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FLEET MOORING UNDERWATER INSPECTION GUIDELINES

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OCEAN ENGINEERING
AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, DC 20374

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FOREWARD

The purpose of this guideline is to standardize fleet mooring inspection procedures by explaining how to prepare for an inspection and obtain and report the inspection data. It also defines the responsibilities of all parties involved.

The "Fleet Mooring Underwater Inspection Guidelines" will replace the "Plan for Fleet Mooring Underwater Inspections." By following the procedures outlined, this document should prove a useful tool for both Underwater Construction Teams and CHESNAVFACENGCOM.

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FLEET MOORING UNDERWATER INSPECTION GUIDELINES

1.0 INTRODUCTION

1.1 Purpose and Use of Guidelines. These guidelines standardize fleet mooring underwater inspection procedures and assist inspection personnel by defining what should be accomplished before and during an underwater inspection. Also defined are the types of data and documentation that must be submitted to the Chesapeake Division, Naval Facilities Engineering Command (CHESNAVFACENGCOM), after completion of the inspection. A step-by-step inspection checklist, located in Annex A, will be used for the actual inspection.

1.2 Background. The Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM) is responsible for the operation and maintenance of all Navy fleet moorings. This includes procurement, installation, inspection, maintenance, and relocation of fleet moorings Navy-wide. Fleet moorings provide temporary or contingency berthing for fleet units in ports and harbors where pier space is limited or unavailable.

In support of COMNAVFACENGCOM's Fleet Mooring Maintenance (FMM) Program, CHESNAVFACENGCOM has been assigned the responsibility to conduct periodic underwater inspections of fleet moorings world-wide. Based on the results of these inspections, the physical condition of each of these moorings will be assessed. A determination will be made as to whether the mooring satisfactorily meets specified load and safety criteria, requires repair or refurbishment, or is unsatisfactory for further fleet usage.

1.3 Types of Inspections. Fleet mooring inspections determine the general physical condition of the buoys, chain assemblies, and anchors and verify or revise existing as-built and maintenance records. The inspection of mooring material components can be conducted while the mooring is in service (installed at an operational mooring site) or out of service (temporarily stored ashore). Major types of fleet mooring inspections are as follows:

1.3.1 Surface Inspection. The responsible shore activity inspects the visible portions of an in-service buoy and its topside hardware, fenders, and chafing rail to ensure satisfactory condition for continued use by fleet units.

1.3.2 Lift Inspection. A floating crane lifts the buoy and as much of the riser and ground legs as possible without disturbing the anchors. The buoy, its upper and lower hardware, and visible portions of the riser and ground legs are visually inspected.

1.3.3 Underwater Inspection. Using a selective sampling technique, divers clean and measure the wire diameter of a sample number of chain links and connecting component hardware. Consistent measurements provide a good indication of the mooring's overall condition. Risers and/or ground legs are observed only to the point at which they become buried in the bottom. No attempt is made to locate and inspect anchors or other mooring material which are buried.

An underwater inspection also includes the inspection of the buoy upper portion and will replace lift inspections of fleet moorings.

1.3.4 Ashore Inspection. The most thorough inspection of mooring material is accomplished while the mooring components are out of service. Onshore, all of the material can be easily cleaned, observed, and measured. If required, the components can be sandblasted to near white metal and a liquid dye penetrant or magnetic particle test conducted. In addition, all components can be readily refurbished.

This document outlines and discusses only those procedures for performing underwater inspections.

1.4 Types of Moorings. Five types of fleet moorings currently in use by the Navy are:

1.4.1 Free Swinging Mooring. This mooring consists of a single buoy to which a ship moors with bow lines or anchor chain. The ship is free to swing 360 degrees around the buoy as it responds to the forces of the wind, sea, and currents. There are two kinds of free swinging moorings as discussed below and shown in Figure 1:

- Riser Free Swinging Mooring. This mooring consists of a hawsepipe or tension bar type buoy, a riser chain (with swivel), ground ring, anchor legs, and anchors. Three or four ground legs connect the anchors to the ground ring which should be about ten feet above the mud line at high tide. The riser chain connects the ground ring with the buoy.

- Non-Riser Free Swinging Mooring. Previously called a Telephone Free Swinging mooring, this is a relatively large buoy held in place by chain anchor legs and anchors. Each of the three to eight anchor legs is attached to a padeye projecting from the lower side of the buoy's hull. A ship, which moors to this buoy, connects its anchor chain or bow lines to a swivel located in the center of the top deck of the buoy. The non-riser mooring has a relatively small watch circle.

1.4.2 Bow and Stern Mooring. This type of mooring is designed for use by a single ship, secured by its bow and stern to separate buoy systems. This mooring is normally installed near a shoreline, parallel to the direction of the water current, and outside the normal navigational channel. Either riser or non-riser buoy systems can be used in the mooring.

1.4.3 Spread (ARDM) Mooring. This type of mooring is designed for use by one or more vessels. When more than one ship uses this type of mooring, they are held together by interconnecting lines and separated by camels or fenders. Chain legs attached to the sides of the ship maintain the vessel's proper position. Figure 2 provides a schematic drawing of this mooring which is primarily used by the Navy to moor the Auxiliary Recovery Drydock Medium (ARDM)

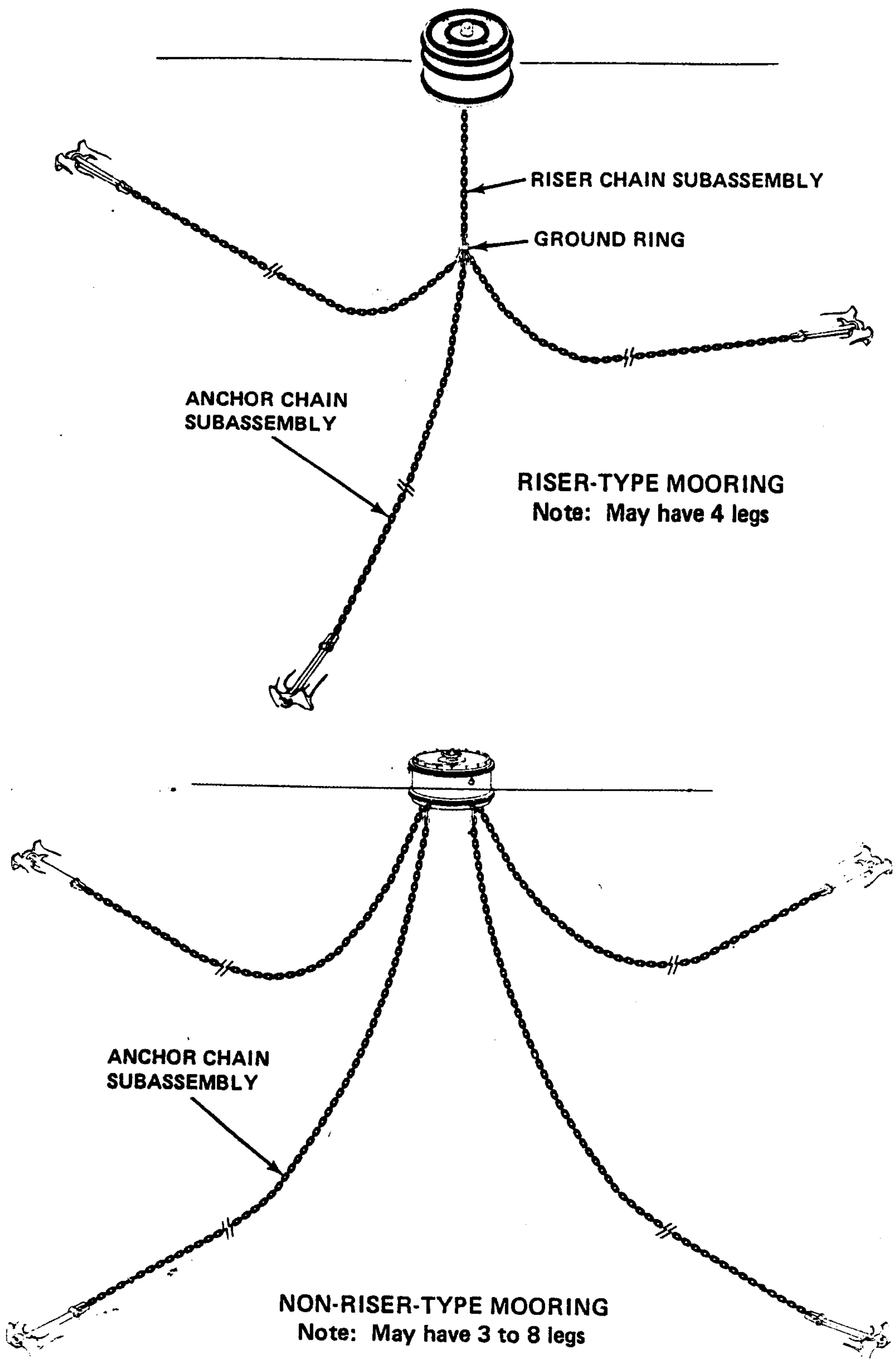


FIGURE 1. RISER AND NON-RISER TYPE MOORINGS

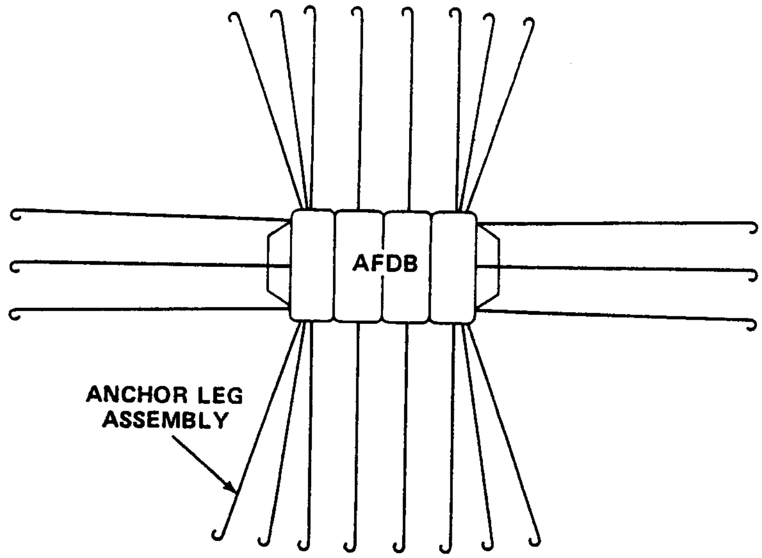


FIGURE 2. SPREAD MOORING

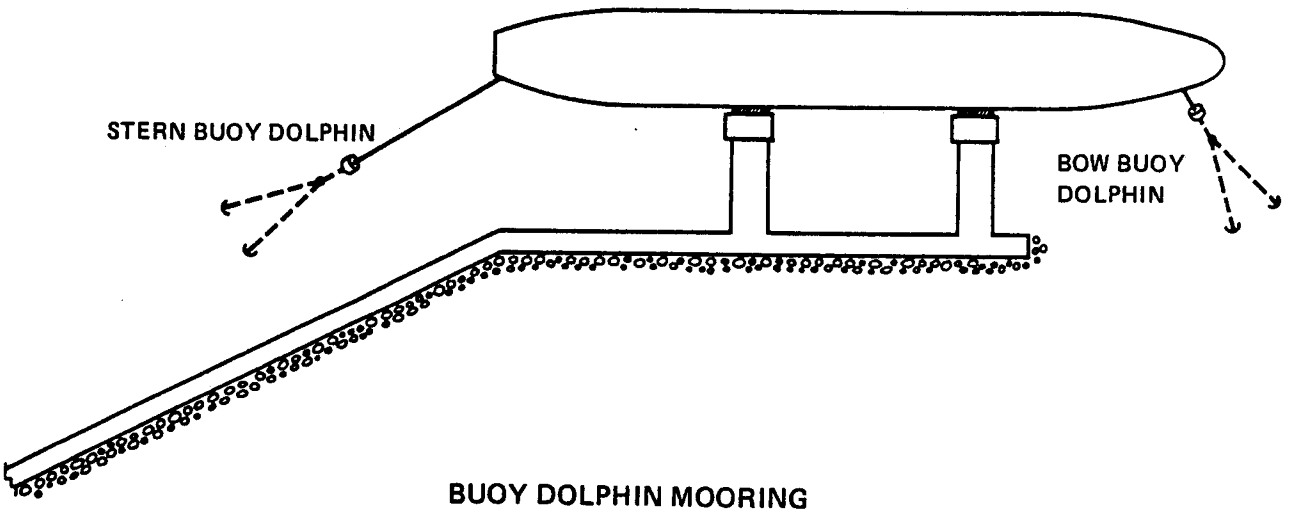
and Large Auxiliary Floating Drydock (AFDB) classes of vessels. THIS TYPE OF MOORING DOES NOT USE BUOYS. Chain legs attached directly to the ship lead to the required number of anchors. One AFDB spread mooring currently in use has 22 legs and anchors as depicted in Figure 2.

1.4.4 <u>Mediterranean Mooring</u>. This type of mooring was developed for use by Fleet Tender classes of ships. The ship is moored perpendicular to a wharf or pier with stern lines to ashore bollards. The bow is secured by two or more bow lines that may include mooring buoys. Each bow line may divide into two anchor legs leading to anchors or stakepiles.

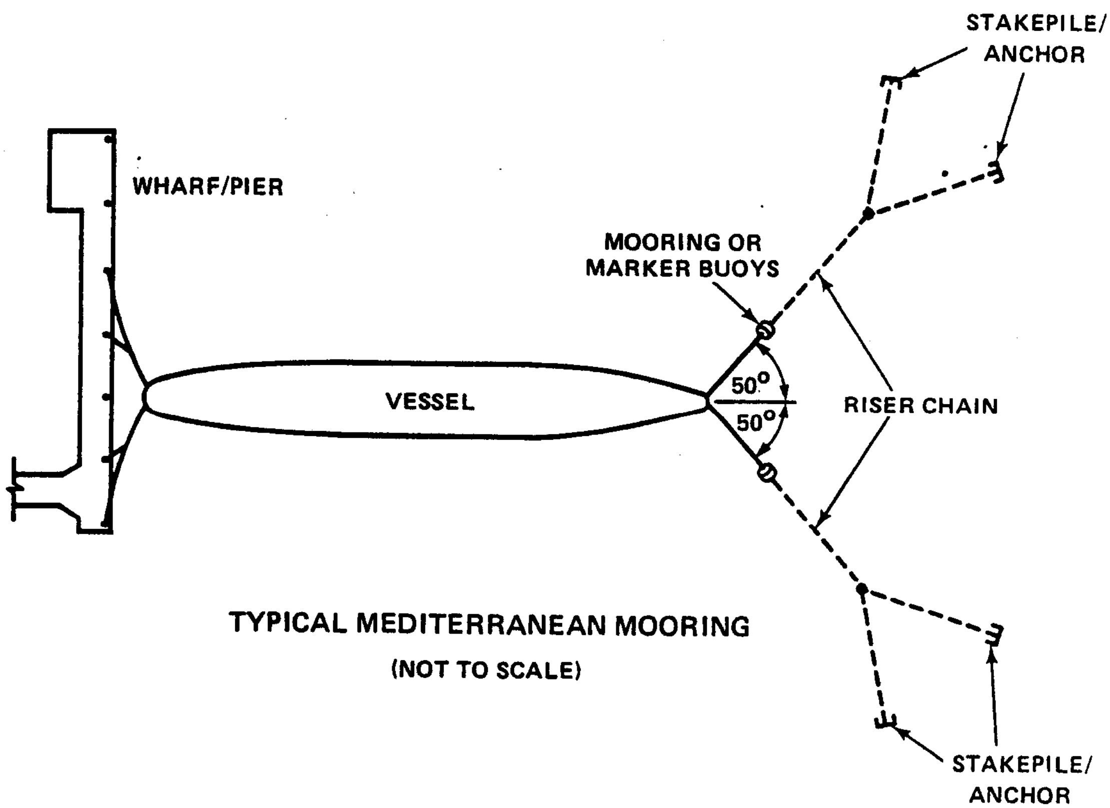
Figure 3 depicts a typical Mediterranean mooring. Tenders are moored in this fashion to allow simultaneous nesting of submarines or destroyers along both the port and starboard sides.

1.4.5 <u>Buoy Dolphin Mooring</u>. This mooring normally consists of bow and stern buoy dolphins which are used by a ship to maintain its position when breasted along one or more finger piers (see Figure 3).

1.5 <u>Mooring Classifications</u>. NAVFAC DM-26, "Harbor and Coastal Facilities Design Manual," identifies 11 classes of fleet moorings. (Refer to Table 1, Classification of Fleet Moorings.) These standard classes of fleet moorings



BUOY DOLPHIN MOORING
(NOT TO SCALE)



TYPICAL MEDITERRANEAN MOORING
(NOT TO SCALE)

FIGURE 3. BUOY DOLPHIN AND MEDITERRANEAN MOORINGS

have been designed and installed to support the various types and sizes of operational fleet vessels. Over 90 percent of the in-service fleet moorings are the smaller A through F classes. The larger classes (AA, BB, and CC) are configured with double legs attached to spider plates, and can have up to eight legs (see Figure 4).

Table 1. Classification of Fleet Moorings

Mooring Class	Type		Holding Power (lbs)	Chain Size (in)		No. of Moorings
	Riser	Telephone		Riser	Ground Leg	
AA	X	X	300,000	4	2 3/4	1
BB	X	X	250,000	3 1/2	2 1/2	6
CC	X	X	200,000	3 1/2	2 1/4	7
DD	X	X	175,000	3	3	0
A	X	X	150,000	2 3/4	2 3/4	26
B	X	X	125,000	2 1/2	2 1/2	24
C	X	X	100,000	2 1/4	2 1/4	24
D	X	X	75,000	2	2	40
E	X		50,000	1 3/4	1 3/4	44
F	X		25,000	1 1/4	1 1/4	20
G	X		5,000	3/4	3/4	2
Totals	11	8				194*

NOTE: There are an additional 34 Special Moorings (Spread, Mediterranean, etc.) that do not meet the characteristics of these standard classes of moorings.

1.6 Types of Buoys. A buoy's size depends on the weight of chain it must support in the water column. The following types of buoys are utilized in fleet moorings (see Figure 5).

1.6.1 Drum Buoy. This buoy is produced in a variety of sizes, and is used to support riser type moorings. The shape of the buoy resembles a drum. It is designed to include either a tension bar or hawsepipe.

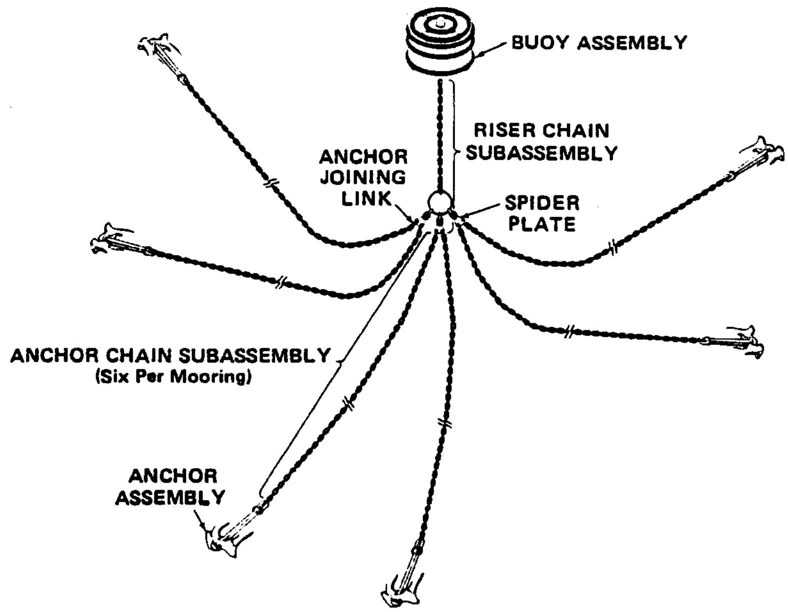


FIGURE 4. TYPICAL RISER TYPE MOORING – CLASSES AA, BB, CC

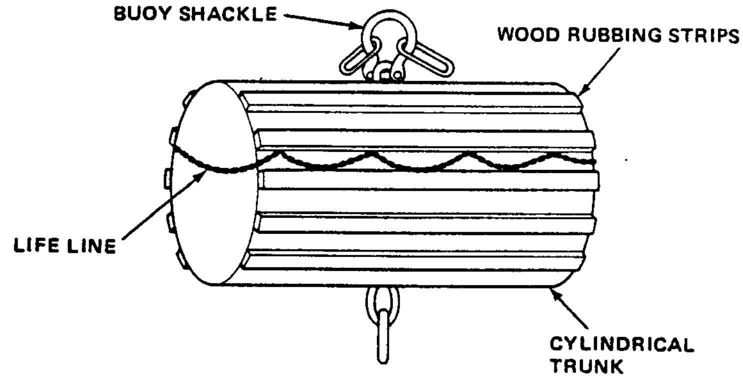
1.6.1.1 Tension Bar. A tension bar is a steel bar which passes through the center of the buoy with padeyes on top and bottom. The lower padeye is connected to the upper link of the riser chain. A moored vessel is connected to the upper padeye by its anchor chain, wire rope, or mooring hawsers.

1.6.1.2 Hawsepipe. A hawsepipe is a cylindrical tube passing through the center of the buoy. The riser chain passes through this tube and its upper link is held on the top of the buoy with a slotted chain plate. A moored vessel ties directly to the riser chain.

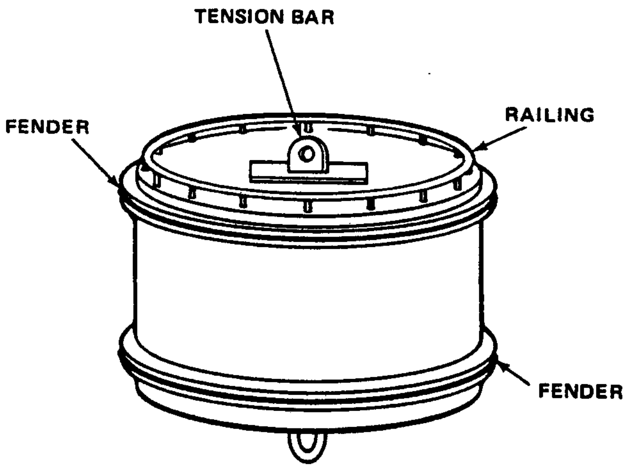
1.6.2 Peg Top Buoy. This buoy is also used to support riser type moorings. It includes either a tension bar or hawsepipe. Peg Top buoys are conically shaped with the top deck area considerably larger than the bottom surface.

1.6.3 Drum Non-Riser Buoy. Also called "Telephone" buoys, non-riser buoys are larger than those used in riser type moorings since they have three or more ground legs to support in the water column. They have a swivel at the top to which the moored vessel's anchor chain or hawser is attached. The ground legs are connected to three or four equally spaced padeyes on the buoy's hull.

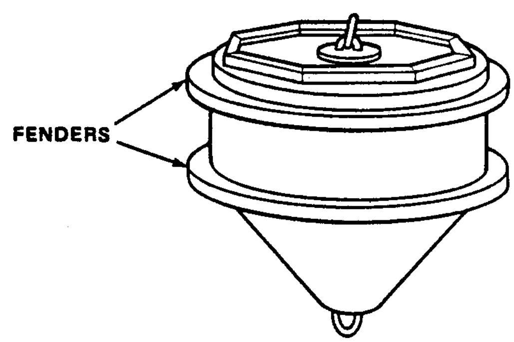
1.6.4 Cylindrical Buoy. This buoy is used in smaller classes of moorings. It is shaped like a cylinder and is designed to include either a tension bar or hawsepipe that passes top to bottom.



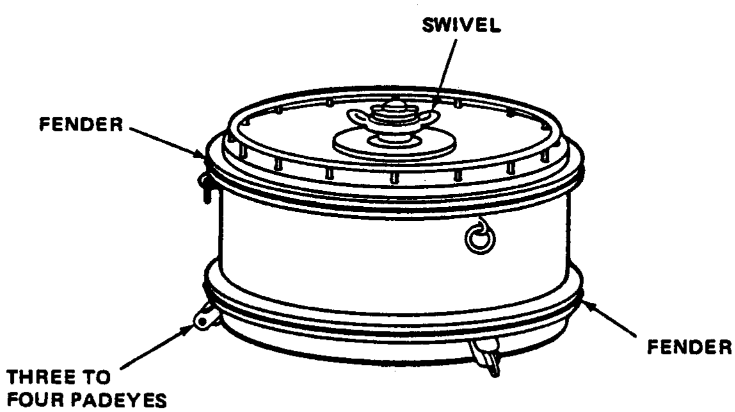
(a) CYLINDRICAL BUOY
WITH HAWSEPIPE



(b) DRUM RISER-TYPE BUOY
WITH TENSION BAR



(c) PEG-TOP MARK II
RISER-TYPE BUOY



(d) DRUM NON-RISER-TYPE
(TELEPHONE) BUOY

FIGURE 5. COMMONLY USED MOORING BUOYS

2.0 PRE-INSPECTION PHASE

2.1 CHESNAVFACENGCOM Responsibilities. During the pre-inspection phase of underwater inspections, CHESNAVFACENGCOM:

- o reviews all available historical maintenance records and develops a list of those moorings which should be scheduled for underwater inspection during a particular fiscal year;
- o develops the annual fiscal year Fleet Mooring Underwater Inspection Schedule after liaison with both Underwater Construction Teams (UCTs);
- o requests copies of the latest mooring maintenance records, as-builts, buoy positioning data, overhaul schedules, and local area charts from those activities whose moorings are scheduled for inspection;
- o designates an Engineer-in-Charge (EIC) for each of the scheduled underwater inspections; and
- o prepares inspection plans, monitors the performance of underwater inspections, evaluates mooring condition, and prepares all inspection reports.

2.2 EIC Responsibilities.

2.2.1 Preparations. The EIC will establish a tentative time frame for the mooring inspection in conjunction with the UCT. This time frame will be based on the maximum availability of station support, anticipated favorable weather conditions, and diver availability. The dive teams must be familiar with project requirements to assist in inspection planning. Equipment requirements must be coordinated with the dive team. In addition, the EIC:

- o arranges for own travel orders, area clearances, camera clearances/ passes, passport, and transportation;
- o arranges for own berthing and messing;
- o provides CHESDIV an inspection cost estimate;

- o prepares a predeployment briefing on project status and planned inspection procedures;
- o assures that the UCT and host activity are aware of their inspection roles; and
- o monitors the inspection and reports the status of all schedules.

The following information should be obtained from the activity or CHESNAVFACENGCOM Fleet Mooring Archives and thoroughly reviewed by the EIC prior to departure for an inspection site:

- o class and types of moorings to be inspected;
- o latest "as-built" documentation or mooring parts list;
- o copies of design drawings;
- o mooring history - when installed, inspected, overhauled, etc.;
- o geographic positions of moorings, benchmarks, and landmarks;
- o type of cathodic protection system (if installed);
- o environmental data;
  - seasonal and possible extreme weather conditions;
  - tide and current tables;
  - depth of water/type bottom; and
  - diving hazards/obstructions, sonars, intakes, and predicted ship movements.

2.2.2 Equipment. In addition to these guidelines, the EIC should carry the following items to the inspection site:

- o inspection data sheets and forms;
- o 35mm camera and color slide film;
- o tape measure (20-foot minimum);
- o drafting supplies, graph paper, scales, etc.;
- o calculator and extra batteries;
- o pre-dive briefing data; and
- o "Harbor and Coastal Facilities Design Manual" (DM-26).

2.3 Dive Team Responsibilities.

2.3.1 Preparations. The dive team:

- o interfaces with the EIC in all inspection planning matters;
- o selects qualified transit operators who will conduct the buoy location survey with the assistance of the EIC who will verify the accuracy of the survey bearings while on site;
- o makes all onsite logistics support arrangements; and
- o contacts host activity (in foreign ports) to determine protocol requirements.

2.3.2 Equipment. The dive team provides all equipment and material required for the underwater inspection and the buoy location survey. This equipment includes:

- o calipers (24-inch minimum);
- o GO/NO-GO gauges;
- o underwater voltmeters;
- o two underwater cameras (35mm) with sufficient color slide film and flash with spare batteries;
- o inclinometer;
- o cleaning equipment (wire brushes, chipping hammers, chisels, etc.);
- o 100-foot underwater tape measure;
- o 1-foot scale;
- o marker tags (such as nylon cable ties) to relocate or mark links or accessories;
- o transits and targets for locating buoy position;
- o hand-held radios;
- o compass;
- o binoculars; and
- o all diving equipment and small boats as required.

2.4 Activity Support. The activity whose moorings are scheduled for inspection should provide support to CHESNAVFACENGCOM and the inspection team by forwarding, when requested, the following information:

- copies of the latest mooring maintenance records, as-built and buoy positioning data, and local area harbor charts;
- clearances and passes for inspection team members and their cameras;
- coordinates of known benchmarks and personnel cognizant of their location;
- copies of new facility drawings;
- responses to requests for other pertinent inspection data; and
- information regarding protocol requirements.

It is the responsibility of the EIC to request the cooperation and support of the activity in matters related to the inspection.

3.0 INSPECTION PHASE

3.1 Responsibilities.

3.1.1 EIC Responsibilities. The EIC documents the inspection procedures, records the data, and maintains a log of events. Any changes to, or improvements in, the current inspection procedures, as deemed necessary during the course of the inspection, should be fully documented.

If possible, the assigned EIC should arrive on site a minimum of one working day before the start of the inspection. This provides the opportunity to meet with appropriate station personnel in order to:

- o brief station personnel on the plans, techniques, and purpose of the inspection;
- o obtain any information concerning the moorings that was previously unavailable;
- o determine mooring usage or ship movements during the inspection period in order to establish the order in which the moorings will be inspected;
- o obtain the latest weather forecast for the local area; and
- o obtain information regarding the following support:
  - navigational aids;
  - Navy and contractor repair facilities;
  - spare/excess mooring material inventory;
  - heavy-lift crane barges;
  - equipment operators;
  - riggers/wharf builders; and
  - shops capable of sandblasting, welding, and dipping chain in protective coating solutions.

In addition, evidence of fleet requirements, days of ship usage per year, and the types/classes of ships using moorings should be obtained.

Prior to beginning diving operations, the EIC shall brief the Petty Officer-in-Charge (POIC) on the latest information obtained from station personnel and ensure that he is aware of any changes to the inspection procedures.

As the CHESNAVFACENGCOM representative, the EIC is authorized to modify inspection procedures on site as necessary, as long as modifications remain within UCT diving policy.

In addition, the EIC must:

- o interface with the UCT POIC in all matters related to the inspection;
- o report the status of the inspection and advise CHESNAVFACENGCOM of any schedule or procedural changes;
- o arrange with the POIC to debrief the divers on the completion of each dive;
- o evaluate the inspection data as it is gathered and determine if additional data is required;
- o assist the dive team in surveying the position of the buoys and locating the positions of the required benchmarks; and
- o with the assistance of the POIC, who will participate, brief activity personnel on mooring conditions following completion of the inspection.

3.1.2 Dive Team Responsibilities. The POIC:

- o interfaces with the EIC on all inspection-related matters;
- o performs the underwater portion of the inspection;
- o takes underwater photographs as required;
- o provides transits and qualified transit operators to conduct the mooring buoy survey with the assistance of the EIC who will verify the accuracy of the survey readings while on site;
- o submits all inspection data, notes, and inspection-related film to the EIC prior to departing the site; and
- o accompanies and assists the EIC in briefing station personnel.

3.2 General Inspection Procedures.

3.2.1 Chain Wire Diameter Sampling. Chain wire diameter measurements are used to evaluate the condition of a mooring. After the chain is cleaned to bare metal, a selective sampling of the wire diameter of chain links and connecting hardware is taken to determine the amount of deterioration due to corrosion and wear.

- o "SINGLE LINK" measurements are taken where chain is slack; detect corrosion loss.
- o "DOUBLE LINK" measurements are taken where two links connect under tension; detect the combined effects of corrosion and wear.
- o Chain links and components which measure 90 percent or greater of original wire diameter are considered to be in "GOOD" condition.
- o Chain links and components with measurements between 80 and 90 percent of original wire diameter are considered to be in "FAIR" condition and are cause for the mooring to be downgraded in classification.
- o Chain links and components with measurements less than 80 percent of original wire diameter are considered to be in "POOR" condition and are cause for the mooring to be declared unsatisfactory for fleet use.

Annex B contains detailed information on the use of measuring devices to determine accurate wire diameter sampling. Table 2 contains chain measurements.

3.2.2 <u>Inspection Limits</u>. Anchor legs and risers are observed only to the point at which they enter the bottom. Per standard underwater inspection procedures, no attempt is made to locate and inspect anchors or other mooring materials which are buried.

3.3 <u>Buoy Inspection Procedures</u>.

3.3.1 <u>Upper Portion of Buoy</u>. The buoy shall be inspected to determine its general condition. The SIZE of the buoy (diameter and height) shall be recorded along with its FREEBOARD (the distance from the water line to the upper edge of the buoy hull). Physical damage such as HOLES, DENTS, or LISTING shall be reported.

Most mooring buoys have one to three FENDERS, mounted on the side of the buoy hull to reduce damage in the event of a collision with a vessel attempting to tie up to the mooring. In addition, most buoys have one or more CHAFING

Table 2. Chain Measurements (80 - 90 Percent of Original Wire Size)

Original Wire Diameter (in)	Overall Length of Link (in)	Single Link Measurement				Double Link Measurement			
		90 Percent		80 Percent		90 Percent		80 Percent	
		Decimal (in)	Fraction (in)	Decimal (in)	Fraction (in)	Decimal (in)	Fraction (in)	Decimal (in)	Fraction (in)
4	24	3.6	3 5/8	3.2	3 1/4	7.2	7 1/4	6.4	6 3/8
3 1/2	21	3.15	3 1/8	2.8	2 3/4	8.3	6 1/4	5.6	5 5/8
3	18	2.7	2 3/4	2.4	2 3/8	5.4	5 3/8	4.8	4 3/4
2 3/4	16 1/2	2.475	2 1/2	2.2	2 1/4	4.95	5	4.4	4 3/8
2 1/2	15	2.25	2 1/4	2	2	4.5	4 1/2	4	4
2 1/4	13 1/2	2.025	2	1.8	1 3/4	4.05	4	3.6	3 5/8
2	12	1.8	1 3/4	1.6	1 5/8	3.6	3 5/8	3.2	3 1/4
1 3/4	10 1/2	1.575	1 5/8	1.4	1 3/8	3.15	3 1/8	2.8	2 3/4
1 1/4	7 1/2	1.125	1 1/8	1	1	2.25	2 1/4	2	2
3/4	4 1/2	0.675	5/8	0.6	5/8	1.35	1 3/8	1.2	1 1/4

RAILS or STRIPS attached to the buoy top. These rails prevent damage to the top deck of the buoy by a ship's mooring chain. Figures 6 and 7 contain schematic drawings of different types of fender/chafing systems. The type, condition, and location of all fendering/chafing material shall be recorded.

The majority of fleet mooring buoys have steel hulls. Most of these are covered with three to four coats of PAINT, but a considerable number are primed and then covered with about a 3/16-inch FIBERGLASS COATING. If properly applied, this coating eliminates rusting, reduces the subsequent deterioration of the buoy's hull, and prolongs the buoy's operational life. The type and condition of the buoy coating should be recorded. In addition, the number and location of the HATCHES shall be recorded and a check made to see if they have been fiberglassed.

Buoy TOP JEWELRY shall be measured with calipers to find the overall outside dimensions and areas of most severe reduction in wire size. (See Annex B.3 for the proper use of calipers.) Each component will be identified and a sketch made of its position relative to other components. A detailed inspection checklist is contained in Annex A.1.

3.3.2 Lower Portion of Buoy. Divers shall thoroughly inspect the buoy below the waterline. The thickness of MARINE GROWTH shall be recorded, but to prevent damage to the buoy's coatings, no attempt will be made to clean the hull or bottom. If the buoy is a riser type with a hawsepipe, the presence and condition of the RUBBING CASTING shall be recorded. The rubbing casting consists of two steel parts bolted to the chain in the hawsepipe. Its purpose is to reduce chain wear caused by the chain rubbing against the hawsepipe. If the buoy is cathodically protected, the condition, dimensions, and connection of ANODES are to be noted. Electrical potential readings are to be taken with an underwater voltmeter at three locations on the buoy bottom. However, fiberglass coated buoys should not be probed with a voltmeter. See Annex D for the proper use of the underwater voltmeter.

The BOTTOM JEWELRY connecting the buoy to the riser shall be identified and measured with calipers. As with the topside jewelry, the overall dimensions and the smallest wire size of each type of link or shackle will be recorded. A detailed checklist of the items to be inspected is contained in Annex A.2.

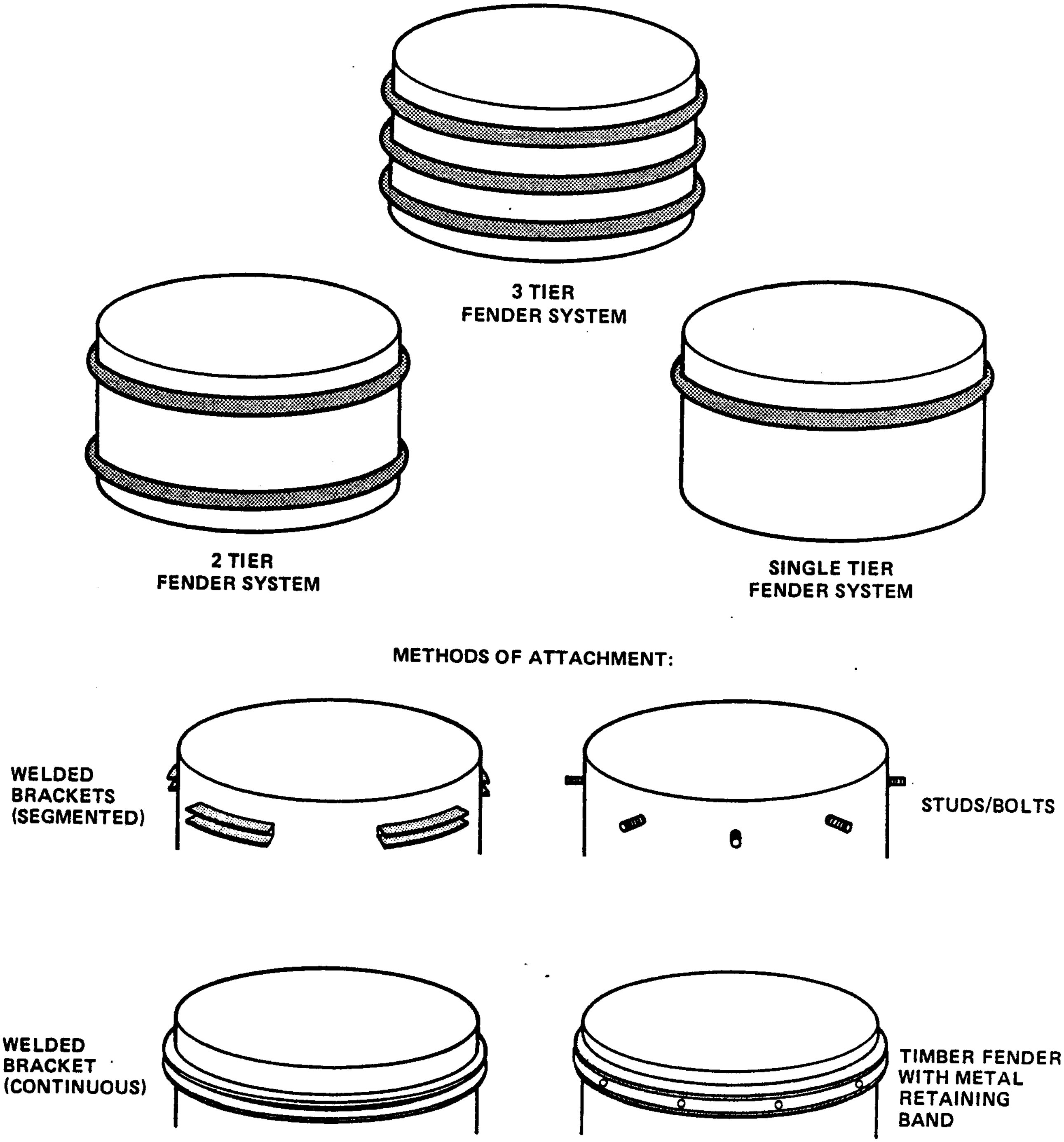


FIGURE 6. FENDER SYSTEMS

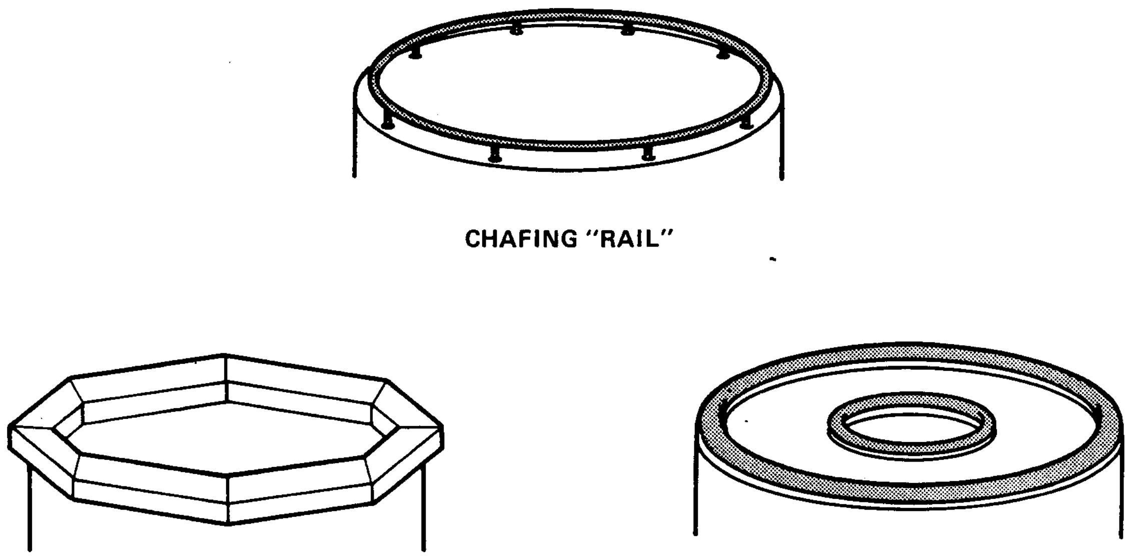


FIGURE 7. FENDER/CHAFING SYSTEMS

3.4 Riser Chain Subassembly.

3.4.1 Types of Chain. The riser chain and the anchor leg chain are constructed of either CAST, FORGED, or DILOK chain. Cast chain consists of a solid piece of material formed by pouring molten steel into a mold. Forged (or welded) chain is manufactured from steel rods which are heated and bent into the shape of a link. The two ends are then flash butt welded and a stud subsequently installed. This type of chain link can be identified by the flash welded seam in the link and the separately installed stud. A Dilok chain link is formed by forging together male and female ends of a link. This type of link is readily identified due to the seam on each side of the link where the two ends were pressed together. The type of chain links in each section of chain should be noted. See Figure 8 for diagrams of the various types of chain.

3.4.2 Chain Components. A riser chain subassembly should contain a SWIVEL which could be joined into position within the chain by two detachable chain links. The purpose of the swivel is to permit a ship to swing 360 degrees around a buoy without twisting the riser chain.

DETACHABLE (or joining) chain links can be used to manually attach or detach sections of chain or chain accessories. All connecting links and swivels shall be inspected for loose or missing parts and the depth of each recorded.

3.4.3 Measurements. Three consecutive DOUBLE LINK measurements using pre-cut GO/NO-GO gauges will be made at both ends and near the center of the riser. (See Annex B.1 for the proper use of GO/NO-GO gauges.) If the riser consists of more than one shot of chain, then wire diameters of both ends and the center of each shot will be measured, depth permitting.

To determine original chain sizes (wire diameter), the LENGTH of a chain link shall be measured at each inspection point. The length of a chain link does not often vary and, since it is equivalent to six times the chain's diameter when manufactured, this measurement can be used to determine the link's original wire diameter.

Material suspected to be worn or damaged will be thoroughly investigated to determine the exact extent of the damage. A nylon cable tie should be attached to any damaged link or component for later reference.

3.4.4. Ground Ring. The GROUND RING shall be examined for general and localized wear. Caliper measurements shall be made of both the wire size in the region of most severe wear and across the inner diameter. The DEPTH of the ground ring shall be recorded. By design, the ground ring should be 10 feet above the bottom at high tide. The COMPONENTS (shackles, joining links, detachable links, etc.) connecting the ground ring to the riser and the anchor legs will be identified, measured, and photographed if damaged. A detailed checklist is found in Annex A.4.

3.5 Anchor Chain Subassembly.

3.5.1. Measurements. Three consecutive DOUBLE LINK measurements of the two ends and center of each anchor leg shot shall be taken. If the leg chain should enter the mud and less than a shot is visible, measurements shall be taken at

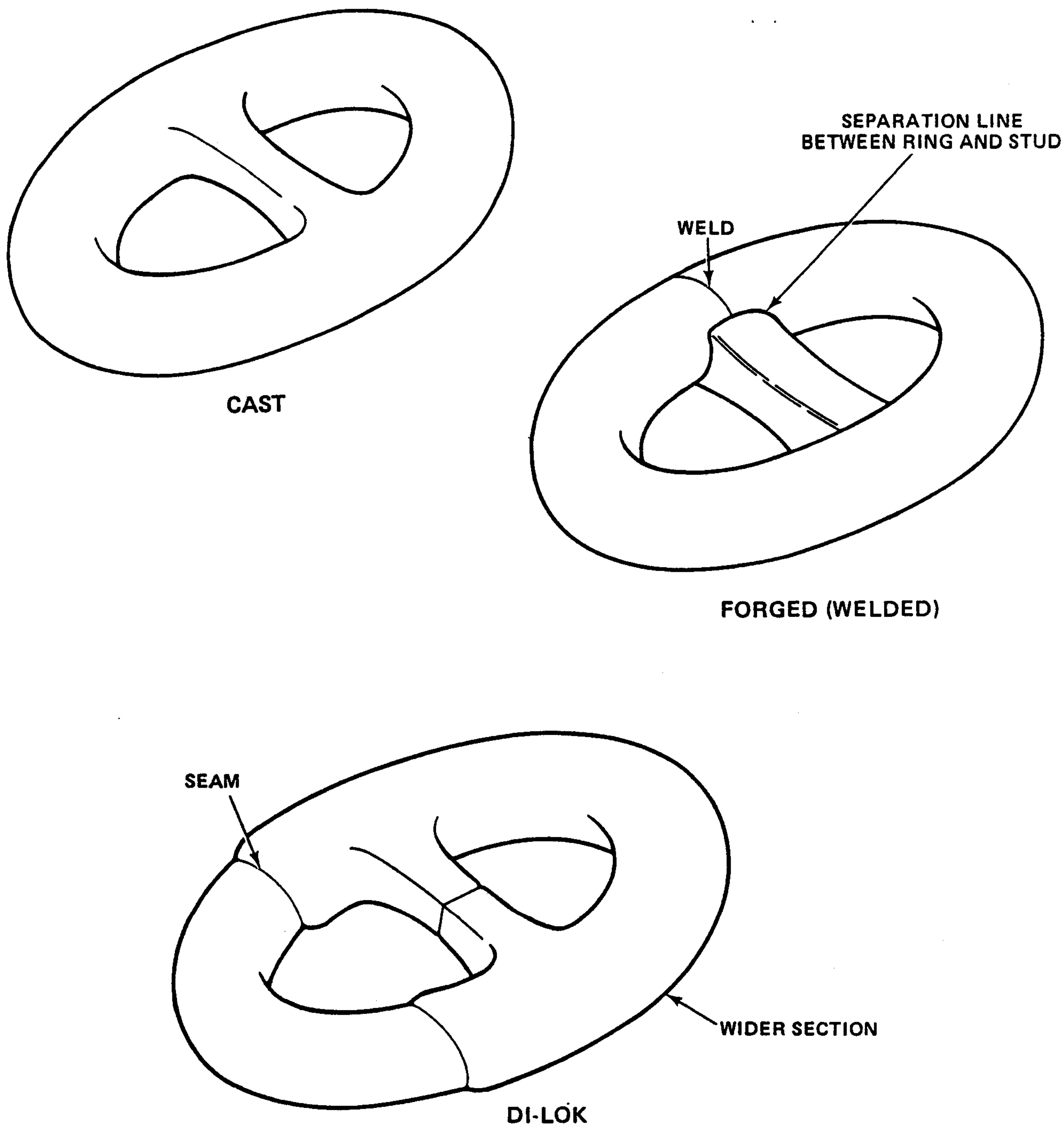


FIGURE 8. TYPICAL CHAIN LINKS

the upper end, where it enters the bottom, and halfway in between. In those cases where the leg chain is not in tension, SINGLE LINK measurements shall be taken. All CONNECTING HARDWARE, including detachable links, anchor joining links, pear links, end links, swivels, and shackles shall be identified and measured with calipers. A sketch of their arrangement should be made. Worn hardware and unusual chain joining practices shall be recorded and photographed. The type of chain comprising the anchor legs (cast, forged, or Dilok) shall be noted. Note if the chain snakes across the bottom, indicating lack of tension, or if the chain has crossed itself or formed a tangled ball. A detailed checklist is contained in Annex A.5.

3.5.2. Leg Orientation. The orientation of the legs in relation to compass north shall be determined as detailed in Figure 9. The LEG ORIENTATION will indicate whether or not the anchors are positioned in the proper location to provide adequate holding for the mooring. Ideally, three anchors and legs should be spaced 120 degrees apart.

3.6 Anchor Subassemblies. If an anchor is located, a pop float should be attached to it so that the relative position of the anchor to the mooring buoy can be observed and recorded from the surface. The HARDWARE connecting an anchor to the anchor leg (shackle, anchor joining link, etc.) shall be measured with calipers, and their wire diameters and overall condition recorded. The type of anchor and its condition shall be recorded. The reason for its visibility should be investigated. A detailed checklist is contained in Annex A.6.

3.6.1 Propellant Embedment Anchors (PEAs). This relatively new anchor has been used in a number of recent mooring installations. An anchor fluke is emplaced in a gun assembly. The entire assembly, consisting of the gun (launch platform), downhaul cable, and anchor fluke is lowered to the bottom. The gun is fired, and the fluke, depending upon the material of the ocean bottom, is driven 10 to 40 feet into the subsurface strata. Attached to the fluke is a wire rope downhaul cable (1 to 3 inches in diameter). The upper end of this downhaul cable is connected to a wire rope pendant and the anchor leg subassembly or directly to the chain by swage and shackle fittings (see Figure 10).

During an underwater inspection, PEAs will not be visible. However, all SWAGE FITTINGS shall be checked for loose or missing parts. The size of the JAW shall be measured and recorded to verify the as-builts. The point that the wire rope enters the swage fitting shall be checked for bends, kinks, or "bird caging." This is the area in which working of the wire rope is likely to occur. A reduction in the diameter of the wire rope, called "necking down," should be noted. This indicates the development of corrosion cells. The length of the wire rope downhaul cable shall be measured and checked for wear at the point it enters the bottom. In addition, any evidence of wire movement on the bottom shall be recorded. A detailed checklist is contained in Annex A.7.

3.6.1.1 Chain Equalizers. PEA systems often include CHAIN EQUALIZERS. Although equalizers contain no movable parts, they do resemble large pulleys. The chain is free to slide back and forth through the equalizer so that each of the ends of the chain are under equal tension. During an underwater inspection, the equalizers should be checked for corrosion, wear, and marine growth within the equalizer itself. A large amount of growth could indicate that the chain is not being worked through the equalizer. See the checklist in Annex A.8.

3.7 Cathodic Protection Systems. The cathodic protection system used on fleet moorings consists of an ANODE (usually 250 or 500 pounds of zinc) connected to the metal of the buoy or chain via an electrically sound mechanical connection. The zinc is anodic to the steel (more electrochemically negative) and therefore will sacrificially corrode, protecting the steel.

The anode is capable of protecting metal several feet from itself by the amount of "throwing power" it has (the area over which the galvanic cell can be established). To increase the amount of chain protection, continuity cables are attached to the anode, woven through the chain, and attached as much as 20 feet from the anode. In this manner, a shot of chain can be protected by a single anode. Wire clips, hose clamps, or "U" bolts have been used to attach the continuity cable to about every eighth link of the chain.

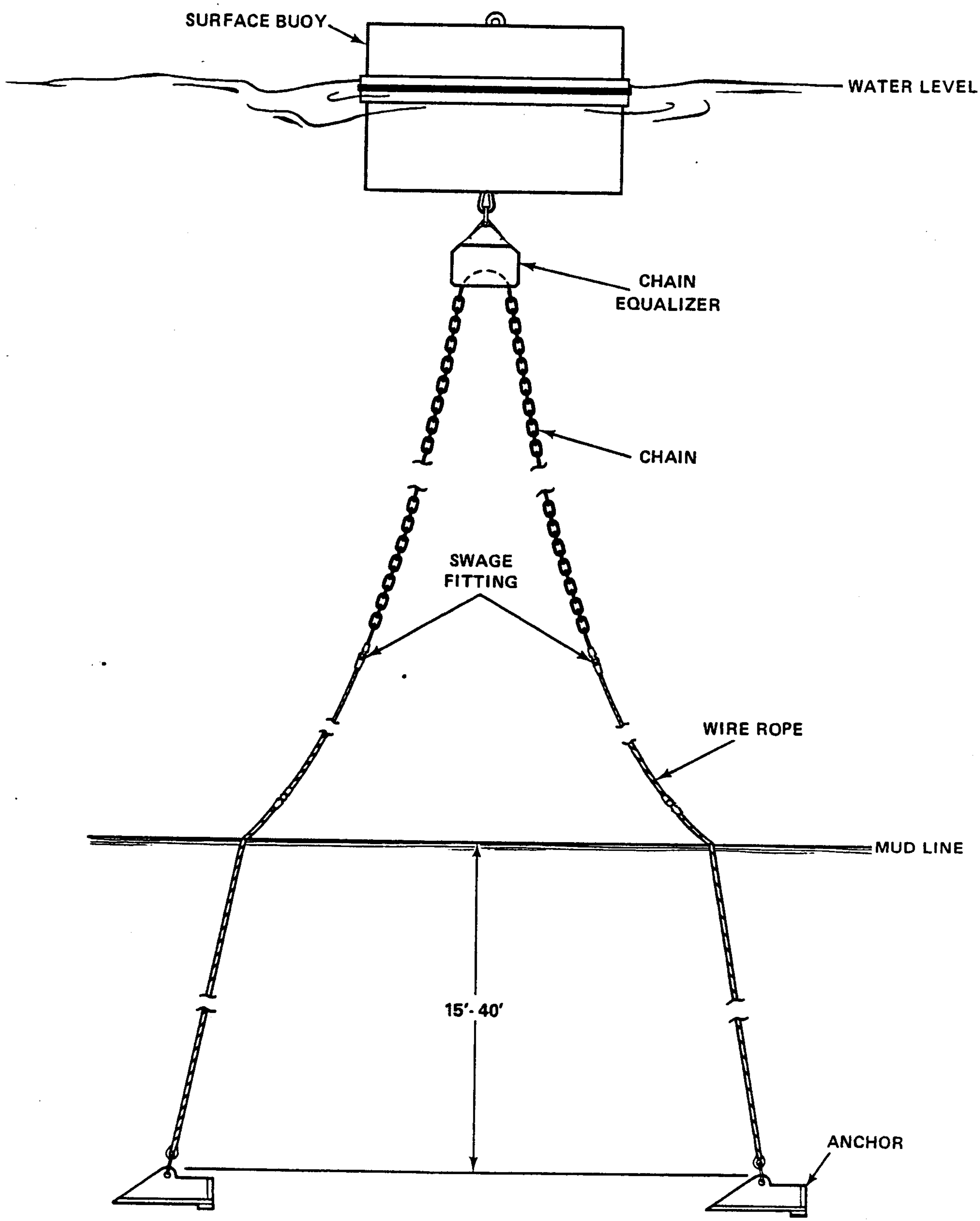


FIGURE 10. TYPICAL PEA MOORING

An UNDERWATER VOLTMETER is used to measure the potential of various areas on the chain and to check how well it is being protected by an anode. Chain that is cathodically protected should have potential readings between -0.80 and -0.90 V. Typically, the largest potentials (-0.85 to -0.90 V) will be near the anode and the smallest (-0.80 to -0.85 V) will be at each end of the continuity cable (see Figure 11). In addition, it is necessary to measure the remaining zinc. The anode and cable must be checked for secure attachment and the loss of zinc due to corrosion shall be noted. The anode should be checked to determine the type and color of the oxidation deposit on its surface. A white coating indicates that the anode is working properly. A black coating, or no coating at all, indicates that the anode is not working. These observations are to be recorded by the diver.

The underwater voltmeter is used to probe the chain every 20 feet commencing with the buoy and bottom jewelry and continuing until the anchor is reached or the chain disappears into the bottom. All potential measurements and their location will be recorded. Before cleaning, divers will record coating thickness, type, and accumulation. Several anodes should be brushed to remove oxidation and length, width, and depth of the remaining zinc measured and photographed. Anodes in poor condition should be measured, reported, photographed, and their color recorded. See Annex D for the proper use of the underwater voltmeter. A detailed checklist is contained in Annex A.9.

3.8 Catenary Profiles. Typically, with ARDM and AFDB moorings, it is necessary to check the catenary of the chain assemblies. Divers gather data required to determine the catenary profile through the use of an inclinometer and a depth gauge. Starting just below the buoy in the case of a Mediterranean type of mooring, or at the waterline in an ARDM type mooring, divers should measure and record the chain angle and depth every 25 feet until it enters or reaches the bottom. A pop float will then be attached to the chain where it reaches the bottom and a surface measurement taken to determine the distance between the center of the buoy and the pop float. With these measurements, the catenary of each chain assembly is determined. See Annex B.4 for the proper use of an inclinometer.

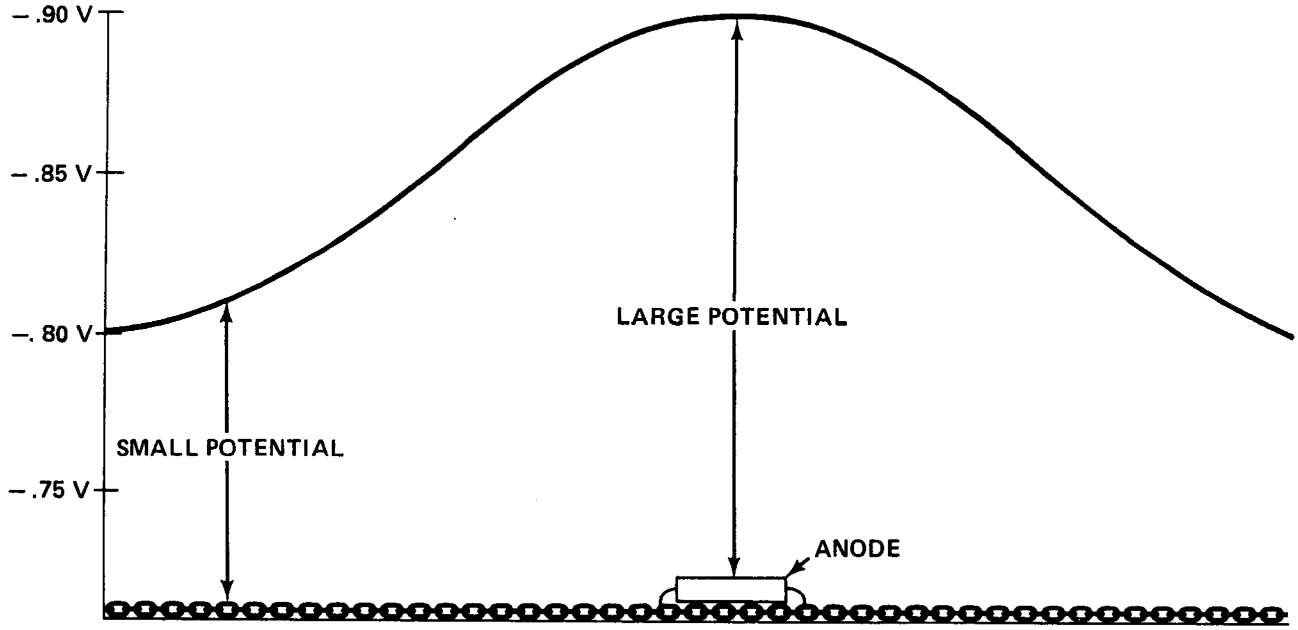


FIGURE 11. CATHODIC PROTECTION SYSTEM POTENTIALS

3.9 Location Survey. A mooring system not in the position indicated by the latest available information could mean:

- o the mooring was not installed in the designated location;
- o the mooring has been dragged off location and may have adversely affected the orientation of the anchor legs; or
- o damage has occurred to the anchor legs.

To determine if one or more of these problems exist, a detailed survey of the mooring's location shall be made.

The dive team shall provide qualified transit operators and all equipment necessary to conduct a survey of each of the onsite buoys (see Section 2.3.2). With the assistance of the mooring activity's personnel and the EIC, the transit operator will determine the proper benchmarks, backsights, and landmarks utilized during each of the buoy surveys. The survey should be conducted precisely, and the highest degree of accuracy, based on the equipment used, should be obtained. See Annex E for survey procedures and techniques.

3.10 Post Inspection Briefing. The EIC should contact CHESNAVFACENGCOM personnel, if possible, and brief them on inspection findings prior to briefing appropriate station personnel. These briefings include the general condition of each mooring inspected, specific problem areas uncovered, and in particular, data concerning those moorings that should be downgraded or are found to be unsafe for further fleet usage.

4.0 DOCUMENTATION

The inspection of fleet moorings occurs in the field, but the actual evaluation of the mooring's condition takes place at CHESNAVFACENGCOM. In order to relate the findings of the inspection to CHESNAVFACENGCOM, all data must be thoroughly documented. Photographs and field notes, as well as link measurements, will prove invaluable in making a proper evaluation. All possible information regarding a mooring must be documented and returned to CHESNAVFACENGCOM.

4.1 Photography.

4.1.1 Surface Photography. The EIC is responsible for all above water photography. For archival consistency, 35mm color slide film shall always be used. Photographs provide an inspection record verifying unique or abnormal observations. These photographs should be available to support the Inspection Report findings and recommendations. Whenever possible, all film should be developed on site to assure photographic quality.

4.1.1.1 Mooring Overall Views. A panoramic view of each mooring should be photographed showing the relationship of the buoy to the general area, other buoys, or landmarks. Because of the restricted nature of some mooring areas, photographs showing ships in the background should be avoided.

A photograph should be taken of any buoy damage or list, and of its markings and fendering system. This photograph will help the EIC identify detail photos of the mooring that will follow.

4.1.1.2 Damage Areas. Any damage to the buoy, its surface coatings, or fenders should be recorded. Damage such as holes, dents, fiberglass cracks, separation or bubbles, and corrosion areas should be photographed.

4.1.1.3 Topsides. Photograph any unusual, worn, damaged, or extraneous hardware. If a ship is moored, photograph the method of attachment. Photograph the type of chafing strips and an overall shot of the buoy surface. A scale (such as a ruler or dive knife) should be included in every photograph of a mooring's detail.

4.1.2 Underwater Photography. All underwater photography is the responsibility of the UCT Detachment. To standardize the photographic archives, 35mm color slide film shall be used. A flash shall be used in all underwater photography to compensate for low light levels. It is highly recommended that the flash be separated from the camera as far as possible to reduce back scatter. In addition, the use of a medium wide angle lens (24 to 35mm) is recommended. A lens of this size will permit the photographer to hold onto the chain and still cover the entire subject matter. It will also reduce the amount of suspended material between the camera and the chain. To facilitate the preparation of the preliminary Inspection Report all inspection related film shall be submitted to the EIC before leaving the site.

4.2 Data Recording.

4.2.1 Field Record Book. The EIC should maintain a "Field Record Book" during the inspection. This can be a hard- or soft-backed, looseleaf, or bound notebook. In it, the EIC will document the inspection procedures used and record the data obtained by the dive team. Additional or alternative inspection procedures deemed necessary during the course of the inspection must be documented. A time log of events occurring during the inspection shall be recorded.

This book should also contain information concerning:

- daily weather/environmental conditions;
- the names of the dive platform and crew;
- name and rank/rate of each dive team member;
- daily diving (start/stop) times and the names of the divers involved;
- underwater observations and data gathered;
- EIC surface observations;
- all mooring buoy survey data including benchmark positions, bearings to buoys, backsights used, etc.;
- details of all dive team briefings/debriefings;
- details of discussions with station personnel; and
- other daily events affecting mooring inspections.

4.2.2 Inspection Data Forms. See Annex C for an example of the proper method of completing the data form. These forms summarize the data contained in the "Field Record Book." They are the basis for the development of accurate mooring as-builts and for the preparation of the Inspection Report containing results of the inspection and recommendations for corrective maintenance actions.

5.0 POST INSPECTION PHASE

5.1 CHESNAVFACENGCOM Briefing. After completion of the scheduled inspection and return to CHESNAVFACENGCOM, the EIC will brief FPO-1 personnel on the preliminary inspection results. This briefing should contain information similar to that provided to the cognizant activity's personnel prior to the EIC departing the inspection site. The briefing will include the general condition of each mooring inspected, specific problem areas, and in particular, data concerning those moorings that should be downgraded or were found to be unsafe for further fleet usage. The briefing should be augmented with the surface and underwater photographs.

A detailed evaluation of the data will then be made to fully assess mooring condition. Appropriate action such as downgrading, reclassifying, repairing, or overhauling the mooring shall be recommended.

5.2 Preliminary Inspection Report. Upon completion of the evaluation, the EIC will prepare a naval message containing the inspection results. This message will be addressed to the activity whose moorings were inspected. Information addressees shall include COMNAVFACENGCOM, the cognizant Engineering Field Division (EFD), the inspection team, and COMCBPAC/COMCBLANT.

5.3 Inspection Report. When the analysis of the data is completed, the EIC will prepare a Fleet Mooring Inspection Report for submittal by CHESNAVFACENGCOM to the activity responsible for the inspected moorings with copies to COMNAVFACENGCOM, the inspection UCT, and the cognizant EFD. This report will include:

- a detailed evaluation of each mooring and specific recommendations for mooring maintenance actions;
- an update of the mooring as-builts; and
- a report on geographic location of the moorings.

5.4 Archives. At the completion of the inspection project, the EIC will organize, label, and submit to CHESNAVFACENGCOM (FPO-1) all files, data, photographs, slides, etc., for inclusion into the Fleet Mooring Maintenance Program archives and data base files.

These files will be maintained and updated whenever mooring information (such as repairs or overhauls) becomes available. When the next inspection is scheduled, it will be from this data that the EIC will begin his investigation.

ANNEX A

INSPECTION CHECKLIST

ANNEX A

INSPECTION CHECKLIST

A.1 <u>UPPER PORTION OF BUOY</u>. (Paragraph 3.3.1)

a. <u>Overall Condition</u>

- o Record buoy type (Drum, Peg Top, etc.), (Paragraph 1.6).
- o Measure and record buoy diameter and freeboard to the waterline.
- o Report any visible damage or listing. If the buoy is listing, determine which inner compartment has water in it.
- o Report the color and markings. Ensure that the identification number on the buoy is the same as that depicted on navigation charts; if not, report it.
- o Record a brief objective view of the buoy's general condition.

b. <u>Fiberglass Coating</u>

- o Report hull dents or separation of the fiberglass from the buoy. The metal could be indented and the fiberglass look undamaged.
- o Report peeling or loose seams and/or edges. Fiberglass will often fail there first.
- o Report any rust bleeding as this indicates trapped moisture between the fiberglass and the buoy's hull.
- o Report blisters, bubbles, cracks, checking, or glazing that may be hidden under paint.

c. <u>Painted Surfaces</u>

- o Report spalling, cracking, peeling, and blisters.
- o Report lack of full paint coverage of the buoy and/or paint discoloration due to chemical reactions or rust bleeding.

d. Top Jewelry

- o Identify each component and prepare a sketch depicting the location of each within the top jewelry.
- o Measure and record the length and wire diameter of each component. (See Annex B.3 for the proper use of calipers.)
- o Report any wear or corrosion of jewelry components.

e. Fenders/Chafing Strips

- o Record the number and location of each (see Figures 6 and 7).
- o Record the method of fender/chafing strip attachment (see Figures 6 and 7).
- o Check for and report any loose, rusted, or broken attachments or bolts.
- o Check the welds securing the fender/chafing strip mounting brackets to the buoy hull and report any cracks or separation of the welding material from the parent metal.
- o Ensure that drainage holes through the chafing strips are open and not clogged with debris.

(1) Timber

- o Report any splintering, dry rot, worm/borer holes, or broken sections.
- o Record paint type and condition.

(2) Rubber

- o Check for and report any rubber brittleness or cracking.
- o Record any tears, or damaged or missing sections.

(3) Steel Pipe Chafing Rail

- o Record pipe rail diameter and height above the deck.
- o Check for rust and a secure attachment at the base of the stanchions and rust on the underside of each horizontal rail.
- o Record any damage such as dents, fractures, or loose parts in which a line may foul.

f. Manhole Covers

- o Report the number, size, and location of each manhole.
- o Report rusting of the covers and/or bolts. The edges of the covers may show a "delamination" of the steel.
- o Check for and report any loose or missing bolts.
- o On fiberglass coated buoys, report whether the manhole covers are fiberglassed or not.

g. Tension Bar

- o Check eye for wear and measure its diameter with calipers.
- o Measure steel bar thickness.
- o Check base plate for cracks, warping, or other damage.
- o Record plate thickness.

h. Hawsepipe

- o Measure and record wire diameter and condition of the chain held in place by the retaining plate.
- o Check for and report bell mouth rusting or wear.

A.2 LOWER PORTION OF BUOY (UNDERWATER). (Paragraph 3.3.2)

a. Lower Fender

- o Record fender material.
- o If timber, report any splintering or broken/missing sections.

- o If rubber, report any tears, rips, or missing sections.
- o If visible, record fender attachment method (see Figure 6).
- o Check for and report any rusted, loose, or broken attachments or bolts, or evidence of corrosion problems.

b. <u>Buoy Bottom</u>

- o Record marine growth thickness.
- o If there is no appreciable marine growth, check and record the type and condition of the protective coating (paint or fiberglass).
- o Report any dents or other bottom hull damage.

c. <u>Tension Bar</u>

- o Check lower tension bar eye for wear and measure its wire diameter with calipers.
- o Check retaining plate and report any observed wear or warping.

d. <u>Hawsepipe</u>

- o Measure and record chain wire diameter at the bottom of the hawse-pipe.
- o Check and report rubbing casting wear. If the rubbing casting is missing then check for rusting and wear of the bell mouth.
- o Ensure that chain is securely attached to rubbing casting.

e. <u>Bottom Jewelry (Tension Bar Type Buoy Only)</u>

- o Identify and report each type of component between lower tension bar eye and riser chain.
- o Measure and record component length and wire diameter.
- o Report any observed wear or corrosion.

f. Cathodic Protection System on Buoy

- o Record number, size, and location of installed anodes.
- o Ensure that each anode is securely attached to buoy.
- o Using an underwater voltmeter, probe buoy bottom in at least three positions and record the potentials. (See Annex D for the proper use of an underwater voltmeter.)

A.3 RISER CHAIN SUBASSEMBLY. (Paragraph 3.4)

a. Links

- o Record chain type (cast, forged, Dilok) (see Figure 8).
- o Using appropriate tools, clean the following for measurements:
  - (1) first three links below bottom jewelry;
  - (2) three links just above ground ring;
  - (3) three links about halfway in between these two areas; and
  - (4) If the riser contains more than one shot of chain, clean links and take measurements at both ends and near the center of each shot.

In a non-riser type mooring clean:

- (1) first three links of each leg just below buoy's padeyes;
- (2) three links just above mud line; and
- (3) three links about halfway in between.

- o Take and record double link measurements of cleaned links. (See Annex B.1 for the proper use of GO/NO-GO gauges.)
- o Record length of one of the links cleaned at each area.
- o Check for and record manufacturer's markings.
- o Check for pitting, measure diameter and depth of any pits found, and record results.
- o Record water depth below buoy where each measurement is taken.

b. Connecting Hardware

- o If visible, identify and record type of each (shackle, detachable link, anchor joining, etc.). Detachable links should be found on either side of the shackle and at the top and bottom of each chain shot (see Annex F).
- o Record component's overall length and wire diameter.
- o Report any loose, broken, or missing parts. If visible, note condition of tapered locking pin in a detachable link.
- o Record water depth below buoy of each connecting component.
- o Record any manufacturer's markings.

c. Swivel

- o Each riser subassembly should contain a swivel. Record swivel depth.
- o Check swivel for marine growth.
- o Record any manufacturer's markings.

A.4 GROUND RING. (Paragraph 3.4.4)

- o Three typical types of ground ring assemblies are:

  (1) a ground ring with four pear links attached;
  (2) a ground ring with four anchor joining links; and
  (3) a ground ring with four shackles.

  Record type of ground ring assembly observed.

- o Measure and record inside diameter (ID) of ring.
- o Check and report any distortion of ring from circular which would indicate overstressing.
- o Record height of assembly above bottom, or if the water is too deep, record depth below buoy.

- o Using calipers, measure wire diameters of links attached to the ground ring and record results.
- o Record any manufacturer's markings.

A.5 ANCHOR CHAIN SUBASSEMBLY. (Paragraph 3.5)

a. Links

- o Record chain type installed (cast, forged, Dilok) (see Figure 8).
- o Using appropriate tools, clean the following for measurements:

  (1) first three links of each leg below the ground ring;
  (2) three links above mud line; and
  (3) three links about halfway in between these two areas.

- o Measure and record double link measurements of the cleaned links. (See Annex B.1 for proper use of GO/NO-GO gauges.) If one or more legs should extend considerable distances before entering the bottom, clean links and take measurements at both ends and near center of each shot visible. If chain is not in tension, single vice double link measurements should be taken and recorded.
- o Record length of one of the links at each area.
- o Check for and record manufacturer's markings.
- o Check for pitting, measure diameter and depth of any pits found, and record results.
- o Record each anchor leg length from ground ring to bottom and from where it touches bottom to the point it becomes buried.
- o Using a compass, note and record the relative bearing of each leg from the ground ring (see Figure 9).

b. Connecting Hardware

- o Identify and record component type (shackle, detachable link, anchor joining, etc.)(see Annex F).

- o Record component's overall length and wire diameter.

- Report any loose, broken, or missing parts.
- Record any manufacturer's markings.
- Record position of each connecting component by leg number and number of feet from ground ring.

c. <u>Swivel</u>

- Each anchor leg subassembly may contain a swivel. If located, record position by its leg number.
- Record any manufacturer's markings.

A.6 <u>ANCHOR SUBASSEMBLY (If Visible)</u>. (Paragraph 3.6)

a. <u>Anchor</u>

- Identify and record type (STATO, Navy Stockless, Light Weight, etc.). Note whether or not anchor has stabilizers.
- Attach a pop float and record its bearing from the buoy using a compass.
- Determine and record anchor's orientation, i.e., flukes buried, flukes up, anchor on its side, anchor facing the wrong direction, etc.

b. <u>Connecting Hardware</u>

- Identify and record component type and location.
- Record component's overall length and wire diameter.
- Report loose, broken, or missing parts.

A.7 <u>PROPELLANT EMBEDMENT ANCHORS</u>. (Paragraph 3.6.1)

a. <u>Swage Fittings</u>

- Check for any loose, broken, or missing pins or parts.
- Check for fraying of the wire rope pendant where it enters the swage fitting and report any noted.

b. Pendant/Down Haul Cable

- o Measure and record the wire diameter.
- o Check for fraying, kinking, "birdcaging," or rusting of the cable and report any noted. Look for a "necking down" of the wire that may indicate the existence of a corrosion cell.
- o Record the amount (in feet) of wire pendant visible between the anchor leg and the point that the pendant enters the bottom.
- o Report any evidence of pendant cable movement on the bottom.

A.8 EQUALIZER. (Paragraph 3.6.1.1)

- o Check for rust and wear.
- o Note the amount of marine growth located within the equalizer.

A.9 CHAIN CATHODIC PROTECTION SYSTEM. (Paragraph 3.7)

a. Anodes

- o Record anode size and location on the chain.
- o Observe and record anode condition and determine whether or not its consumption is uniform.
- o Record the color and estimate the thickness of the oxidation coating.
- o Ensure secure attachment to the chain and the continuity wire.
- o Using an underwater voltmeter, measure and record the chain's potential. (See Annex D for the proper use of an underwater voltmeter and the areas to probe on the chain.)

b. Continuity Cables/Clips

- o Check and record cable's secure connection to the chain.
- o Probe chain every 20 feet until anchor is reached or chain disappears into the bottom and record the potentials.

A.10 PHOTOGRAPHY. (Paragraph 4.1)

a. Surface Photography. A photograph should be taken of:

- o panoramic view of the mooring area;
- o each buoy including an identifying number;
- o buoy damage or listing;
- o fender or chafing strip damage;
- o top jewelry damage or unusual practices;
- o a method of attachment of the ship to the buoy (DO NOT INCLUDE SHIP IN PHOTO); and
- o surface coating damage.

b. Underwater Photography. A photograph should be taken of:

- o extreme marine growth (selective);
- o damaged or unusual bottom jewelry;
- o chain measurements (selective);
- o anodes damaged or before and after cleaning (selective);
- o diver using GO/NO-GO gauge or voltmeter (selective);
- o worn, damaged, or badly pitted chain or components;
- o chain in abnormal configuration (balled, crossed, etc);
- o anchors (if found);
- o swage fittings (selective or damaged); and
- o equalizers (selective or damaged).

ANNEX B

MEASURING DEVICES AND THEIR USES

ANNEX B

MEASURING DEVICES AND THEIR USES

B.1 GO/NO-GO GAUGES.

Prior to attempting measurement of chain wire diameter, a diver should measure the length of one link of the chain and report this measurement to the EIC. Since the length of a chain link is six times its wire diameter, the original wire diameter can be easily determined. Once this is accomplished the EIC will know which size gauge to give to the diver for the chain inspection.

If non-standard chain sizes are encountered, calipers should be used.

The preferred measuring devices are back-to-back 80 and 90 percent GO/NO-GO gauges. These gauges simplify the diver's job in that, unlike calipers, they have to be damaged to be knocked out of adjustment. The locations for measuring chain links are shown in Figure B-1. Figure B-2 contains the drawings and data required to fabricate these gauges. These gauges provide a simpler way of sampling the wire size of chain links and some jewelry.

To use the GO/NO-GO gauge on cast and forged chain, scrape the chain to remove all marine growth and heavy oxidation in the areas indicated in Figure B-1. For double link measurements the gauge is then pressed firmly onto the point of the chain where two links are in contact.

Where chain is slack, single link measurements are taken on the side of the chain as indicated in Figure B-1. Do not get too close to the stud because the chain is thicker in that area.

In addition, measure and record overall length of the link indicated in Figure B-1.

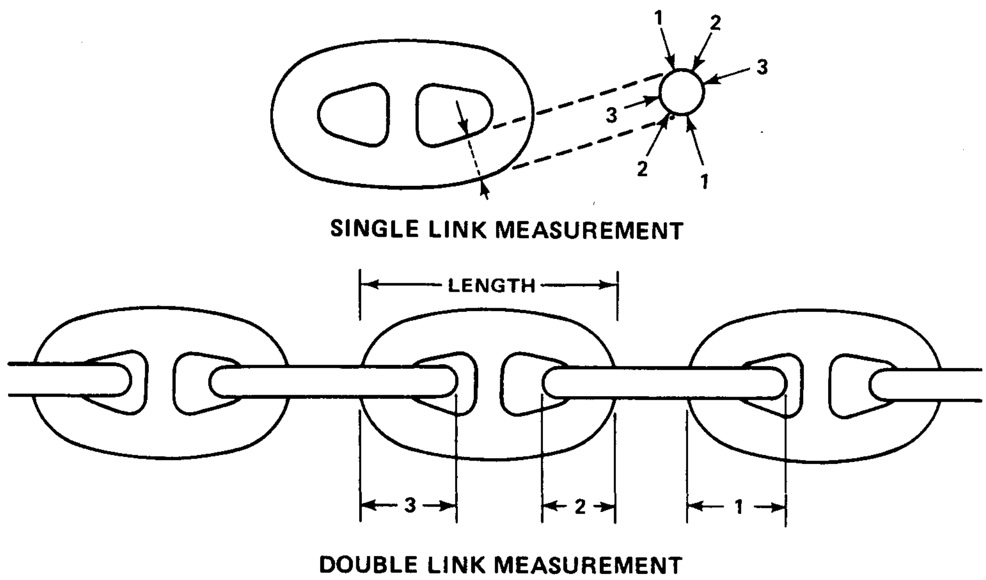
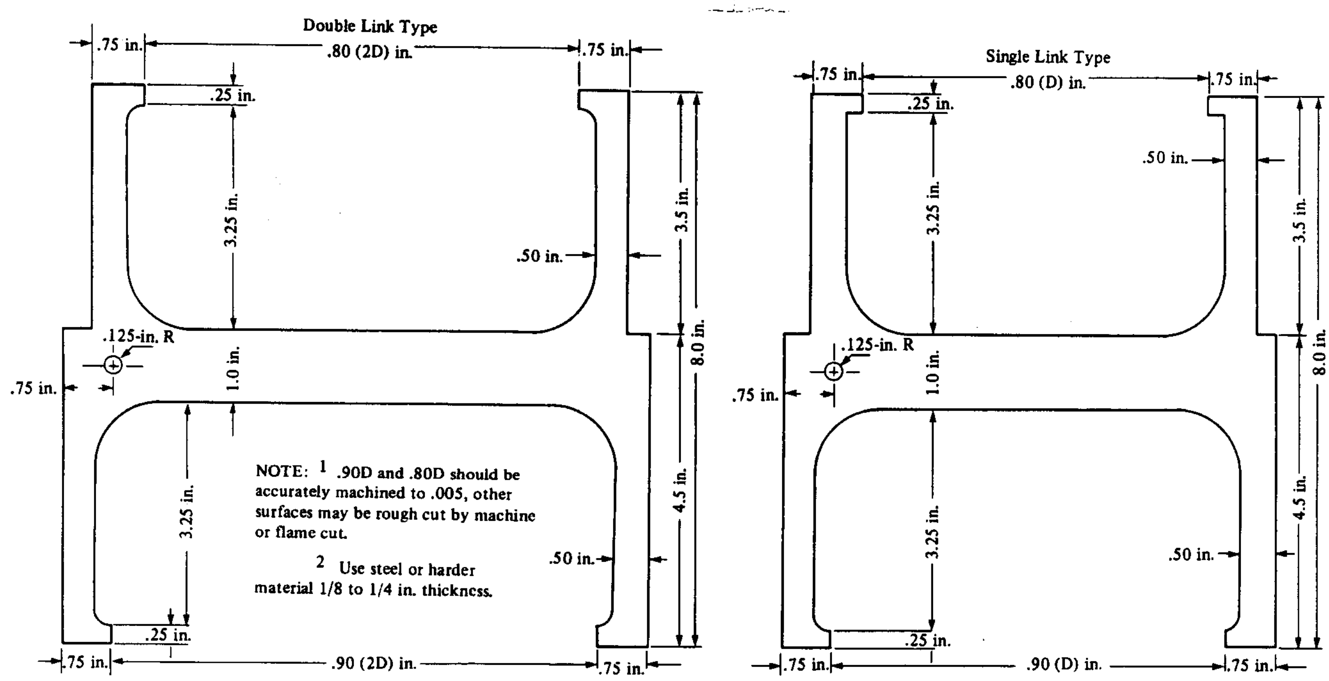


FIGURE B-1. LOCATIONS FOR TAKING CHAIN LINK MEASUREMENTS



D"	Single Link		Double Link		D"	Single Link		Double Link		D"	Single Link		Double Link	
	.90D	.80D	.90(2D)	.80(2D)		.90D	.80D	.90(2D)	.80(2D)		.90D	.80D	.90(2D)	.80(2D)
6-1/2	5.850	5.20	11.70	10.40	3-1/2	3.150	2.80	6.300	5.600	2	1.800	1.600	3.600	3.200
6	5.400	4.80	10.80	9.60	3	2.700	2.40	5.400	4.800	1-7/8	1.687	1.500	3.375	3.000
5-1/2	4.950	4.40	9.90	8.80	2-3/4	2.475	2.200	4.950	4.400	1-3/4	1.575	1.400	3.150	2.800
4-1/2	4.050	3.60	8.10	7.20	2-1/2	2.250	2.000	4.500	4.000	1-1/2	1.350	1.200	2.700	2.400
4	3.600	3.20	7.20	6.40	2-1/4	2.025	1.800	4.050	3.600	1-1/4	1.125	1.000	2.250	2.000

FIGURE B-2. 80/90 PERCENT "GO/NO-GO" GAUGES

B.2 MEASURING DILOK CHAIN.

Double link measurements of Dilok chain are taken in the same manner as forged and cast chain (see Section B.1). The difference is in taking the single link measurement. Due to the manufacturing process of Dilok, one side of the link is thicker than the other. When taking single link measurements, the measurement must be taken on the side indicated in Figure B-3. Take measurements at any accessible wear areas.

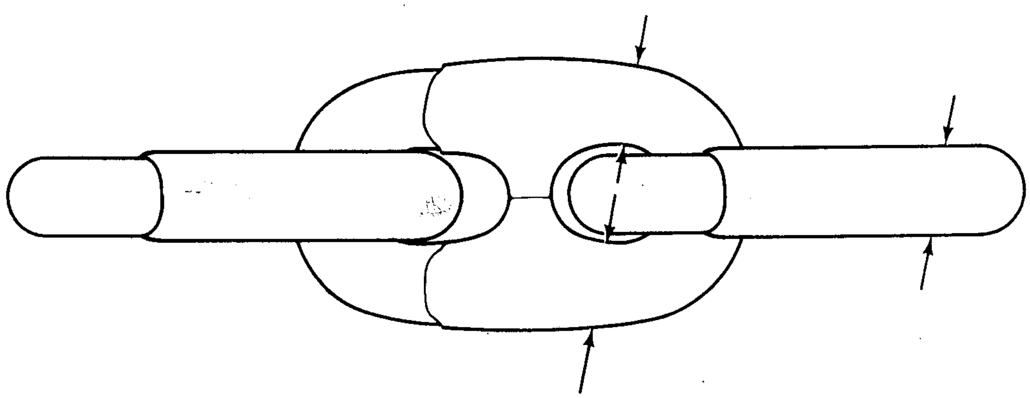


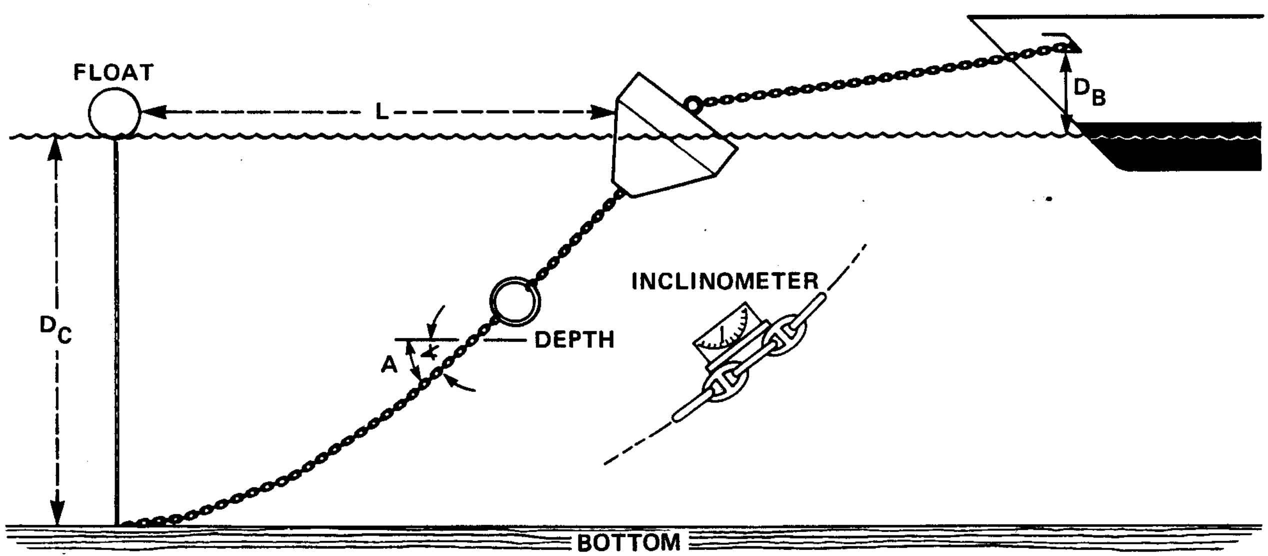
FIGURE B-3. SINGLE LINK MEASUREMENTS OF DILOK CHAIN

B.3 CALIPERS.

The lower portion of Figure B-2 contains the 80 and 90 percent measurements for mooring components. This table is based on the standard sizes of mooring material listed in DM-26 and can be used to preset calipers before measuring various items. For example, a class BB riser type mooring will require calipers set to 3.15" (90%) and 2.8" (80%) for single link measurements on the riser. These values are then doubled, obtaining 6.3" (90%) and 5.6" (80%) for double link measurements on the riser. Similarly, for the ground legs, single link measurements of 2.25" (90%) and 2.0" (80%) are obtained. These values are also doubled to obtain 4.5" and 4.0" for double link measurements. For the ground ring the single link measurements are determined to be 5.85" and 5.2".

B.4 INCLINOMETER.

Catenary profiles are not developed in most underwater inspections. In special cases, such as Mediterranean and ARDM type moorings, however, this data is required. Using an inclinometer, the divers will measure and record the angle of the chain off the dock, the angle at which the chain enters or reaches the bottom, and the depth of the water where the chain enters the bottom. A pop float will be secured to the chain where the leg reaches or enters the bottom and a surface measurement made to determine the distance between the deck edge of the floating dock and the pop float. Figure B-4 depicts the measurements required for determining the catenary of each anchor chain sub-assembly leg.



Catenary Data

L = Lateral Distance

A = Inclinometer Angle

D_C = Depth Where Chain Enters Mud

D_B = Distance to Waterline From Deck or Pipe.

FIGURE B-4. MEASURING CATENARY

ANNEX C

UNDERWATER INSPECTION FORM

Underwater Inspection Form

Page C-3 is a model of a completed Diver Report Sheet. These inspection sheets provide the source of the final FM Underwater Inspection Report. These report sheets are to be completed by the EIC and are based on the information and data provided by the dive team.

MOORING NO.: D-4 CLASS: FR LOCATION: HUDSON BAY LAT: 60°-14'-24"N LONG: 85°-41'-24"W

WATER DEPTH: 75' ANCHOR SIZE/TYPE: NOT VISIBLE BUOY TYPE: PEG TOP W/TENSION BAR

BOTTOM TYPE: ☐ SAND ☒ MUD ☐ CLAY ☐ CORAL ☐ ROCK Visibility 5'

COMPONENTS		GAUGE SIZE	CONDITION								COMMENT
			NEW	SINGLE LINK %			DOUBLE LINK %			DEPTH	
				90+	80+	80–	90+	80+	80–		
BUOY HARDWARE											12' x 9'6" PEG TOP BUOY WITH 60"
4" SHACKLE				✓							FREEBOARD AND A 2½" THICK
13" GROUND RING				✓							TENSION BAR. A ¾" WIRE ROPE HANGS
2½" SHACKLE				✓							OVER THE SIDE FROM THE 4" SHACKLE
											BOTTOM WOOD FENDER IS MISSING.
RISER	NEAR BUOY	2½"	2½"	✓✓✓			✓✓✓			10'	HEAVY GROWTH ON BUOY BOTTOM IN
	MIDDLE	2"	2"	✓✓✓				✓✓✓		45'	ADDITION TO SOME PITTING. HOLE IN
	NEAR GRD RG	2"	2"	✓✓✓				✓✓✓		65'	TOP DECK WELD. ABOVE 25', 2½"
GROUND RING											RISER CHAIN LOOKED NEW. BELOW 25'
GROUND LEG NO. A	UPPER END										THE 2" CHAIN WAS MEASURED TO BE
	MIDDLE										ONLY 85% OF ORIGINAL WIRE SIZE.
	ENTERS BOTTOM										NO SWIVEL NOTED IN RISER. ABOUT
GROUND LEG NO.B	UPPER END										15' OF CHAIN RESTS ON BOTTOM
	MIDDLE		NOT								BEFORE RISER ENTERS THE MUD.
	ENTERS BOTTOM		VISIBLE								
GROUND LEG NO. C	UPPER END										
	MIDDLE										
	ENTERS BOTTOM		✓								
GROUND LEG NO. D	UPPER END										
	MIDDLE										DIVE TIME 18 MINUTES
	ENTERS BOTTOM										

DATE: 25 AUGUST 1983 ENGINEER-IN-CHARGE: WEBER DIVERS: RYAN / SMITH

ANNEX D

UNDERWATER VOLTMETERS

ANNEX D

THE USE OF UNDERWATER VOLTMETERS

D.1 INTRODUCTION.

Fleet moorings are cathodically protected by a variety of methods. The most common cathodic protection system (CPS) involves the use of 150- to 500-pound zinc anodes attached to buoy hulls and each shot of chain. To determine how well these anodes are protecting the steel it is necessary to measure the relative potentials of the buoy and chain at certain distances from the anode. For this, an underwater voltmeter is used. (See Paragraph 3.7.)

The practical theory of the underwater voltmeter is very simple. If a piece of metal in seawater is connected to one terminal of a voltmeter and the other terminal is connected to a standard reference electrode, an electromotive force (a charge) can be recorded. This is the potential of the metal (see Figure D-1).

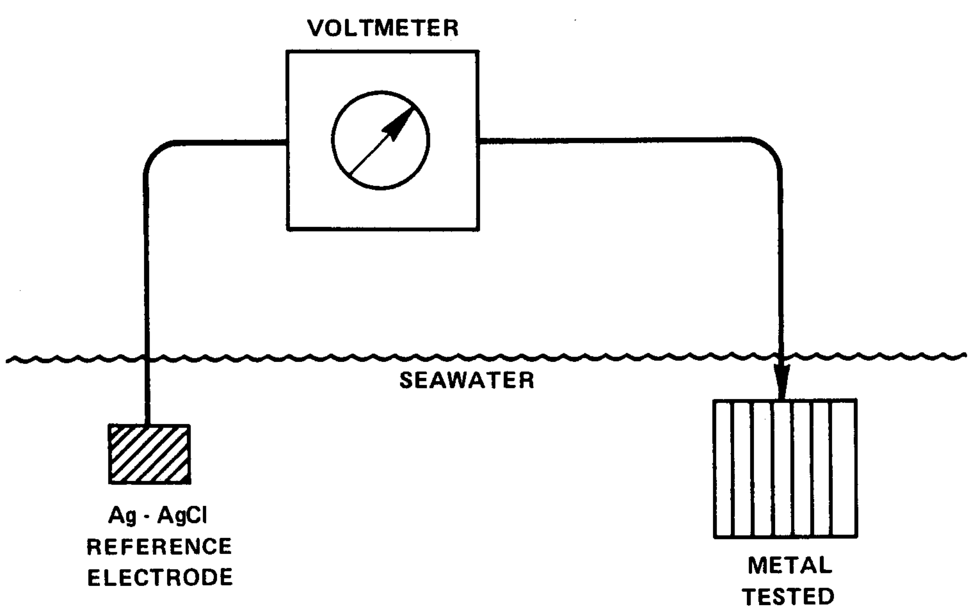


FIGURE D-1. MEASURING POTENTIALS OF A METAL

A typical reference electrode is silver/silver chloride (Ag-AgCl). The difference between this electrode and the metal being tested is the potential displayed by the voltmeter. Because steel is more electronegative than the reference electrode, the voltage will be negative.

Steel that is protected from corrosion by placing an even more electronegative zinc anode on its surface should have potentials that fall between -0.80 V and -0.90 V. A greater potential (-1.50 V) indicates that the anode is overworking and serious damages could occur to the metal. A lesser potential (-0.50 V) indicates that the cathodic protection system is not operating effectively and that the steel as well as the anode material will probably corrode.

D.2 UNDERWATER VOLTMETERS.

a. Description.

Voltmeter readings can be taken one of two ways: the diver can take an underwater voltmeter below and readings are displayed, via electrical cables, on a VOLTMETER DISPLAY UNIT at the surface; or the diver can take and record the readings himself with a self-contained voltmeter. Fleet mooring inspection divers will normally use the self-contained unit.

The following description and operating instructions refer to a typical underwater voltmeter presently maintained by the Ocean Construction Equipment Inventory (OCEI) Facility. (See Figure D.2.) This voltmeter consists of a digital display, surface readout facility, and rechargeable battery. A robust Ag-AgCl reference electrode is mounted in the nose cone 5 cm from the probe tip. The probe and the half cell are connected internally to a digital voltmeter. Operation involves monitoring the readout. The potential is shown on the liquid crystal display (LCD) which is back-illuminated for operation in low visibility.

The voltmeter is supplied with six probes. This should be suitable for all mooring inspections. The probes are attached to the front of the instrument by screwing them onto the stainless steel stud. Silicon grease should be applied to the probe threads before attachment. A definite bottoming should be felt when the probe has been fully screwed in.

The unit is switched on by using the 4-pin blanking plug provided, which, in order to conserve battery life, should be disconnected when the instrument is not in use. Silicon grease will ease insertion. THE PLUG IS NOT UNDERWATER PLUGGABLE AND MUST BE INSERTED BEFORE THE INSTRUMENT IS IMMERSED, OR ELECTRONICS DAMAGE WILL RESULT.

Under normal usage, a fully charged battery will operate for 60 hours. A "1" displayed on the LCD indicates low voltage. Should this occur, a maximum charge of 14 hours at the high charge setting will bring the battery back to the fully charged condition. This should be done with the supplied battery charger. As a general guide, 10 minutes of recharging (at 9 milliamperes (mA)) is required for every hour of use.

The low-charge setting provides a continuous trickle charge output of 1 mA and can be used to ensure that the batteries maintain a full charge when the unit is kept on the shelf.

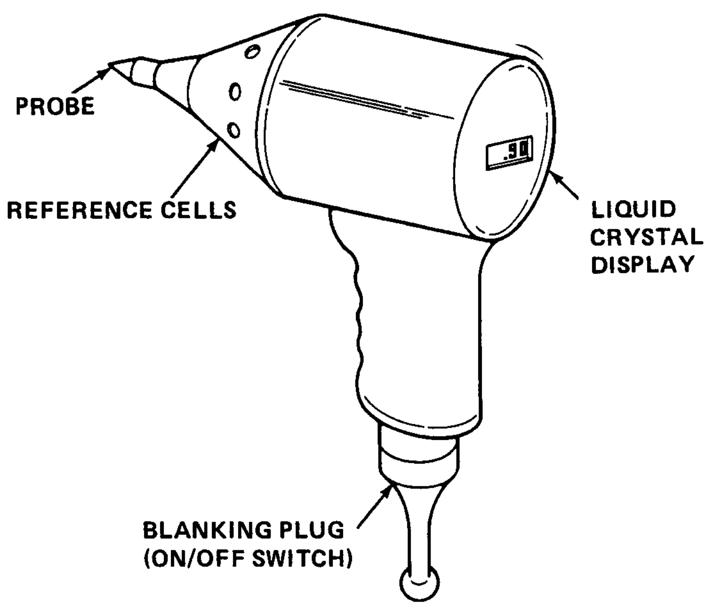


FIGURE D-2. UNDERWATER VOLTMETER

Because some drying out may occur during storage, it is recommended that prior to initial use the half cell be allowed to soak for 20 to 30 minutes. A thin stream of bubbles may be seen emitting from the half cell area, indicating the ingress of water into voids, expelling any trapped air.

The unit operates on the principle of measuring the potential difference between the structure (steel) and a reference electrode (silver). The probe, a different metal than the reference electrode, will exhibit a small potential difference which will be shown as a reading on the digital display. However, the exposed area of the probe tips has been kept to a minimum and any surface being tested will be many hundreds of times greater in area. Therefore, when contact of the probe with the surface is made, only the structure potential will be indicated. Any slight interference from the probe will be masked by the structure's potential. Some slight readings may still be apparent on the display when the unit is removed from the water. This is due to surface moisture allowing tracking from the half cell to the probe which, although slight, will be displayed because of the high input impedance of the meter.

b. Calibration and Maintenance.

In order to keep a check on the operation and calibration of the silver reference electrode, tests should be carried out at the surface prior to each operational use as follows:

(1) Samples of magnesium, steel, and zinc are used, their potential measurements with the underwater voltmeter taken, and a log of these readings kept to check if any significant variance occurs. THE METER MUST BE UNDERWATER WHEN CALIBRATED.

(2) Differences of 10 millivolts (mV) (.01 V) or so between calibration readings are quite possible and will be caused mainly by variations in water salinity or temperature.

(3) Very little mechanical maintenance is required, apart from general cleaning in fresh water after each use and ensuring that the nose cone, behind which the reference electrode is situated, is kept clear of any obstruction such as dirt or marine growth.

D.3 PROCEDURES.

a. To assure proper protection of the chain, underwater voltmeter readings must be taken at 20-foot intervals on the chain, on each side of each anode, at each end of the continuity cable, and on each side of each swivel. Wherever readings are taken, potentials, depth and element measured (whether chain, anode, etc.) shall be recorded.

b. In addition, anode size must be measured. The anode and cable must be checked for secure attachment to the chain and the amount of loss due to corrosion shall be noted.

c. The anode should be checked to determine the type and color of the oxidation deposit on its surface. A white coating indicates that the anode is working properly. A black coating, or no coating at all, indicates that the anode is not working. These observations are to be recorded by the diver.

d. Chain that is cathodically protected must have potential readings between -0.80 V to -0.90 V. (NOTE: The negative sign will not appear on the voltmeter readout.) Typically, the largest potentials (-0.85 V to -0.90 V) will be at the anode and the smallest (-0.80 V to -0.85 V) will be at each end of the continuity cable. Any readings higher (-0.50 V, etc.) or lower (-1.50 V, etc.) than this range will be investigated as follows:

(1) Return to the last checkpoint within the correct range.

(2) Probe and read the voltmeter every 5 feet until the corrosion cell or faulty area is located.

(3) Report this unprotected or overprotected area by relating it to the appropriate leg (i.e., leg A). Identify the cell by its physical position (e.g., near a swivel or an anode) and record the depth. Record at least two positions, preferably one higher and one lower than the corrosion cell on the chain.

(4) Chain and connecting links in an area where the CPS readings are small are to be checked with the 80/90 percent GO/NO-GO gauges to determine the deterioration since installation.
NOTE: Where chain is in tension a CPS may protect the chain even with missing anodes and broken continuity wire.

ANNEX E

SURVEY PRACTICES

ANNEX E

SURVEY PRACTICES

E.1 INTRODUCTION.

In preparing to determine the location of fleet moorings, several items should be considered before arriving on site:

- The degree of accuracy required to determine the location of the mooring and the accuracy of the equipment available to conduct the survey must be compatible.
- All available information regarding the last known locations of the moorings, benchmarks, and landmarks must be obtained from the activity or the state (or local) government. In addition, a person knowledgeable of the benchmark locations and type of local grid system should be identified.
- All equipment required must be obtained in sufficient time so that they can be tested and calibrated. Also, sufficient time must be available to acquire replacement parts should the need arise.

E.2 TERMS.

a. Bearings. A bearing measures the angle between a given meridian (the baseline) and the line to the object. The given angles are from 0 to 90 degrees in four quadrants.

b. Azimuths. For the angle measurements required in a mooring location survey, azimuths will be used. An azimuth is measured clockwise from a meridian (such as TRUE NORTH or the baseline) and varies from 0 to 360 degrees.

c. Baseline. A baseline is the base of a triangle whose apex is the target (a buoy in this case). See Figure E-1.

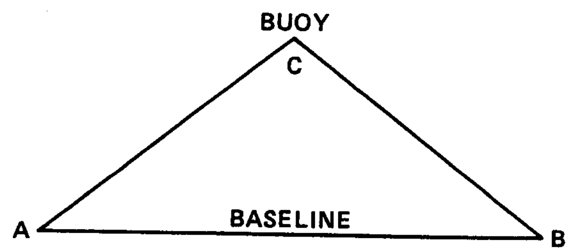


FIGURE E-1. THE BASELINE

The first baseline in a survey must be established between two known points. These points can be benchmarks and/or landmarks.

(1) BENCHMARKS are points that have been surveyed by professional surveyors (the activity, state or federal surveyors) and can be located precisely within the grid system used. Benchmarks throughout the U.S. were established before World War II by the U.S. Coast and Geodetic Survey. The grid systems may utilize latitude and longitude or use local or state references.

(2) LANDMARKS are any readily available target that can be plotted with a high degree of accuracy. Steeples, water towers, pier ends, etc., make good landmarks.

Information regarding benchmarks and landmarks can be obtained from the National Oceanographic and Atmospheric Administration (NOAA) or the activity.

E.3 TRANSITS.

Several different types of equipment are available to perform a survey (sextant, compass, theodolite, Distance Measuring Unit (DMU), transit, etc.). The degree of accuracy required in a survey should be determined well in advance of the actual survey. The equipment chosen must match or better the degree of accuracy required. For the purpose of plotting the Fleet Mooring location, a transit (with an accuracy of 20 to 30 seconds) should be used.

E.4 MEASUREMENTS.

The buoy position is established by plotting the angles measured between the benchmarks or target landmarks and the buoy.

The baseline should be a length that allows angle BAC and angle ABC to be as great as possible while allowing angle ACB to approach 90° (see Figure E-1).

From one end of the baseline, a sight should be taken on each buoy, starting at the extreme left and working clockwise.

The transit should be turned clockwise from the backsight whenever possible. The direction turned, however, must always be noted.

The same procedure is then repeated at the other benchmark.
(See Figure E-2.)

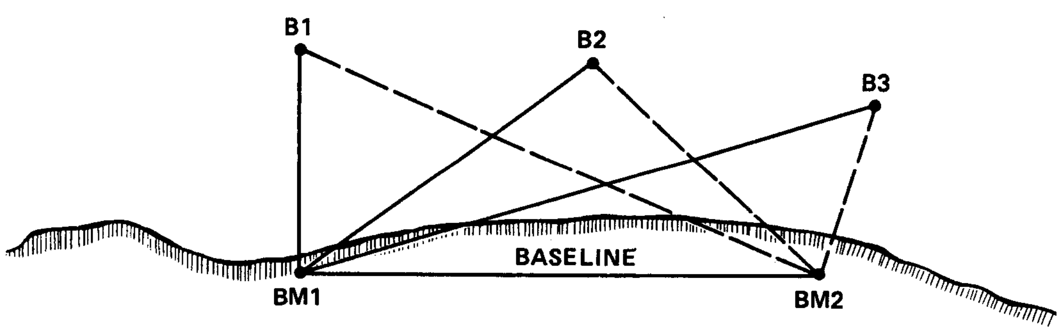


FIGURE E-2. SIGHTING BUOYS

a. Accuracy in Measurements. Measurement accuracy is determined by the equipment and the skill of the operator. A transit can only be read to the degree of accuracy to which the vernier scale is divided. (See Figure E-3.)

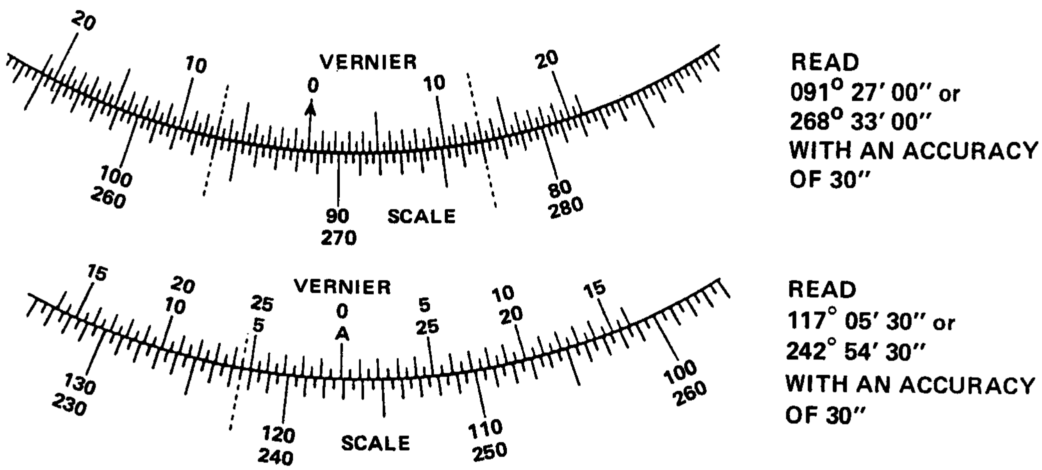


FIGURE E-3. VERNIER SCALE

A rule of thumb regarding angular accuracy is that a mistake of 1 minute will cause an error of 3.5 inches in 1,000 feet. (See Figure E-4.)

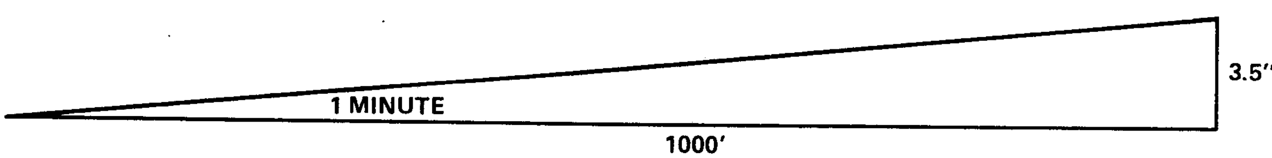


FIGURE E-4. ACCURACY DIAGRAM

b. Turning the Transit. In some cases, the buoy will be further than 5000 feet from the transit. At this range, it is necessary to increase the accuracy by turning the transit. "Turning" means that two (or more) sightings on the target will be averaged. For instance, the measurements of a transit that can be read to 20 seconds will have an accuracy of ±10 seconds if the transit is turned once.

Turning is accomplished in the following manner:

(1) After backsighting the baseline and sighting the buoy, the top transit ring is locked and the bottom ring loosened.

(2) The transit is turned back to the baseline and locked. The backsight, which originally read 00° 00' 00', now reads whatever the angle was to the buoy (say 110° 00' 00").

(3) The transit is then turned back to sight on the buoy in the normal manner. If all was done correctly, the new angle will read 220° 00' 00" (twice the original angle). When this number is averaged an angle of 110° 00' 00" is obtained. No error occured in the measurement. If, however, the second reading is 220° 01' 00" then the average reading is 110° 00' 30".

In theory, the transit can be turned again and again, but that is not necessary in this type of survey.

See Table E-1 for examples of measurements that could be encountered during a typical survey.

Table E-1. Sample Survey Measurements

Site A	Angles from Baseline		
	First Meas.	Second Meas.	Average
Buoy B1	037° 29' 30"	074° 59' 00"	037° 29' 30"
Buoy B2	120° 18' 30"	240° 37' 30"	120° 18' 45"
Buoy B3	239° 31' 00"	119° 03' 00"	239° 31' 30"

E.5 ESTABLISHING BENCHMARKS.

In most areas of the United States, benchmarks were established by the U.S. Coast and Geodetic Survey prior to World War II. (Benchmarks were established in other countries by their own survey organizations.) Because of their age, many of the benchmarks have been destroyed, lost, or moved. If the federal, state, or activity authorities do not know the exact location of a benchmark it may be necessary to create one.

Four considerations must be made when creating a benchmark:

- The location of one benchmark must be established in whatever grid system is being utilized.
- The buoys are readily visible from the benchmark we want to establish and the known benchmark.
- The location of readily visible landmarks must be known and plotted on the same grid as the known benchmark.
- The landmark must be visible to new and known benchmarks.

a. One Unknown Benchmark. To create a benchmark (with the help of one other known benchmark), a known landmark must be available as a target for the backsight (baseline). Then, the following steps are taken:

- Locate a position that will not erode or be lost in the foreseeable future. A building roof, pier end, etc., are good examples.
- From the known benchmark, sight the known landmark and establish a baseline that can be plotted on a chart. The length of the baseline must be known.
- Sight a target on the new benchmark location.
- Repeat the procedures from the new benchmark.
- Trigonometry gives all three angles and the new benchmark can now be plotted. (See Figure E-5.)

b. Two Unknown Benchmarks. To establish two benchmarks (when none are available but two landmarks are visible), is very complex and beyond the scope of these guidelines. For a detailed explanation see Chapter 13 of the Department of Transportation's Aids to Navigation Manual (CG-222-2).

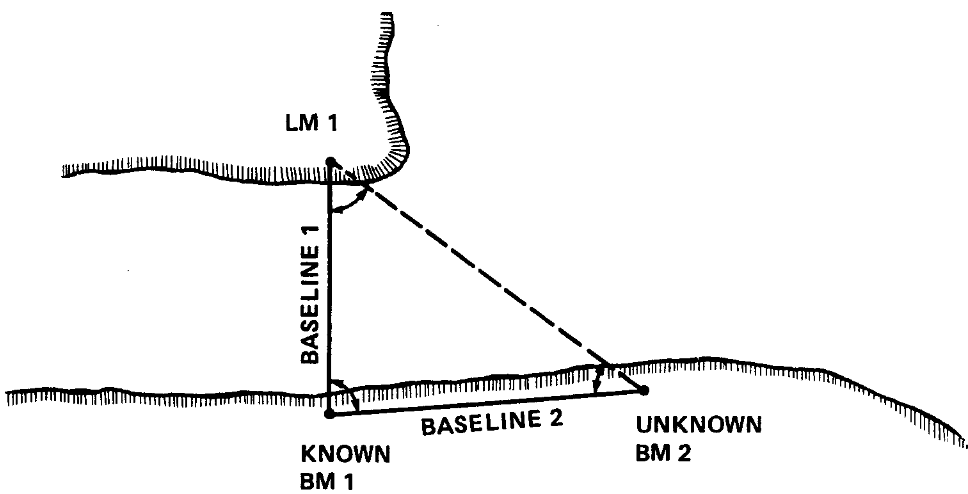


FIGURE E-5. CREATING A BENCHMARK

E-6 PLOTTING.

The buoy's location can be plotted on a nautical chart once the benchmarks, baseline, and angles have been established and plotted on the chart. The location can be determined mathematically by using coordinates in a grid system, or schematically by plotting the benchmarks and angles directly on a nautical chart.

One of the purposes of the mooring survey is to compare the new survey coordinates to the last available location information. Whatever coordinates were used originally (grid and or latitude/longitude) should be used here. Minor deviations of the buoy's current position as compared to its original position do not necessarily indicate that the mooring has been displaced. These deviations can be the result of a large buoy watch circle (buoy excursion from a center position due to wind or tide). In order to compare the amount of excursion due to the tide, the time and date of each sighting must be recorded along with wind speed and direction. Then with the use of tidal charts a comparison can be made.

a. Local Grids. In most areas, the local grid system uses grid north as the meridian instead of true north. The activity or local government would have information about the system's point of origin and reliability.

b. Latitude/Longitude. Latitude and longitude must be used when no local grid exists. Nautical charts are often available for any given locality and often contain more information than a locally drawn chart.

When a benchmark is plotted on a nautical chart, its latitude/longitude is known to a high degree of precision. Well established structures such as piers and buildings are located accurately on the latitude/longitude grid. The shore line, however, is often misrepresented by many feet. Therefore when plotting a buoy's location, rely on the grid system printed on the chart and not on the plot of the land.

E.7 INFORMATION.

More information regarding survey practices in general can be found in most survey manuals or textbooks. Examples are:

Davis, Raymond E., and Francis Foote. Surveying Theory and Practice, New York: McGraw Hill Book Co, 1953.

Brinker, Russel C. Elementary Surveying, International Textbook Co., 1969.

Department of Transportation. Aids to Navigation Manual.

ANNEX F

FLEET MOORING MATERIAL COMPONENTS

Fleet Mooring Material Components

Pages F-3 and F-4 contain sketches of the more commonly used mooring components. These sketches are to provide inspection team members assistance in the identification of mooring material. Also see Figures 1, 4, 5, 6, 7, 8, and 10.

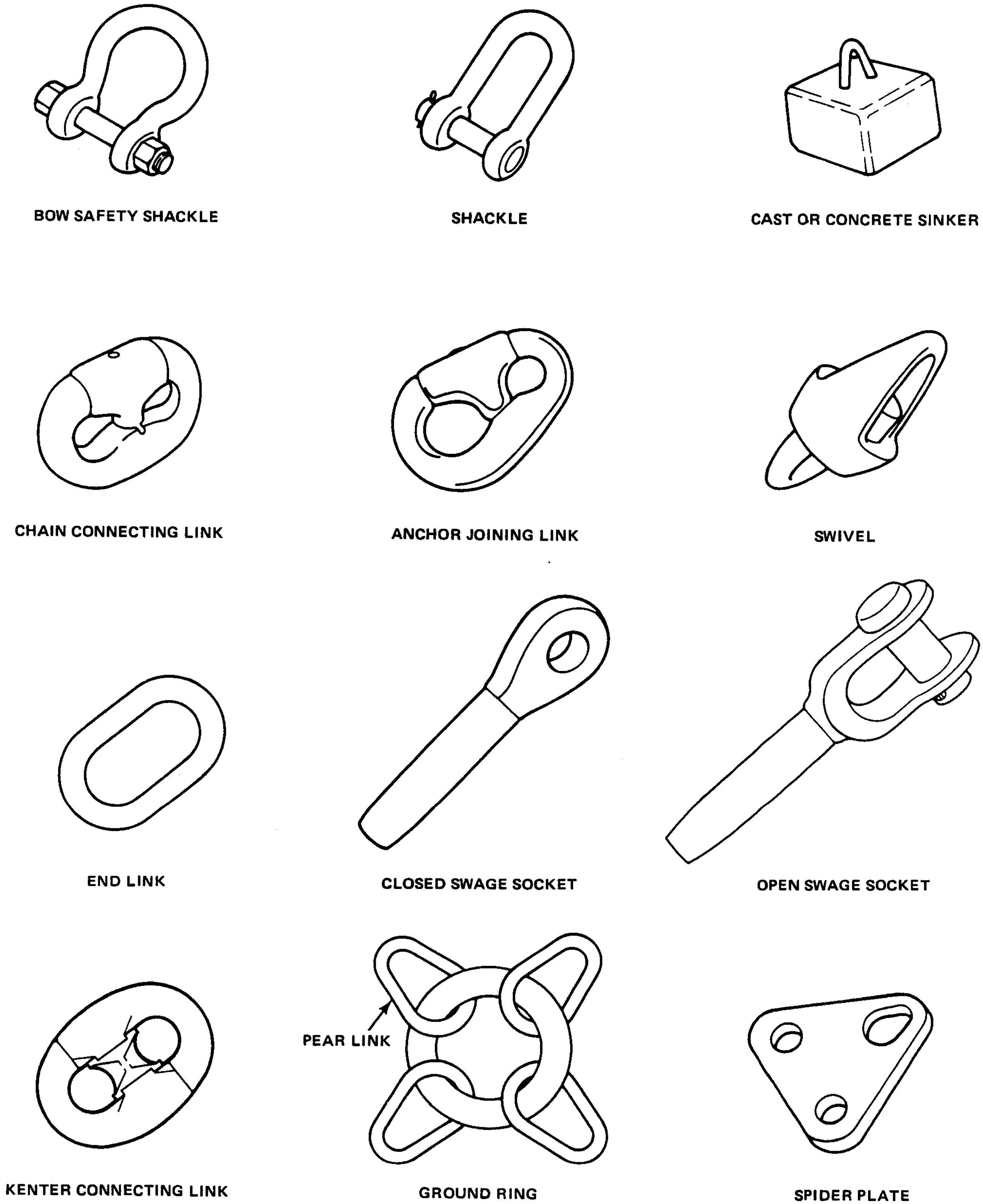
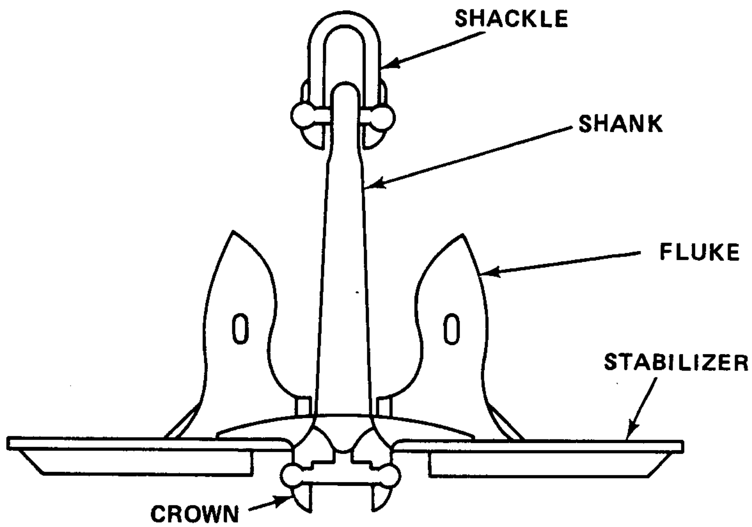
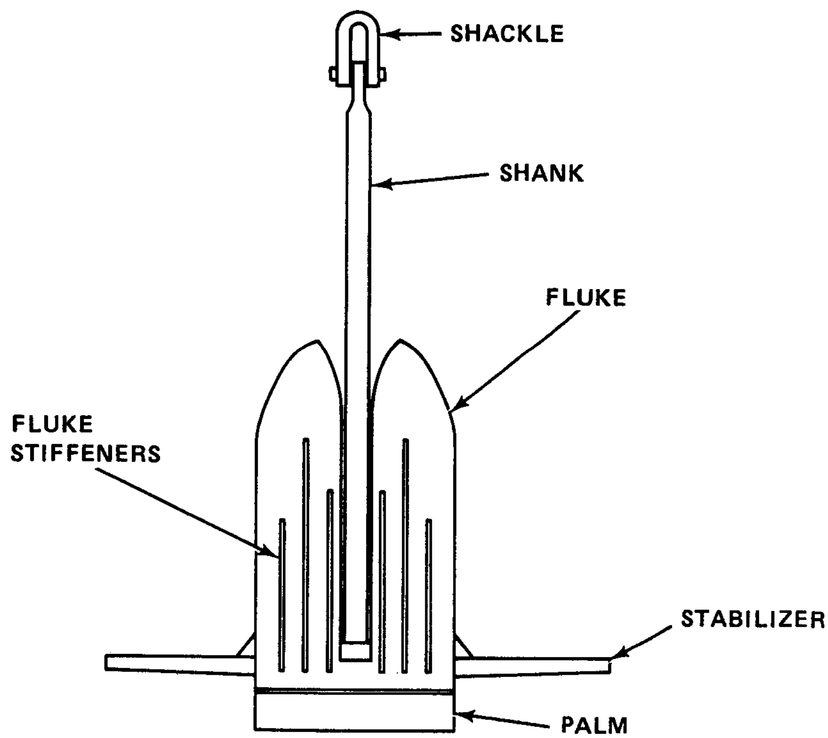


FIGURE F-1. FLEET MOORING MATERIAL COMPONENTS (Not To Scale)



NAVY STOCKLESS ANCHOR WITH STABILIZERS



NAVFAC STATO MOORING ANCHOR

FIGURE F-2. TYPICAL ANCHORS

ANNEX G

GLOSSARY OF TERMS

GLOSSARY

Abrasive. The agent used for abrasive blast cleaning; for example, sand, grit, steel shot, etc.

Accurate. Free from error as a result of care.

Anode. Electrode from which electrons flow; a component of cathodic protection systems.

Anchorage. An area designated for ships to anchor in with their own equipment.

Anchor Shackle (Jew's Harp). A shackle used to connect the anchor shank to the chain.

Apron. Area of pier or wharf upon which cargo is loaded.

ARDM. Auxiliary Repair Drydock Medium.

Basin. Area of a harbor set aside for large vessels to anchor, moor, or turn around in.

Beam. Maximum width of vessel hull.

Bell Mouth. The splayed open section at the bottom and top of the hawsepipe.

Benchmark. A permanently fixed point of known location used for reference during survey or alignment.

Bending Shackle. A shackle used to secure a chain to the anchor shackle.

Bitt. Double post fitting to which mooring lines from vessels are attached.

Bitter End. In-board end of an anchor chain.

Bollard. Steel or iron post on a dock, peer, or wharf used in securing ship's lines.

Buoy. A floating object moored to the bottom to mark the position of a shoal, channel, or anchorage limits, or a floating component of a Fleet mooring.

Cable. Any heavy wire rope such as a towing cable or degaussing cable. A unit of length, 120 fathoms or 720 feet.

Camel. Float used as a fender between two ships or a ship and a pier.

Catenary. The dip in a length of chain or cable which provides a spring or elastic effect in towing, anchoring, or in a mooring system.

Cathodic Protection. An electrical method of preventing metal corrosion in a conducting medium by placing a charge on the item.

Channels, Ship. The established limits of navigable waters dredged and maintained for ingress and egress of vessels.

Chock. A metal casting with two horn-shaped arms used for passage, guiding, or steadying of mooring or towing lines.

Clump. Steel or concrete weight attached to anchor legs to dampen the effects of sudden strain on the mooring.

Dolphin. A structure usually consisting of a cluster of piles. It is placed near piers and wharves or similar structures, or alongshore, to guide vessels into their moorings, to fend vessels away from structures, shoals, or the shore, or to support navigable aids.

Downhaul. Line or wire that pulls downward.

Draft. Depth of vessel hull or buoy below the waterline.

Electrical Potential. A quantity in an electrical field measured (in volts) with reference to some arbitrary level of potential, such as a reference half-cell.

Electrolyte. A nonmetallic medium such as seawater capable of conducting electricity by the movement of ions rather than electrons.

Fender. A device placed in position to absorb the shock of contact between ships or between a ship and a pier.

Fleet Mooring. An off-shore ship anchoring system consisting of a ground tackle arrangement connected to a buoy to which a ship can be made fast.

Flukes. Broad arms or palms of an anchor.

Fouling. An accumulation of deposits, especially marine biological growth.

Freeboard. Distance between the deck of a floating vessel or buoy and the waterline.

Galvanic Corrosion. An accelerated form of corrosion occurring in an electrolyte when a pair of dissimilar metals capable of acting together as a source of electricity are in contact with each other.

Ground Leg. A distinct portion of the ground tackle system.

Ground Ring. Steel ring to which riser chain and ground legs of a Fleet mooring are secured.

Ground Tackle. The anchors, chain, and other supporting equipment used to secure a buoy in a specific location.

Harbor. In general, a sheltered arm of the sea, easily accessible to maritime routes in which ships may seek refuge, transfer cargo, or undergo repair.

Hawsepipe. A cast-iron or steel pipe placed in the bow or stern of a ship or center of a buoy for the anchor chains or tension bar to pass through.

Marine Borer. Destructive organism in seawaters that attacks untreated or poorly treated wood; especially active in warm waters.

Mooring. System of anchors, chain, buoy, and their accessories used to secure ships temporarily in a fixed position.

Pad Eye. A metal ring or eye securely welded to a deck or bulkhead.

Pendant. Length of line or wire fitted with an eye or block at one or both ends.

Pier. Stucture for mooring vessels which is built out into the water perpendicular to the shore line.

Piling. Wood, concrete, or metal poles driven into a harbor or sea bottom for support or protection of piers or wharves.

POL. Petroleum, oil, and lubricant products.

Precise. Exactly or sharply defined or stated, minutely exact.

Preservative. A material with the property of retarding deterioration.

Reference Half-Cell. A single electrode which when immersed in an electrolyte solution, produces a fixed, known electrical potential; it is used as a standard for the measurement of potential differences.

Riser Chain. Vertical chain extending from a ground ring upward to mooring buoy.

Sacrificial Anode. An anode which supplies its own electrons for cathodic protection, thereby consuming or "sacrificing" itself.

Shackle. A chain joining link.

Shot. Fifteen-fathom (90-foot) length of chain.

Sinker. A weight, usually concrete, attached to a mooring leg to remove direct tension from the anchor, to absorb impact loading, to control chain movement near the anchor, and to localize chain wear.

Spider. A steel plate or casting with three or more holes to join several chains.

Stake Piles. Steel piling anchors driven vertically into a firm bottom.

Stud. Center cross bar in steel chain link.

Survey. Official procedure in expending accountable material from books or records. May be a special, formal, or informal survey. Also: To survey an area is to explore and chart it.

Wharf. Structure parallel to the shoreline to which ships moor for loading, unloading, or repair.

VSE CORPORATION
INTEROFFICE MEMORANDUM

Date: May 16, 1996

To: Craig Pennington, NFESC-ECDET

From: Tom Hughes, OEG

Subj: **Buoy Inspections**

During surface or underwater inspections the following should be checked.

a. **Top and bottom pad eye bushings.** The bushings are in place as wear plates. There is no data at this time as to how long they last, if the shackles or swivels are wearing then the bushings should be closely examined during the change out. Depending on the mooring and it's usage, wear areas could be localized or initiate splits or cracks in the bushing material. Repair or replacement of the bushings is far more desirable than the repair of the pad eye steel itself. Bushings can be knocked out and new ones pounded back in. Heating of the steel may be required. Currently there is no inventory of these bushings.

b. **Tension bar anodes.** There are two anodes required on the lower pad eye just above the eye itself, one on each side of the plate. When new, cap bolts are placed in these holes is the same size bolts as the chain studs. The bolt holes are the same size as the chain anode bolts. It has not been determined what is the best size anode but whatever is being used on the chain is adequate. These should also be checked on each inspection for depletion. It should be noted on the installation and anode change out records, the size used.

c. **Reflective tape.** Reflective tape should be checked for adherence or missing pieceses. Clean the area as best as possible with cleaner and let dry before applying new tape. In some cases new tape can be applied above or below existing tape.

d. **Rails.** Rails should be checked for tightness or damage. Simply yanking or kicking the rails should indicate looseness. Check for other damage around caulk lines and bolt plugs on the top of the rails. If rails are bent or excessively lose all way around then NFESC-ECDET should be notified for further action.

e. **Bolts.** All external bolts should be checked for tightness whenever possible. If not tight then remove, add RTV, and reinstall.

f. **Pad eye paint.** If during surface inspection the pad eye shows pitting, chipping, or large areas of paint wear, then the area should be scraped, wire brushed, and dried. A coat of white epoxy paint should be applied. During a full overhaul or other effort requiring the buoy to be lifted then both the top and bottom pad eyes should be inspected, cleaned, and a coat of epoxy white paint applied, two coats if time permits.

g. **Buoy hull.** Check the hull for rips and abasion areas and indicate the location ,depth, and extent of damage. The seal or bond between the tension bar and urethane skin on both the top and bottom should be checked. A thin wire can be used to check the depth.