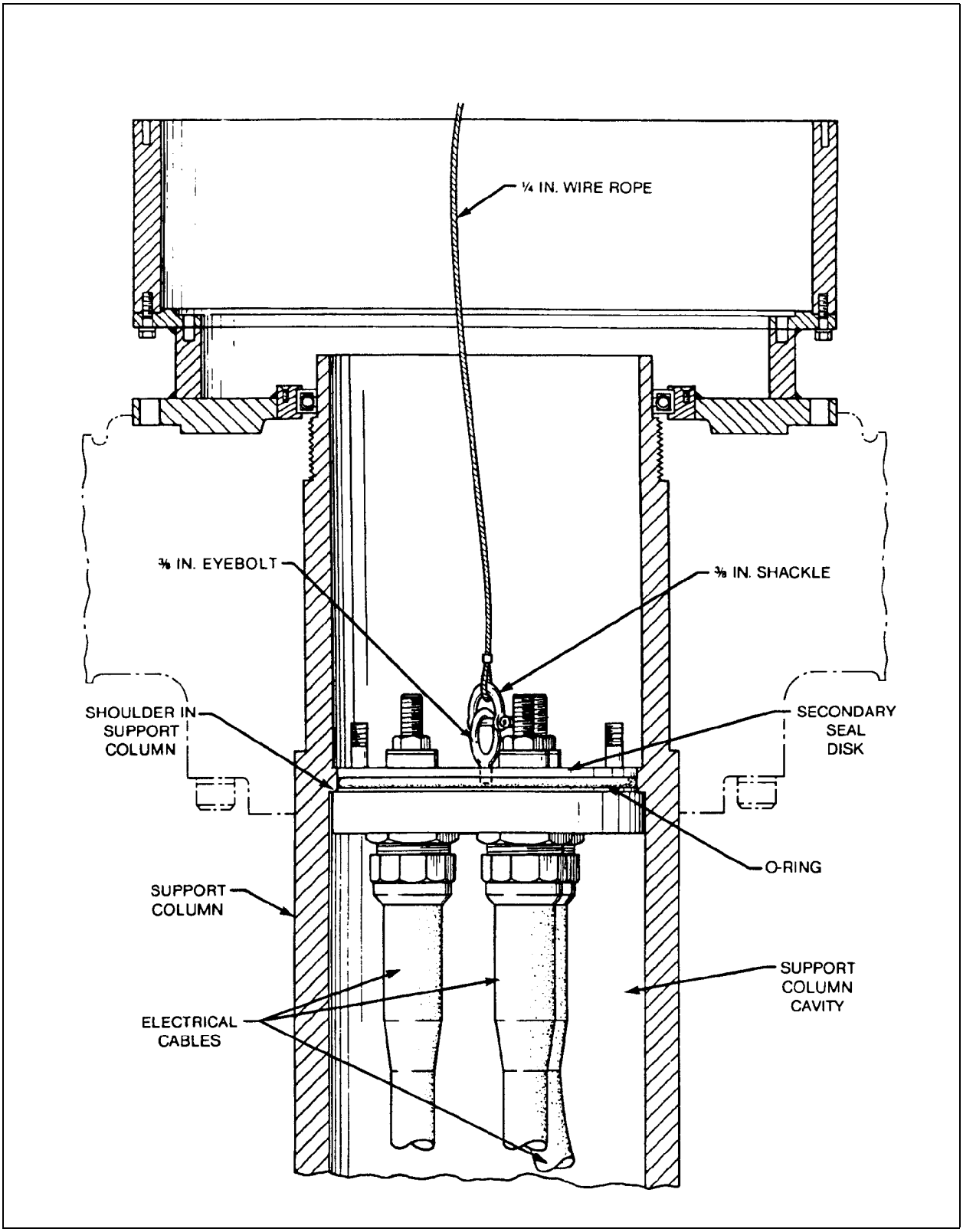

Figure 8-20. Support Column with Secondary Seal

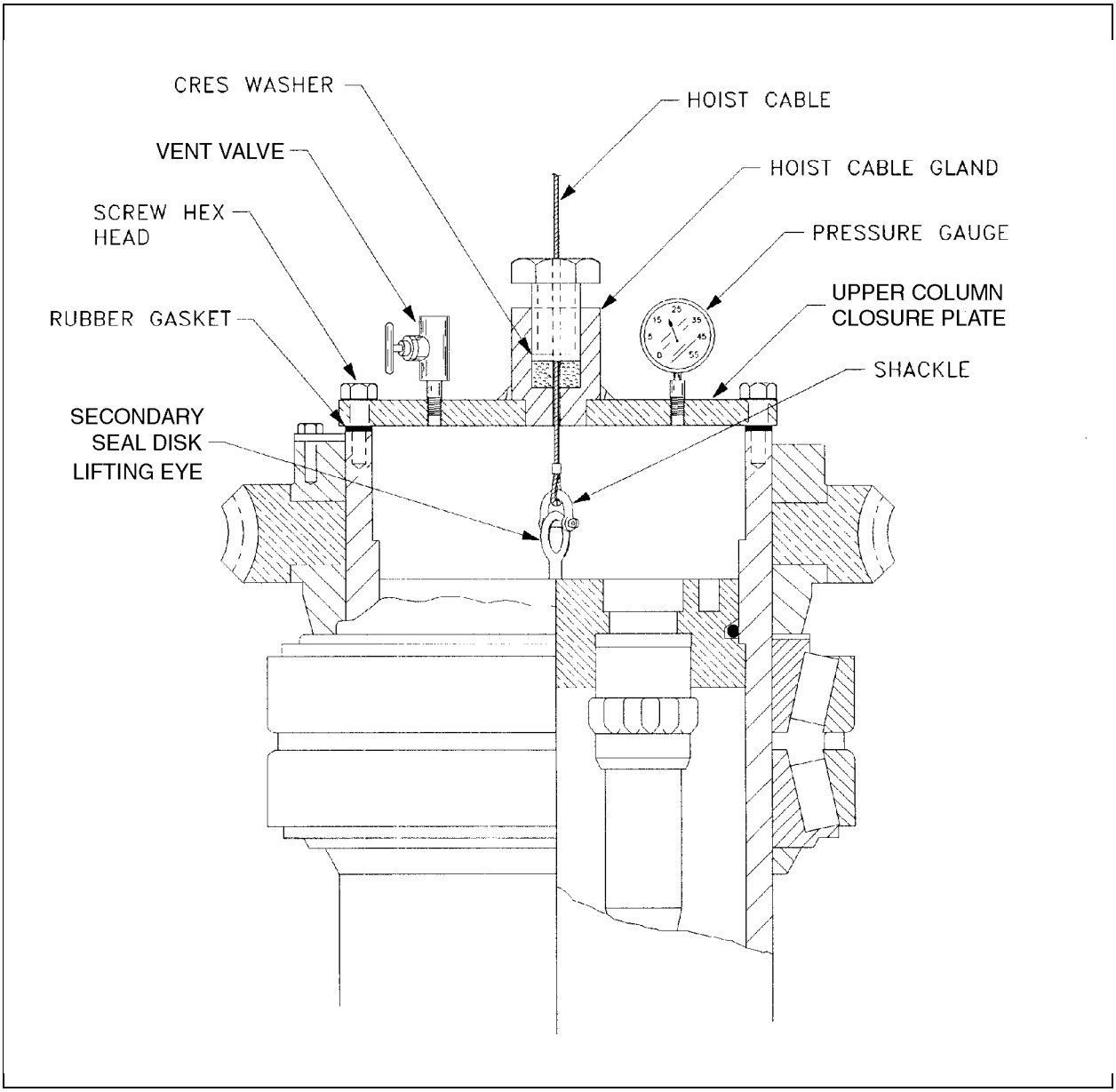

Figure 8-21. Closure Plate Installation.

NOTE

The stiffness of the electrical cables will prevent the secondary seal disk from travelling any significant distance down the support column.

8-4.5.21 (DV) Close the vent valve in the lower column cover.

8-4.5.22 (DV) Disconnect the vacuum hose from the vent valve in the lower column over.

8-4.5.23 (TOP) Remove the slack in the 1/4-inch wire rope.

8-4.5.24 (DV) Open the vent valve in the lower column cover so that the interior of the support column equalizes with the pressure in the cofferdam.

8-4.5.25 (DV) Remove the lower column cover from the bottom of the column.

8-4.5.26 (DV) Reeve out on the boat winch and pull the electrical cables and the secondary seal disk down and out of the column.

NOTE

Ensure that the secondary seal disk and cables do not get wet.

8-4.5.27 (DV) Disconnect the shackle from the eyebolt on the secondary disk and transport the electrical cables and secondary seal disk to the surface in a dry environment. The shackle will remain attached to the 1/4-inch wire rope.

8-4.5.28 (DV) Install the lower column cover and gasket on the bottom of the column, and perform another air tightness test.

8-4.5.29 (TOP) Remove and discard the O-ring from the secondary seal disk.

8-4.5.30 (TOP) Disconnect the electrical cables from the secondary seal disk.

8-4.5.31 (TOP) Mark both ends of each new electrical cable with tie wraps (T1-T1, T2-T2 and T3-T3) to match the markings on the SPM motor connectors and on the secondary seal disk connectors.

8-4.5.32 (TOP) Blow dry all electrical connectors individually with dry nitrogen immediately prior to making connections. Ensure that all electrical conductor surfaces are clean and dry.

8-4.5.33 (TOP) Connect each new electrical cable to its matching terminal on the secondary seal disk.

8-4.5.34 (TOP) Transfer dry Delrin sealing caps from old cable(s) to new cable(s), ensuring the caps are properly installed and compress sealing surfaces.

8-4.5.35 (TOP) Conduct megger checks on all three electrical cables in accordance references (c) or (d), and (e).

8-4.5.36 (TOP) Lubricate and install a new O-ring (item 66) on the secondary seal disk.

CAUTION

Water contacting the electrical cables can damage insulation and prevent proper electrical connection. Use extreme care when packaging and transporting electrical cables to the cofferdam.

NOTE

Dry hands before working on the support column and cables.

8-4.5.37 (TOP) Equalize pressure within the SPM column by venting the valve on the upper column closure plate.

8-4.5.38 (DV) Transport the electrical cables and secondary seal disk to the cofferdam in a dry environment.

8-4.5.39 (DV) Remove the lower column cover from the bottom of the column.

NOTE

Do not allow the electrical cables to contact water.

8-4.5.40 (DV) Attach the 1/4-inch wire rope (hanging in the support column) to the eyebolt in the secondary seal disk with the 3/8-inch shackle.

8-4.5.41 (TOP) Use the winch to pull the secondary seal disk and the electrical cables up inside the column until the secondary seal disk is seated against the shoulder in the upper column ensuring that no water touches the cables.

8-4.5.42 (DV) Install the lower column cover and gasket on the bottom flange of the column (Figure 8-17).

8-4.5.43 (DV) Close the vent valve in the lower column cover.

8-4.5.44 (TOP) Ensure the valve to the pressure gauge is open and pressurize the column to approximately 35 psig using the column vent and drain assembly.

8-4.5.45 (TOP) Close the valve used to introduce the compressed air, but leave the valve to the pressure gauge open.

8-4.5.46 (TOP) Monitor the pressure for 15 minutes.

8-4.5.47 (DV/SF) If any leakage is detected by the loss of pressure, investigate for the cause and correct the problem before proceeding.

8-4.5.48 (TOP) Decrease the pressure inside the main column to the same pressure inside the cofferdam air cavity (air cavity pressure (psig) equals 0.445 times the depth in feet to the bottom edge of the cofferdam).

8-4.5.49 (TOP) Equalize pressure within the SPM column by venting the valve on the closure plate. Disconnect upper closure plate.

8-4.5.50 (DV) Disconnect the 3/8-inch shackle and the 1/4-inch wire rope from the eyebolt in the secondary seal disk.

8-4.5.51 (TOP) Remove the eyebolt from the secondary seal disk.

8-4.5.52 (TOP) Install the support ring for the slip ring with hex nuts and lock washers to complete the secondary seal installation (Figure 8-19).

8-4.6 SPM REPLACEMENT (SSN 637 AND SSN 640)

The underwater replacement of the SPM can only be accomplished if the following conditions are met:

a. Cofferdam is installed and dewatered.

b. Column vent and drain assembly installed.

c. Column lowered, cable motor connector caps in place, lower column cover in place, vent valve closed.

d. Old SPM removed.

e. Fairing plate attached to new SPM and is within fit-up tolerance.

f. All shipping protection removed from new SPM.

8-4.6.1 (SHOP) Transfer cable markings from the old SPM to the new SPM.

8-4.6.2 (SHOP) Transfer flange marks from the old SPM to the new SPM.

8-4.6.3 (SHOP) Thoroughly clean the three motor terminal pins on the new SPM. Megger test the new SPM.

8-4.6.4 (SHOP) Apply a very light film of silicone compound (item 37) to the rubber seals of the motor connectors. Ensure that all electrical contact surfaces are clean and dry. Install brass sealing caps (item 25), ensuring proper compression of rubber seals..

8-4.6.5 (TOP) Double wrap a 13-foot, 3-ton SWL polyester roundsling (item 23) in a basket configuration around the forward end of the SPM. Make sure that the roundsling does not lie in the groove between the SPM and the forward shroud. Connect the roundsling to a 3-foot long, 3-ton SWL "lazy" roundsling using a 1-inch shackle on top of the SPM, and drape the roundsling on the starboard side of the SPM.

8-4.6.6 (TOP) Double wrap a 11-foot, 3-ton SWL polyester roundsling (item 20) in a basket configuration around the aft end of the SPM, forward of the Kort nozzle. Do not rig through or allow the roundsling to rest on the Kort nozzle. Connect the roundsling to a 3-foot long, 3-ton SWL, "lazy" roundsling using a 1-inch shackle on top of the SPM, and drape the pendant on the starboard side of the SPM.

CAUTION

Ensure that there is clear communication between the divers and the crane operator to prevent the SPM from bottoming out on the seabed.

8-4.6.7 (TOP) Using the 7/8-inch shackles, connect the two 45-foot eyeslings from the pier crane to the two 3-foot roundslings on the SPM, and lower the new SPM into the water to a point where the SPM will clear the ship and cofferdam when raised by the chain hoists.

CAUTION

Refer to CAUTION immediately before paragraph 8-4.4.10.

8-4.6.8 (DV) Connect the chain hoists to the 1-inch shackles on the "lazy" roundslings on the SPM and take up all slack.

8-4.6.9 (DV/TOP) Slowly raise the SPM with the chain hoists while lowering the pier crane until the SPM has cleared the ship and the full weight of the SPM is borne by the chain hoists.

8-4.6.10 (TOP) Remove the 45-foot eyeslings from the 3-foot roundslings on the SPM.

NOTE

Ensure that the shackles remain on the 45-foot eyeslings.

8-4.6.11 (DV) Open the vent valve on the lower column cover to equalize the pressure between the column and the cofferdam.

8-4.6.12 (DV) Remove the cover from the support column (Figure 8-18).

8-4.6.13 (DV) Remove and discard the O-ring from the column flange and install new O-ring (item 65).

8-4.6.14 (DV) Raise the SPM to a point where the electrical cables can be connected.

8-4.6.15 (DV) Remove the caps from the motor terminals on the SPM and from the cable motor connectors.

8-4.6.16 (DV) Blow dry the motor connectors and motor terminals with dry nitrogen (item 33). Ensure that all electrical conductor surfaces are clean and dry.

8-4.6.17 (DV) Conduct O-ring contact check by lubricating the motor connector primary rubber seal, installing the cable onto the proper motor terminal, torquing the connector to 50 ft-lbs over running torque using the 2-1/2-inch and 2-3/4-inch crow's foot (items 67 and 68) and torque wrenches, and then removing the cable connector. A clear imprint of the entire O-ring should be left on the sealing surface.

8-4.6.18 (DV) Lubricate the primary rubber seal again and connect the cables to their proper terminals on the SPM. In accordance with Appendix B, torque to 50 ft-lbs over running torque using the 2-1/2-inch and 2-3/4-inch crow's foot (items 67 and 68) and torque wrenches.

WARNING

All divers must be out of the water when megger testing is being conducted.

8-4.6.19 (TOP) With the divers out of the water, megger test the cables from inside the ship and record the results to ensure proper installation in accordance with the electrical test procedures as described in references (c) or (d), and (e).

CAUTION

Improper alignment of the flange surfaces could dislodge the O-ring and prevent a proper seal when the flange is tightened. Ensure that O-ring (item 65) on the support column flange has not been dislodged.

8-4.6.20 (DV) Align the benchmark on the SPM flange with the benchmark on the support column flange and carefully raise the SPM.

8-4.6.21 (DV) Mate the SPM with the column flange using new self-locking nuts (item 35). Sequentially torque the nuts to torque values calculated in accordance with reference (g). Final torque values shall equal calculated torque values plus lock nut running torques.

8-4.6.22 (TOP) With LP air, blow down the SPM column to remove any water that may be contained in the column.

8-4.6.23 (TOP) Using the column vent and drain assembly, and with the pressure gauge valve open, pressurize the column to approximately 35 psig.

8-4.6.24 (TOP) Shut the air inlet valve and monitor the column pressure for 15 minutes to determine if there is any air leakage, and document this test result.

NOTE

If any air leakage is detected by the loss of air pressure, investigate for the cause and correct the problem before proceeding.

8-4.6.25 (TOP) Remove column vent and drain assembly and restore column to original operational condition.

8-4.6.26 (TOP) After the SPM has soaked in sea water for 24 hours, megger check the SPM and SPM cables in accordance with references (c) or (d), and (e).

8-4.7 COFFERDAM REMOVAL PROCEDURES (SSN 637 AND SSN 640)

8-4.7.1 (DV) Remove rigging gear and return gear to the surface.

8-4.7.2 (DV) Remove all tools and connector caps from the SPM cavity and clear the tool log. Thoroughly inspect the SPM cavity for any loose gear.

8-4.7.3 (DV) Vent the cofferdam, loosen and remove all turnbuckles, and return them to the

surface. Lower the cofferdam below the SPM and raise it to the pier, using reversed installation procedures, paragraphs 8-4.3.1.1 through 8-4.3.1.17 for SSN 640 Class Submarines or paragraphs 8-4.3.2.1 through 8-4.3.2.17 for SSN 637 Class Submarines.

8-4.7.4 (TOP) Place the cofferdam on the pier and disconnect the wire ropes from the crane hook.

8-4.7.5 (TOP) Detach the wire ropes from the cofferdam.

8-4.7.6 (DV) Apply a handful of grease to the fairing plate bumper stops.

NOTE

Ensure that the SPM is in the zero degree relative bearing position.

8-4.7.7 (TOP) Upon receiving authorization from the dive supervisor, remove the tags from the SPM system and proceed to fully raise the SPM. Tag out SPM system after SPM is raised

8-4.7.8 (DV) Measure and record the fairing plate vertical alignment with the hull. Measurements shall be taken forward, aft, port, and starboard. Each measurement shall be recorded as positive if the outside surface of the plate is outside the hull outer surface, and negative if the fairing plate outer surface is inside of the hull outer surface. The fairing plate vertical alignment inside or outside the hull shall not exceed tolerances specified in NAVSEA drawing 2012206 (SSN 640 Class) or 2140608 (SSN 637 Class).

8-4.7.9 (DV) Measure the transverse gap between the fairing plate and the hull. Measurements shall be taken forward, aft, port, and starboard. The transverse gap between the fairing plate and the hull should be within local repair activity QA criteria, but shall not exceed 1 inch at any point around the perimeter.

8-4.7.10 (TOP) Upon receiving authorization from the dive supervisor, remove all tags from the SPM system.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-4.7.11 (TOP) Lower and train the SPM.

8-4.7.12 (TOP) Perform propeller rotation test on SPM to ensure proper cable hookup.

8-4.7.13 (TOP) Tag out the SPM system.

8-4.7.14 (DV) Inspect the fairing plate bumper stops to ensure that the fairing plate is properly seated in place within the hull of the ship (even transfer of grease on the bumper stops). If not, adjust bumper stops.

8-4.7.15 (TOP) Upon receiving authorization from the diving supervisor, remove the tags from the SPM system.

NOTE

Ensure that the SPM is in the zero relative bearing position.

WARNING

Divers shall clear the SPM cavity before the SPM is raised, lowered, or trained.

8-4.7.16 (TOP) Raise the SPM.

8-4.7.17 (TOP) Inform the ship's force or cognizant repair activity representative that SPM related underwater work has been completed.

8-4.8 DEBRIEF SHIP'S FORCE

(TOP) The lead dive supervisor should debrief the proper ship's officers on the final status of the SPM and/or cable replacement.

8-4.9 PREPARE FINAL REPORT

(TOP) Prepare a final report documenting the accomplished repair. Documentation should consist of inspection reports, data sheets, photographs, and video logs. The final report shall include details regarding any problems encountered, new or special tools needed, or modifications to tools or procedures found to facilitate the SPM and/or cable replacement. Send copy of final report to NAVSEA 00C5.

APPENDIX A

Preparation of Bintsuke

Required items:

55 gallon drum, clean, cut in half
160 yards of cheesecloth, cut into 6 foot by 2 foot strips

Summer Bintsuke	Winter Bintsuke
5 gallons soybean oil	Same
25 pounds resin	30 pounds resin
25 pounds beeswax	Same
2 pounds tallow	3 pounds tallow
2 pounds paraffin	Same

In a clean 55 gallon drum, heat the oil to the boiling point, then add the resin. When the resin has melted, add the beeswax and tallow. When all components have melted, let the mixture cool to approximately 150 degrees Fahrenheit, and add the paraffin. When this has melted and all components are thoroughly mixed, let the mixture stand until cool enough to immerse cheesecloth strips. Use approximately 70 to 80 strips. After cheesecloth has been added, let stand until cold. When cold, take cheesecloth strips out and twist into cords for storage until use. Bintsuke will become stiff when stored, but will become flexible when worked by hand.

Item	NSN	Unit of Issue
Beeswax	9160-00-253-1171	pound
Paraffin	9160-00-285-2044	pound
Cheesecloth	8305-00-222-2423	yard
Tallow	9168-00-263-8757	5 pound can

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APPENDIX B

TORQUE COMPUTATIONS

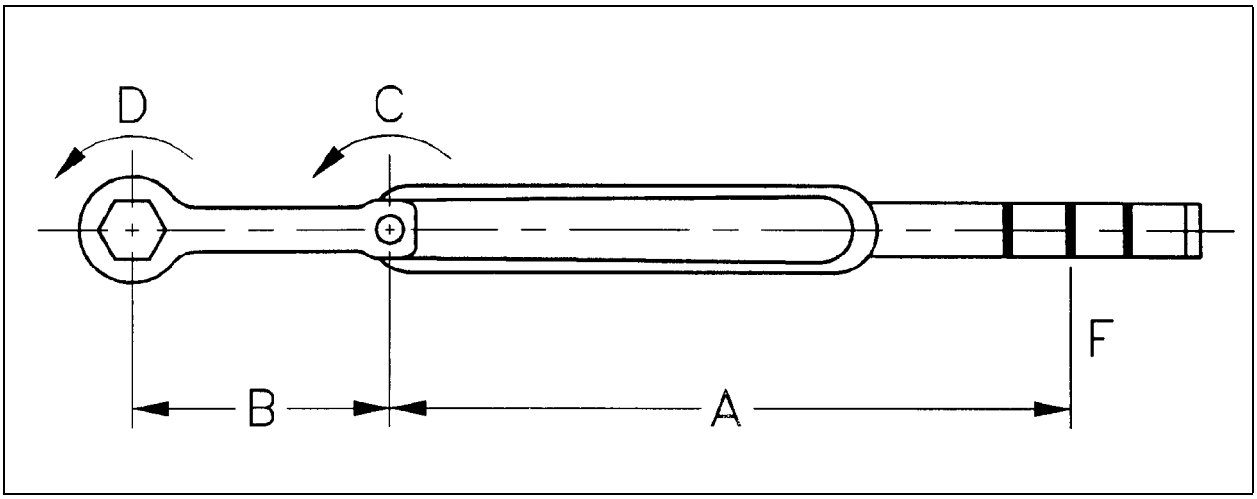

Figure B-1. Torque Computations

A = Distance from center of torque wrench square drive to center of torque wrench hand grip.

B = Distance from center of wrench square drive to center of drive at end of extension.

C = Torque wrench setting.

D = Torque desired at drive end of extension.

F = Force applied.

To compute the torque value D, multiply the value D by the quantity (A/(A+B)). This computation is equal to the value (C) required on the torque wrench [C=Dx(A/(A+B))].

For example, if A = 18", B = 2", and the torque required (D) is 50 ft-lbs, then the torque value C is equal to 50 x 18/(18 + 2), or 45 ft-lbs.

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APPENDIX C.

SSN 640 FAIRING PLATE ALIGNMENT CHECK OFF

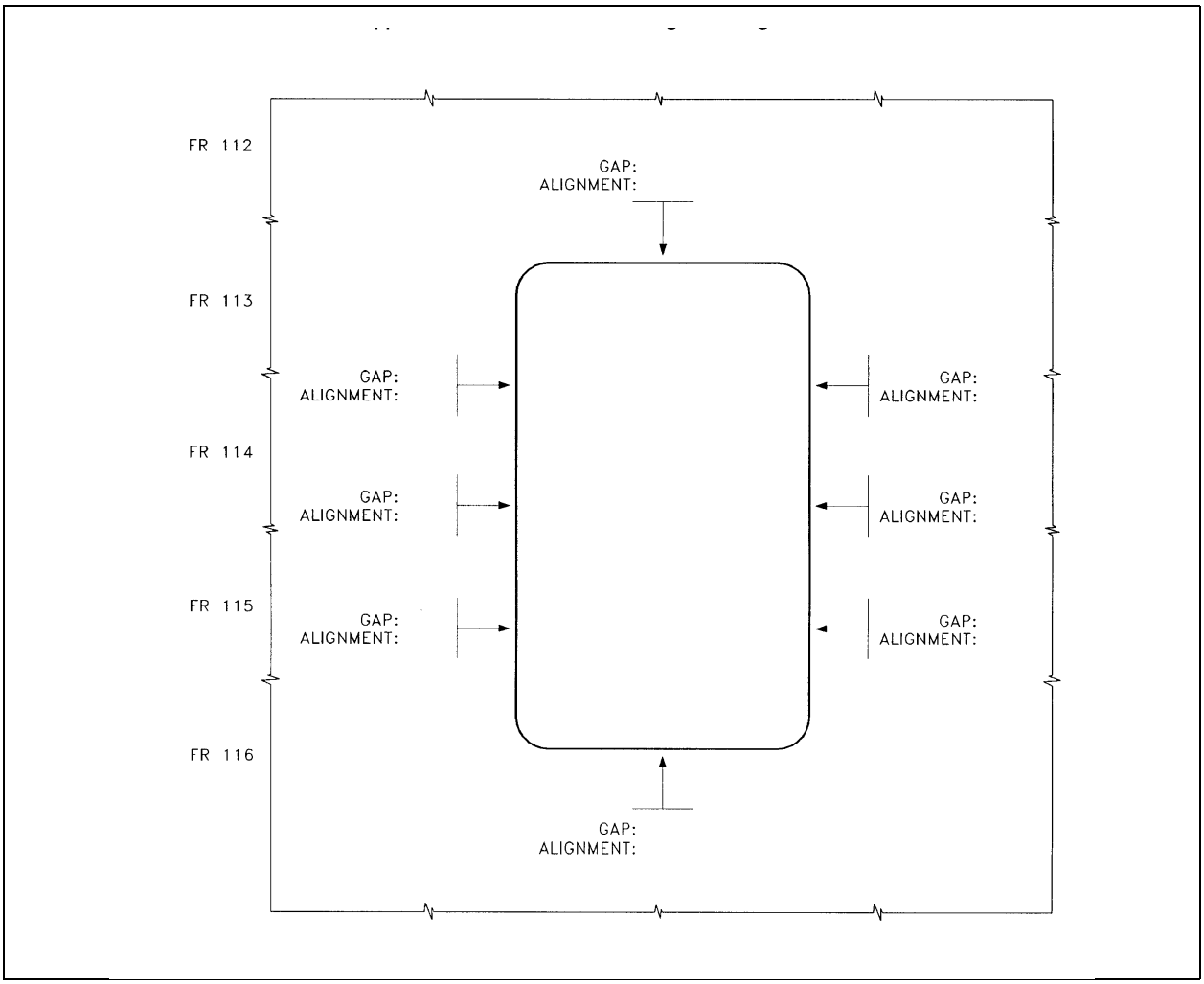

Figure C-1. SSN 640 Fairing Plate Alignment Check Off.

NOTES:

1. Fairing Plate Alignment Shall Be Recorded as Positive if it Extends Outside the Hull, and Negative if it Retracts Inside the Hull.

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APPENDIX D.

SSN 637 FAIRING PLATE ALIGNMENT CHECK OFF

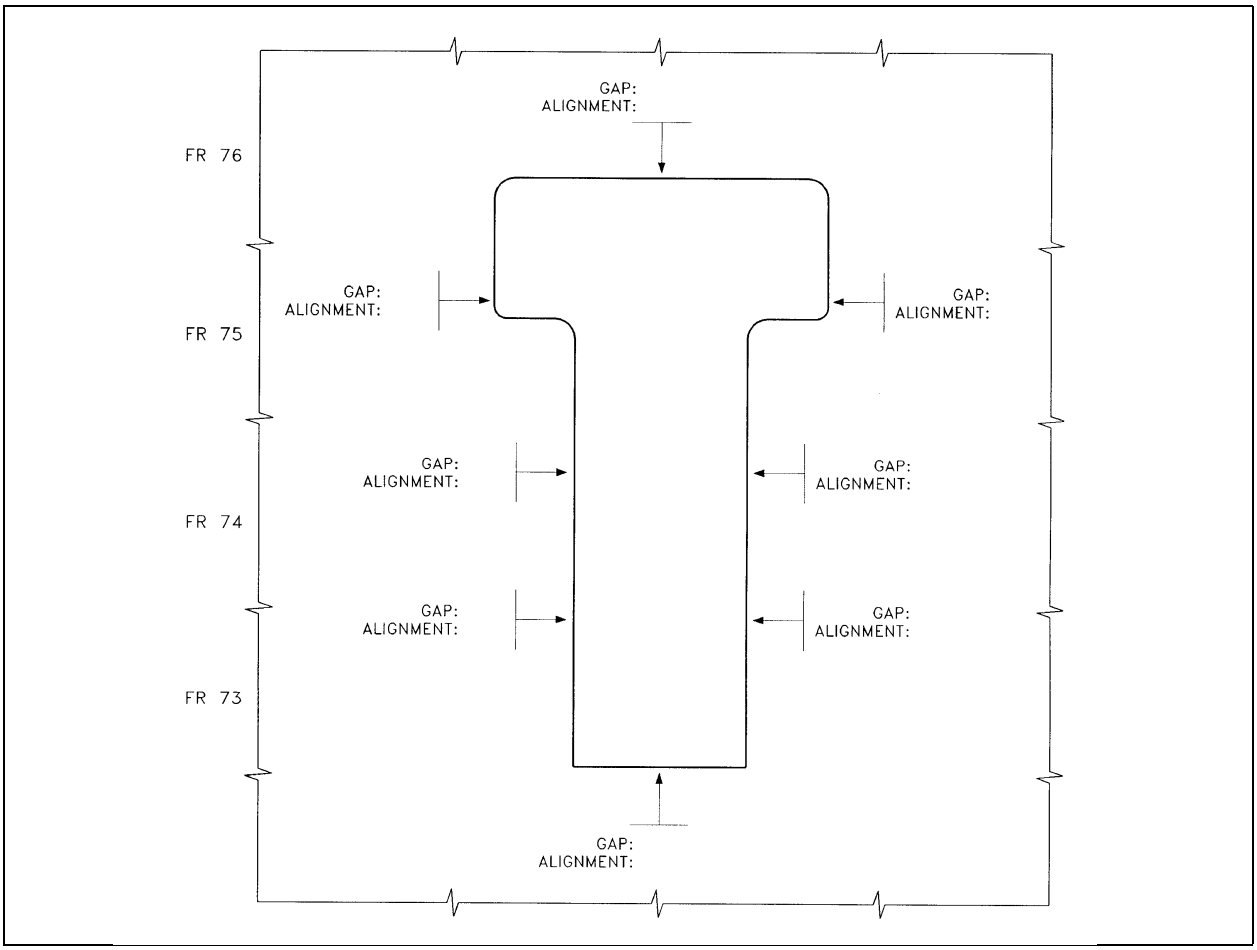

Figure D-1. SSN 637 Fairing Plate Alignment Checkoff.

NOTES:

1. Fairing Plate Alignment Shall Be Recorded as Positive if it Extends Outside the Hull, and Negative if it Retracts Inside the Hull.

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APPENDIX E.

SSN 688 FAIRING PLATE ALIGNMENT CHECK OFF

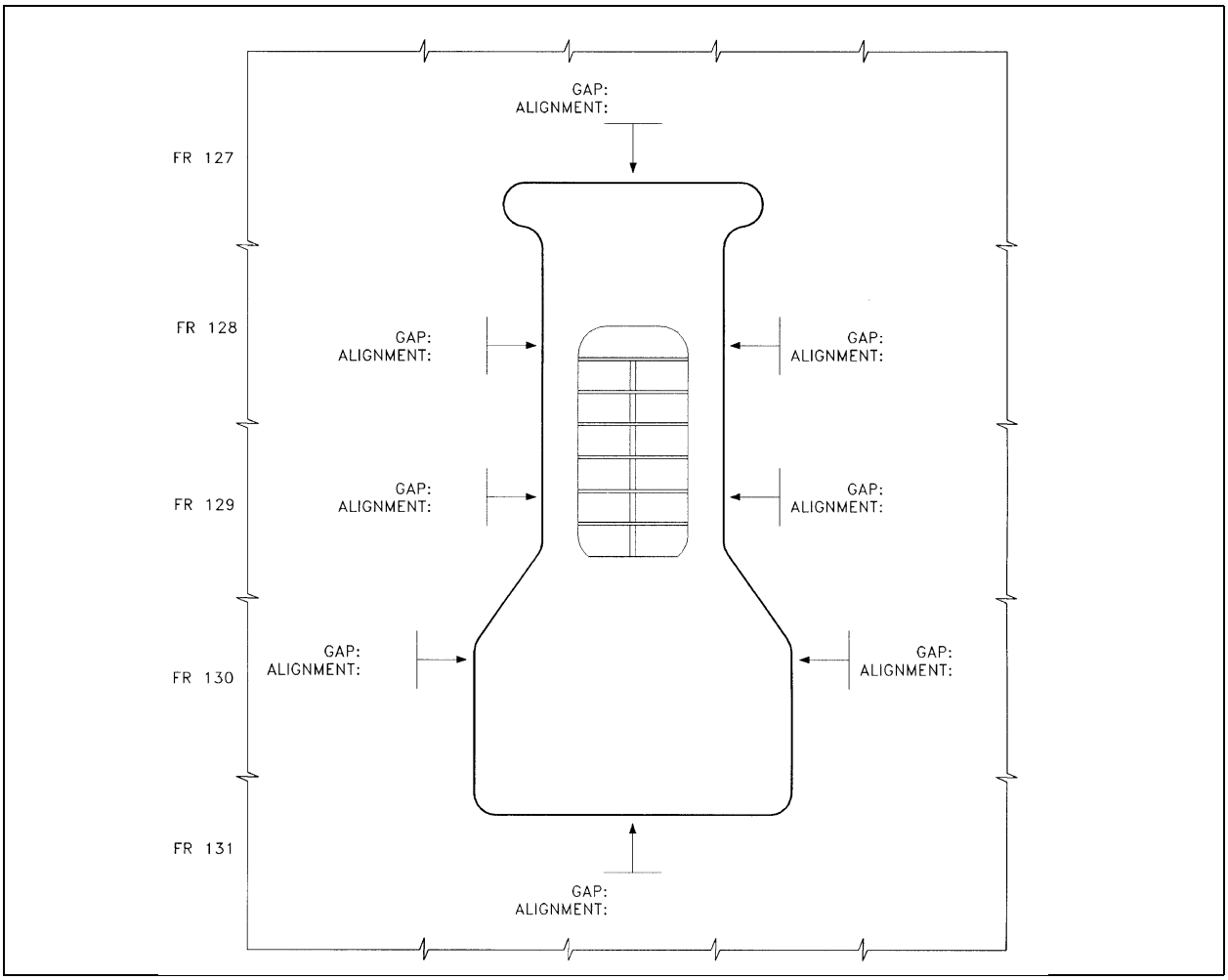

Figure E-1. SSN 688 Fairing Plate Alignment Check Off.

NOTES:

1. Fairing Plate Alignment Shall Be Recorded as Positive if it Extends Outside the Hull, and Negative if it Retracts Inside the Hull.

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APPENDIX F.

SSN 688 Class Hull Penetrations

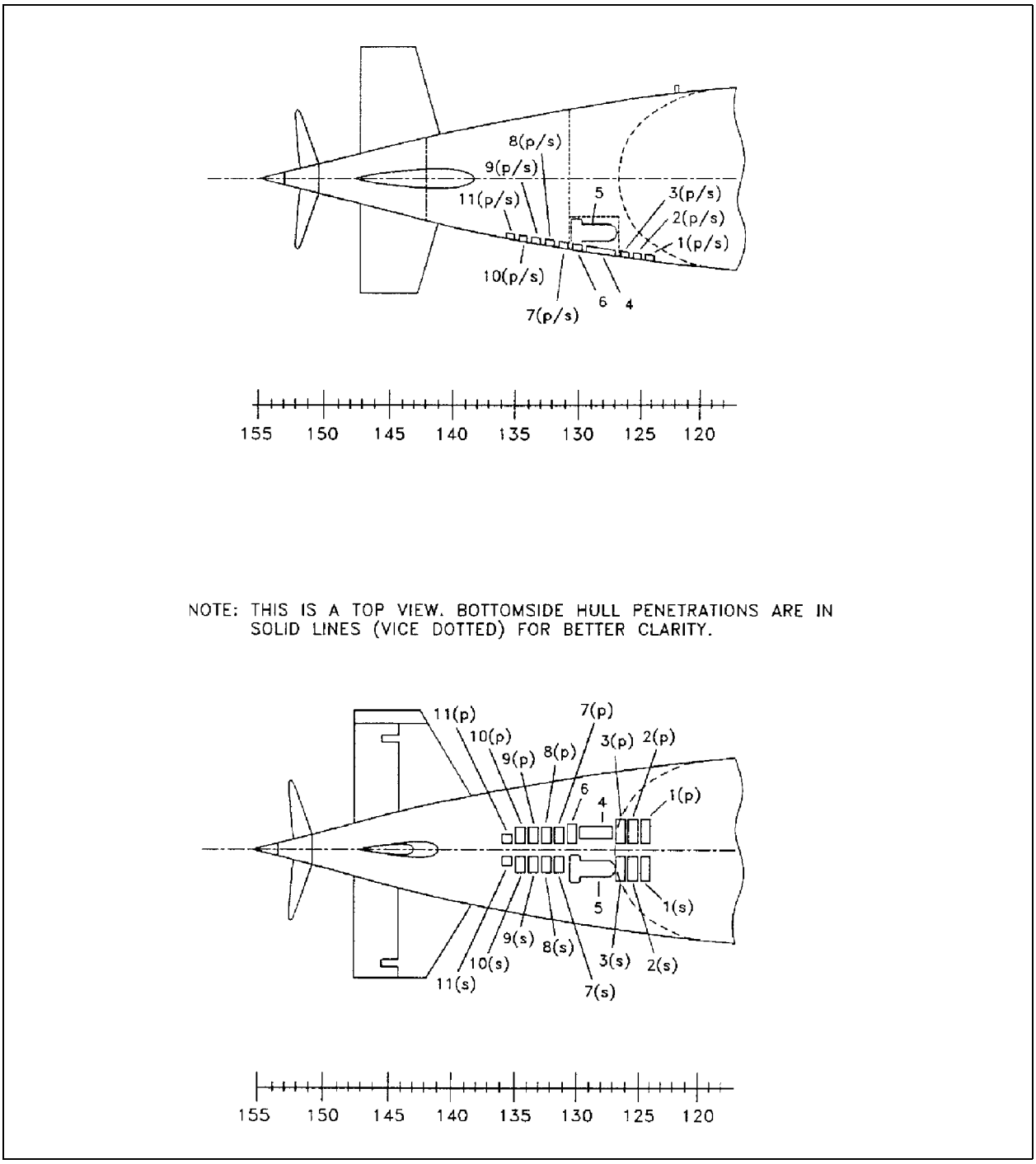

Figure F-1. SSN 68 Class Hull Penetrations

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APPENDIX G.

SSN 637 Class Hull Penetrations

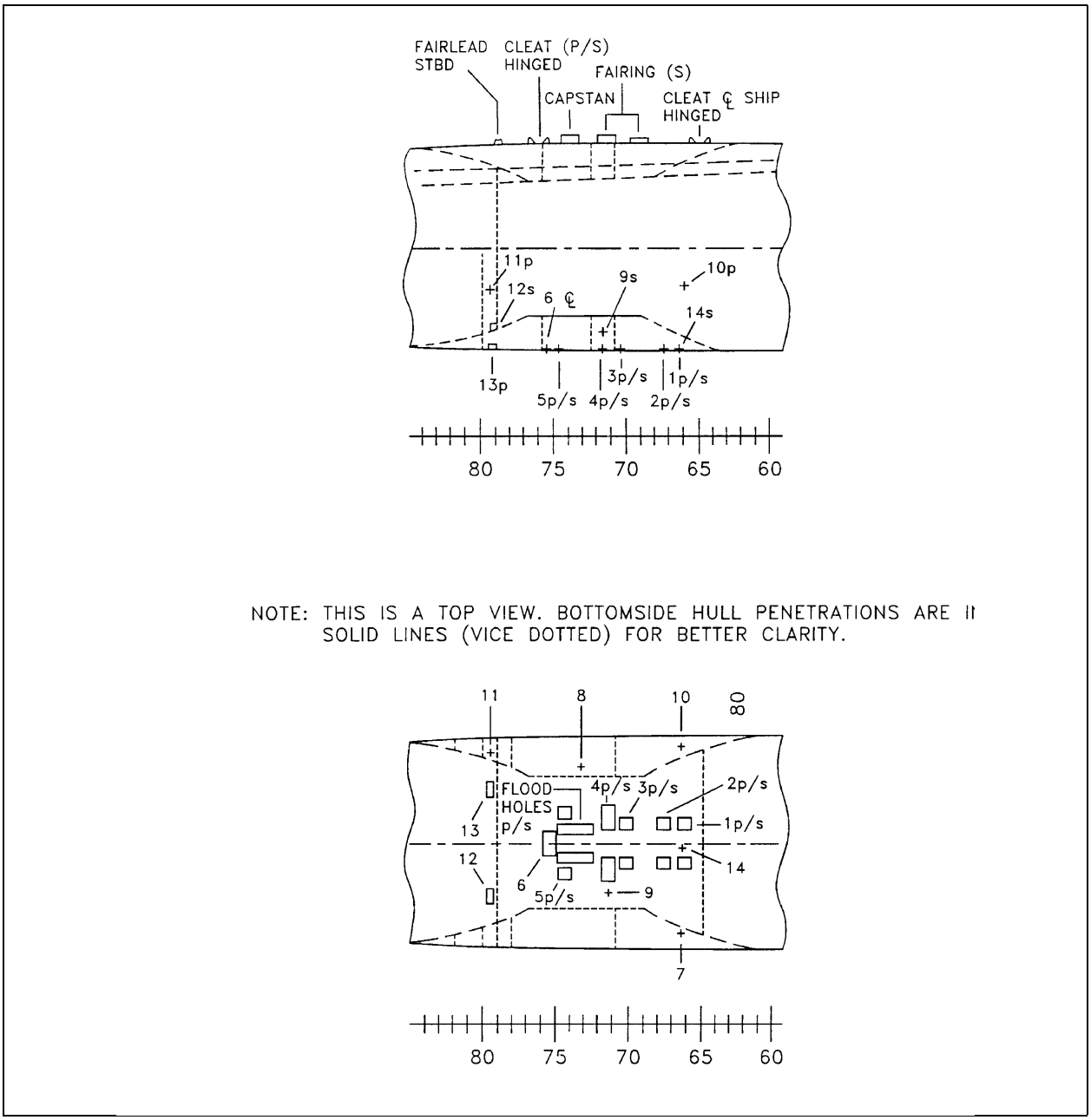

Figure G-1. SSN 637 Class Hull Penetrations

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APPENDIX H.

SSN 640 Class Hull Penetrations

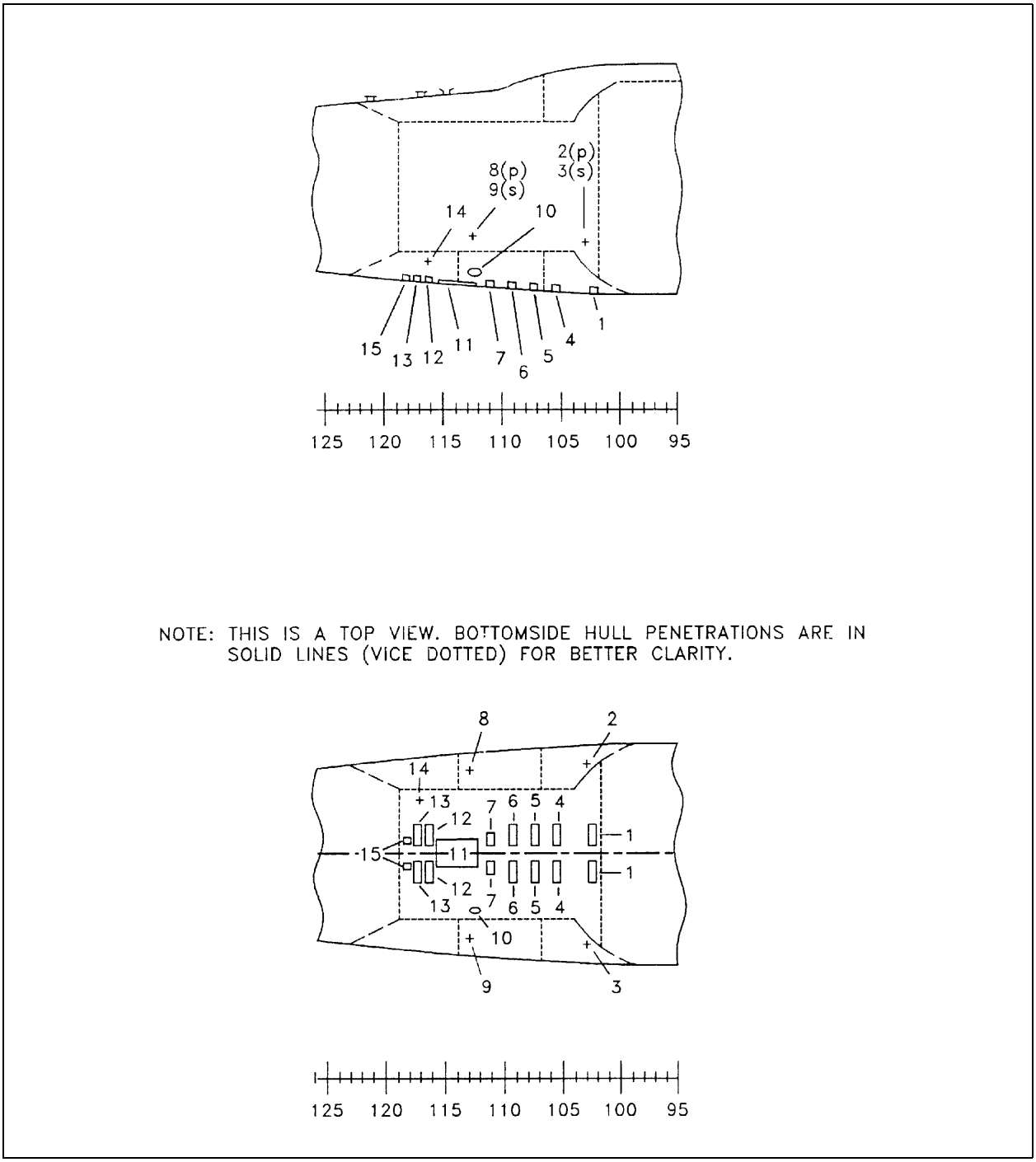

Figure H-1. SSN 640 Class Hull Penetrations

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APPENDIX I.

SSBN 726 Class Hull Penetrations

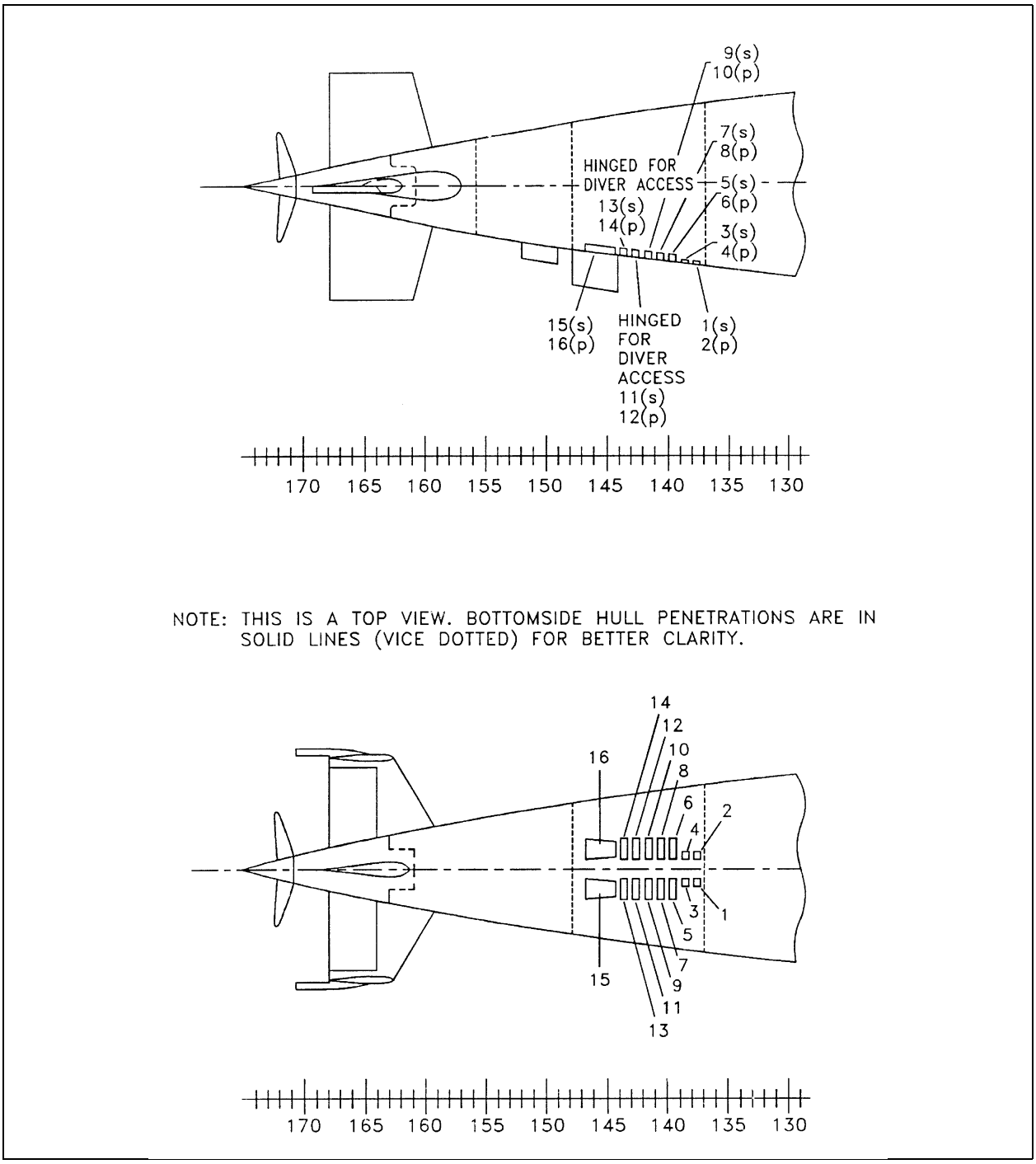

Figure I-1. SSBN 726 Class Hull Penetrations

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