MOORING INSPECTION REPORT

COOPER RIVER
U.S. NAVAL AMMUNITION DEPOT
CHARLESTON, SOUTH CAROLINA

PREPARED FOR: NAVAL FACILITIES ENGINEERING COMMAND
ALEXANDRIA, VIRGINIA

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**ARDM-2 (USS Alamogordo) Mooring Inspection Report Cooper River U.S. Naval Ammunition Depot Charleston, South Carolina**

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An underwater inspection of the condition of the mooring chains of the ARDM-2, USS Alamogordo, moored in the Cooper River at the U.S. Naval Ammunition Depot, Charleston, S.C., was requested by the Ocean Engineering and Construction Project Office (FPO-I) & the Underwater Construction Team (Con't)

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ARDM-2
(USS Alamogordo)
MOORING INSPECTION REPORT

COOPER RIVER
U.S. NAVAL AMMUNITION DEPOT
CHARLESTON, SOUTH CAROLINA

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JANUARY 1979
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Justification

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BACKGROUND

An underwater inspection of the condition of the mooring chains of the ARDM-2, USS ALAMOGORDO, moored in the Cooper River at the U.S. Naval Ammunition Depot, Charleston, S.C., was requested of the Ocean Engineering and Construction Project Office (FPO-I) and the Underwater Construction Team One (UCT-1) by the Naval Facilities Engineering Command by COMNAVFAC msg 101944Z August 1978. FPO-I was tasked to provide the inspection criteria and procedures, provide an on-site field engineer, interpret the data and prepare the inspection report. UCT-1 was tasked with performing the underwater inspection. The mooring inspection plan is provided as Appendix 1 and the mooring inspection was completed in November 1978.
SCOPE

This report describes the inspection procedures, inspection equipment, inspection criteria and summarizes the obtained data. Recommendations concerning the derating of the ARDM-2 mooring chains which did not meet the prescribed criteria are presented. Precautions to be followed in future inspections and potential areas are discussed.

APPROACH

The basic guidelines for the mooring inspection were provided in the "ARDM-2 Mooring Inspection Plan," Appendix 1. Single and double-link calipers that were machined to 80% and 90% of the standard chain dimensions were used to make the measurements. The diver cleans marine growth and corrosion products from the chain and attempts to slide the 90% calipers or the 80% calipers over the chain section to be measured. This measurement quickly and reliably indicates whether the measured section was greater or less than the nominal measurement. The underwater Ag-AgCl voltmeter was used to obtain an indication of the corroding potential of the chain at/or near the surface or at the lowest position where readings on the digital indicator are discernible. The divers utilized MK-1 diving gear with surface communication equipment and a diesel operated air supply.
INSPECTION

The inspection procedure was varied slightly from the procedure outlined in Appendix 1, as follows:

a. One thickness measurement was taken on the chain at the water surface or near the ARDM.

b. Because of the decrease in visibility along the chain, measurements were taken at 10 foot intervals of water depth as determined by the surface depth indicator of the surface equipment and at the position where the chain entered the bottom mud.

c. Underwater voltmeter readings were obtained near the ARDM and the lowest position where the underwater voltmeter indicator was visible.

d. Bearings of the anchors were not obtained because all anchor lines either dropped vertically into the mud of the dredged area of the ARDM-2 mooring site or entered the mud in the dredged area within 50 feet of the ARDM. Changes in current/tide direction and changes in wind direction resulted in a continual slight variation in the angular relationship between the vessel and the chain.
A copy of inspection form for each leg is provided in Appendix 2. In accordance with the downgrading criteria provided in the "Design Manual for Harbor and Coastal Facilities," NAVFAC DM 26, reference (1) and "Mooring Maintenance" NAVFAC MO-124, reference (2) and the guidance provided in Appendix I and recommended in reference (3), some of the chains in the ARDM moor were required to be downgraded and re-classified to the load capacity of the next lower standard size chain.

The measured chain diameter on the ARDM-2 mooring legs A, B, C, D, H, and M, (see Figure 1) exceed 90% of the original chain diameter and did not require downgrading in capacity. The measured diameter on the ARDM-2 mooring legs E, F, G, and K exceed 80% of the original chain diameter and should be downgraded in capacity to the next largest standard chain size. The ARDM-2 mooring legs I, J, and L were not inspected because auxiliary barges attached to the ARDM-2 presented a possible safety hazard to the divers. These chains should be tentatively downgraded in capacity to the next largest standard chain size.

The adequate capacity of a mooring chain should be based upon the capability of the weakest link to withstand the maximum design loads anticipated for the moor. The maximum design loads for the ARDM-2 original mooring design are tabulated in Appendix 3. The mooring components that form the weakest portion of each mooring leg are tabulated in Appendix 4. The chain size that corresponds to the smallest size of an anchor joining link or chain joining link is, also, tabulated in Appendix 4. The working capacity of downgraded chains is tabulated in Appendix 5. The present capacity which includes the downrated capacity of each mooring leg is
summarized in Table 1 and it shows that the working capacity of all mooring lines exceed the design load of 120,000 lbs.

If all of the chains were to be downgraded in capacity at a future inspection, the rated capacity of each leg for this downgrading is summarized in Table 2 and it shows that the capacity of the mooring legs still exceeds the design load of 120,000 lbs.

SINGLE AND DOUBLE-LINK MEASUREMENTS

The standard double-link measurement criteria is based upon 80% and 90% measurement of double the single wire measurements. These measurements are intended to indicate whether or not the chain links have been degraded by the combined action of wear and corrosion. The predominant mode of degradation of a suspended mooring chain will result from crevice corrosion at the chain link interface. In most forms of crevice corrosion, one boundary or side of the crevice will be degraded more than the other side. As the chain links flex, the corrosion products are removed, a tighter crevice is formed and the process keeps repeating itself. If this degradation cycle only degrades the one link, the capacity of the mooring chain is degraded to a greater extent than initially indicated.

As an extreme example, assume a nominal double-link measurement of a 2 inch chain, i.e. 90% of a double-link measurement is 0.90 (4.00) = 3.60 inches, removes 0.40 inches. This amount removed from a single-link results in the removal of 80% of the chain link and under the present criteria the chain must be removed. Since the single link measurement does not measure the diameter of the link at the site of the crevice, the capacity of the chain is likely to be overrated. Additional examinations
of worn chains or mooring components that have been utilized in actual
moors should be conducted before the double-link criteria is considered
to be a mandatory criteria. Also, mooring components that are situated
in the portion of the moor which experiences a continual flexing should
be measured in order to verify the validity of single and double-link
criteria.

COMPARISON OF THE DESIGN LOADS WITH MOORING CAPACITY

In order to evaluate whether or not a mooring chain or any component
of a moor can meet the anticipated design requirements, the as-built
drawings and the original or revised calculations should be considered
before downgrading or replacing a mooring component. In evaluating the
mooring for the ARDM-2, the as-built drawings, reference (4), the results
of the original design loads, Appendix 3, and a quick check of the chain
tension and scope, Appendix 6, were conducted to assure the adequacy of
the mooring design. The results are provided in Table 3 and show that the
maximum line tension under the design loading is 122,000 lbs. This is
approximately 10,000 lbs lower than the working capacity tabulated in
Table 1 and approximately 4,500 lbs lower than the maximum working capacity
shown in Table 2. Also, under the design loads sufficient chain will remain
on the bottom to insure that a 0° angle is maintained between the chain and
the anchor. According to the as-built drawings, the design holding capacity
of the 25,000 lb anchors is 125,000 lbs, therefore, the maximum design load
of 122,000 lbs will not exceed the anchor holding capacity.
UNDERWATER VOLTMETER READINGS

Underwater potential readings depend on many variables such as resistivity of the water, water flow past the measured point, and relative position of anodic and cathodic areas. Since the river along the ARDM is dynamic and subject to periodic infringement by salt water wedges from the sea and fresh water runoff, the water chemistry is highly variable. The dynamics of active and passive areas on the steel surface and the degree of crevice corrosion, fretting corrosion, general corrosion, pitting, etc., of slowly flexing chain creates a local environment with varying stable potentials at particular instances of time. Further details on the variation of potential readings to the test location and environment are contained in references (5) through (8). Due to the possible variations in the potential reading at the testing point, a conclusive interpretation concerning the significance of the measurements with respect to the condition of the chain cannot be made. The readings will be kept on file for future reference and comparison purposes.

ARDM-2, IMPRESSED CURRENT SYSTEM

The impressed current system for the ARDM-2 consists of two 300 amp capacity, SCR controlled constant potential systems. The systems are set to provide a constant negative potential of -0.85 volts and the recorded check voltages show that the potential has remained between 0.84 and 0.89 negative volts. The amperage records show that each of the two systems have been providing a varying amperage output from 10-30 amps to a maximum of 180-250 amps. At the time of the inspection of the anchor chains, the
ship's personnel asked whether or not the system was operating correctly and whether or not there was a logical explanation for the continual output of 150 to 250 amps by both systems. A review of the regular voltage and amperage records along with information concerning the utilization and location of the ARDM-2 at various times revealed the following:

a. The current demand increased during movement of the ARDM-2 from moorings just off the Charleston Harbor State Port Authority, off the Charleston Naval Shipyard, to the Naval Ammunition Depot on the Cooper River.

b. Current demand increased when additional barges were securely attached to the ARDM-2 and when the ARDM-2 contained other ships for repair and outfitting.

c. Current demand increased when there was increased release of freshwater from an upstream dam or during periods of wet weather.

Among the many logical explanations for this varying increase in amperage that is required to maintain the proper control potential of a negative 0.85 volts are the following:

a. The resistivity of the water would increase during transfer of the ARDM-2 from the Port Authority and the Charleston Harbor to the position on the Cooper River.

b. The resistivity of the water would increase during additional release of fresh water from upstream dams or runoff from rainwater.

c. The polarization of localized anodic and cathodic areas was removed by the flow of water past the ARDM-2.

d. The area requiring protection by the impressed current system increased when additional barges were attached to the ARDM or ships requiring repair or outfitting were loaded into the ARDM.
Although many other factors could contribute to the increased demand in current, the above mechanisms are the most probable causes. Additional information can, also, be obtained in the article "Application of Automatic Potential Controlled Rectifiers in Sea Water Cathodic Protection" by C.R. Ferry in reference (9).

If the capacity of the rectifiers is exceeded, the most practical solution is to attach auxiliary sacrificial zinc anodes to the barges that are attached to the ARDM or attach zinc anodes to the ARDM at locations remote from the impressed current anodes. A convenient method of attaching auxiliary zinc anodes is to rig 150 lb zinc anodes in a flexible cable ladder and firmly secure the ladder to port and starboard sides of the barge or ship. When the barge is removed from the ARDM or the ARDM changes locations, the sacrificial zinc anodes can be stored aboard the ship until needed. These auxiliary anodes should be removed prior to towing or movement of a barge or ship to another location.

The previously cited reference by C.R. Ferry discusses the use of sacrificial anodes in conjunction with an impressed current system and various environmental effects that will change the operational characteristics of the system.

SUMMARY OF RESULTS

The following items summarize the results of the inspection of the ARDM-2, USS ALAMOGORDO, moored at the U.S. Naval Ammunition Facility on the Cooper River near Charleston, S.C.:
a. The chain capacity of legs E, F, G, and K should be downgraded to the next largest chain size on the basis of actual measurements and the chain capacity of legs I, J, and L should be tentatively downgraded.

b. The mooring capacity of the ARDM-2 in the Cooper River exceeds the design capacity of the moor and does not require removal or replacement of any mooring components at the present time.

c. The ARDM-2 mooring will exceed the design capacity of the moor even if the lines that did not require downgrading and the downgraded lines are downgraded to the next lower chain size in the future.

d. The scope of the mooring lines is sufficient to keep the anchors from lifting from bottom even under maximum design loads.

e. The varying measurements obtained by the underwater voltmeter cannot be used to predict the condition or future condition of this moor.

f. The anchor capacity of the anchors used in the ARDM-2 moor exceeds the original design loads.

RECOMMENDATIONS AND CONCLUSIONS

a. The presence of an impressed current system or a sacrificial anode system should be known prior to a diver inspection.

b. The as-built drawings and the original or anticipated design loads for a particular mooring system should be verified prior to inspecting a moor.

c. The mooring capacity of a moor should be dependent upon the capacity of downgraded components and should not be downgraded just on the basis of a percent change of a particular measurement.

d. The validity of the double-link chain measurements should be verified because corrosion and wear probably does not uniformly degrade both parts of a crevice/joint uniformly.

e. The validity of the single-link inspection of suspended mooring chains should be verified because of the joint or fretting surface of a mooring chain cannot usually be inspected in a diver operation.
(f) The validity of evaluating underwater potential measurements on chain links should be verified because of the great variance in potentials that may be present at a specific location along the moor.

(g) The subsequent underwater inspection of the ARDM-2 mooring should be programmed at two-year intervals. Since underwater inspection is a new effort, this time interval should be reviewed for possible adjustments to reflect information gained from other underwater inspections.
REFERENCES


7. "What Does 'Potential' Mean?" by Palmer, J.D., pp. 203-211, 17th Annual Appalachian Underground Corrosion Short Course, Engineering Experiment Station Bulletin 106, West Virginia University, Morgantown, W. VA.

Figure 1. Schematic of Spread Mooring for ARDM-2 (USS ALAMOGORDO)
<table>
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<tr>
<th>LEG</th>
<th>WEAKEST LINK</th>
<th>WORKING CAPACITY* (lbs)</th>
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<tbody>
<tr>
<td>A</td>
<td>2-3/16&quot; Stud Link Anchor Chain</td>
<td>131,915</td>
</tr>
<tr>
<td>B,C</td>
<td>2-3/16&quot; Stud Link Anchor Chain</td>
<td>131,915</td>
</tr>
<tr>
<td>D,H,M</td>
<td>2-3/4&quot; Stud Link Chain</td>
<td>206,130</td>
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* Based upon 0.35X Breaking Strength
### TABLE 2.

**FUTURE DOWNGRADED MOORING LEG WORKING CAPACITY**

<table>
<thead>
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<th>LEG</th>
<th>WEAKEST LINK</th>
<th>WORKING CAPACITY* (lbs)</th>
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<tbody>
<tr>
<td>A,B,C</td>
<td>2-3/16&quot; Chain Downgraded to 2-1/8&quot; Chain</td>
<td>126,540</td>
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<tr>
<td>D,H,M</td>
<td>2-3/4&quot; Stud Link Chain Downgraded to 2-5/8&quot; Chain</td>
<td>188,870</td>
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<tr>
<td>E,F,G</td>
<td>2-3/4&quot; Chain Downgraded in Capacity Twice to 2-1/2&quot; Chain</td>
<td>172,270</td>
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*Based upon 0.35X Breaking Strength*
<table>
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<tr>
<th>LEG</th>
<th>MAX. TENSION (kips)</th>
<th>CHAIN LIFTED 2-3/4&quot; Chain</th>
<th>FROM BOTTOM 2-3/16&quot; Chain</th>
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<tbody>
<tr>
<td>A</td>
<td>107.4</td>
<td>0%</td>
<td>65.4%</td>
</tr>
<tr>
<td>B</td>
<td>101.3</td>
<td>28.5%</td>
<td>100%</td>
</tr>
<tr>
<td>C</td>
<td>101.2</td>
<td>24.8%</td>
<td>100%</td>
</tr>
<tr>
<td>D</td>
<td>108.1</td>
<td>81.1%</td>
<td>---</td>
</tr>
<tr>
<td>E</td>
<td>108.1</td>
<td>47.7%</td>
<td>---</td>
</tr>
<tr>
<td>F</td>
<td>108.6</td>
<td>81.2%</td>
<td>---</td>
</tr>
<tr>
<td>G</td>
<td>108.6</td>
<td>48.5%</td>
<td>---</td>
</tr>
<tr>
<td>H</td>
<td>116.0</td>
<td>84.0%</td>
<td>---</td>
</tr>
<tr>
<td>I</td>
<td>116.0</td>
<td>49.4%</td>
<td>---</td>
</tr>
<tr>
<td>J</td>
<td>122.0</td>
<td>86.2%</td>
<td>---</td>
</tr>
<tr>
<td>K</td>
<td>122.0</td>
<td>50.7%</td>
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<tr>
<td>L</td>
<td>117.0</td>
<td>84.4%</td>
<td>---</td>
</tr>
<tr>
<td>M</td>
<td>117.0</td>
<td>84.4%</td>
<td>---</td>
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*As-Built configuration, including Rev. D*
ARDM-2
(USS ALAMOCORDO)
MOORING INSPECTION PLAN

FPO-1-73(1)
October 1973

Ocean Engineering and Construction
Project Office (FPO-1)
Chesapeake Division
Naval Facilities Engineering Command
Bldg. 57, Washington Navy Yard
Washington, DC 20374

Approved
C. E. BONET, FPO-VE

Date
25 Oct 73

E. R. SPENCER, FPO-1G
Date

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BACKGROUND

The Ocean Engineering and Construction Project Office (FPO-1) of the Chesapeake Division and Underwater Construction Team (UCT) have been tasked by NAVFACNAVCOM to conduct an underwater inspection of an ARDM mooring (figures 1, 2, 3, 4) at Charleston, SC (figure 5). FPO-1 is tasked by COMNAVFAC Msg 101944Z Aug 78 to provide the inspection criteria and procedures, record and interpret the data and write the inspection report. UCT One is tasked with performing the underwater inspection.

UNDERWATER INSPECTION

General Procedure

The inspections are intended to be a quick, economical method of establishing the general condition of moorings. The procedures are derived primarily from CEL TM No. M-42-78-12 entitled "San Diego Fleet Mooring Inspection" but are intended to be complete without referring to the reference document. The information derived from these inspections is suitable for maintenance decisions of extent and scheduling of overhauls and certifications of the class of moorings.

An initial diving check shall be performed to verify the drawings (Yd&D Drawing No. 1046632) or parts lists of each mooring (figures 1, 2, 3, 4). Assuming these documents are up to date, the divers can make simple, fast "go, no-go" measurements to establish the mooring condition on the ascent. If the mooring is not as in the drawings, an inventory of what is present must be taken before these measurements can be made.

Each leg of the mooring shall be visually inspected from the surface until it becomes buried in the seafloor or about 30 feet past the wearpoint (where the chain is picked up and set down on the bottom by tides and waves) whichever comes first. Bearing should be taken on this end point to determine the general mooring layout when possible by using a compass. The visual inspection should identify and record any obvious weak points in the chain such as cracked links, highly corroded sections, inoperative shackles and swivels, fouling by extraneous wire rope or chain, and condition of joining links and corrosion protection.

Measurements

The inspection consists of measuring the chain to determine the amount of corrosion and wear. Chain which is less than 90% of its original diameter should be downgraded in classification; chain which is less than 80% of its
104 FATHOMS OF DOCK'S
2 3/4" CHAIN TO CENTER BOW
HAWSE PIPE

90' SHOT OF
2 3/4" CHAIN

2 3/4" JL

2 3/4" SWIVEL

2 3/4" JL

2 3/4" JL

2 1/4" JL

2 1/2" JL

25000# ANCHOR
WITH STABILIZERS

BOTTOM: FINE SAND & MED. TO STIFF CLAY

DETAILS - LEG A
NO SCALE

FIGURE 2

Reproduced from best available copy
SWIVEL CHAIN SHOT
2 3/4" CHAIN 40'

2 3/4" AJL

BOTTOM
FINE SAND TO STIFF CLAY

TYPICAL DETAIL

NOTE: MOORING STAPLES ARE GENERALLY SUBMERGED
PULLING HYE
1/2" BALST
DETACHABLE ANCHOR
CONNECTING LINK

7 SHOTS 2 1/2" CHAIN FOR LEGS E, G, I & K
7 SHOTS 2 1/2" CHAIN FOR LEGS D, F, H, J, L, M

USE J.L. BETWEEN SHOTS

TAILS: LEGS D, E, F, G, H, I, J, K, L, M

NO SCALE
Measurements (continued)

Original diameter should be replaced. Single and double link measurements should be performed as in figure 6 at a randomly selected set of links, at areas listed below. Single link measurements on the wire diameter of a single A-link shall be performed to detect corrosion loss; double link measurements shall be taken where the two A-links contact in order to detect wear. Single link measurements should be made on three different diameters on the same approximate cross-section as shown in figure 6. The double link measurements should be made on three adjoining links as shown in figure 6.

The recommended procedure for two divers doing an inspection is as outlined in CEL TM No. M-42-78-12 and repeated below. One diver carries the voltmeter and the inspection form taped to a slate (when MK1 is used results can be recorded on surface instead). Diver 1 removes the growth and corroded materials down to bare metal, makes the caliper measurements and signals the results to diver 2 for recording on an inspection form taped to slate or transmitting using MK1 communications to the FPO-1 representative on the surface. Diver 2 then takes the voltmeter readings and records or transmits them likewise.

Location of Measurements

A selective measurement approach should be utilized. Areas which are known to corrode or wear rapidly shall be subjected to detailed inspection. These areas include the following:

a. Chain just below where it is connected to the ARDM

b. Chain at three equally distributed depths along the riser

c. Chain at the wear point (where the chain is picked up and set down on the bottom by tides and waves) which can be identified by less fouling or clean chain.

d. For the bowlines, measurements should be performed midway on the 2 3/16" chain, on both sides of the 2 1/4" anchor joining link (AJL), midway on the 2 3/4" chain, and at the wearpoint. If possible the chain in the hawse pipe should also be inspected. Anchor joining links should be visually inspected. Anchors should also be inspected when visible.
Calipers should be specially made in advance. Sizes required for the Charleston ARC mooring inspection include 2.46" (90% of 2 3/4"), 2.20" (80% of 2 3/4"), 2.05" (90% double link for 2 3/4" chain), 1.90" (90% double link for 2 3/4" chain), 1.97" (90% of 2 3/16"), 1.75" (80% of 2 3/16"), 3.94" (90% double link for 2 3/16" chain), and 3.50" (80% double link for 3 3/16" chain). All calipers should be accurately machined to ± .005 inches.

A recommended type of gage is the back to back type (figure 7). Each should be marked so they can be identified by feel underwater. This marking can be accomplished by wrapping tape around each gage to clearly identify the difference between the 80% and 90% calipers.

Cleaning tools such as a chipping hammer and a wire brush are required for cleaning growth and corroded material from the chain prior to taking measurements.

The inspection form (figure 8) is set up for use on each leg. The "other" locations can be used for the extra locations needed to be inspected on the bowlines or other areas that may show up during the visual inspection.

Reporting

Divers shall provide all inspection data to the on-site EPO-1 engineer who shall write up the inspection completion report and designate the status of each inspected line, i.e., downgrade, replace, or acceptable as is.
### Inspection Reporting Form

**ARM-2 Mooring**  
**Charleston, S. Carolina**

**Mooring Leg:**  

**Bearing to Anchor:**  

**Water depth:** 46'

**Date:** 11/7/78

**Divers:** Dahl, Chitwood

**Bottom Type:**  
- Sand
- Mud X
- Clay
- Rock

**Voltmeter Readings**  

11/8/78

<table>
<thead>
<tr>
<th>Location</th>
<th>MI</th>
<th>Condition</th>
<th>Single Link %</th>
<th>Double Link %</th>
<th>D</th>
<th>U/W Voltmeter Readings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near-Ash Surface</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>-.596</td>
<td></td>
</tr>
<tr>
<td>10'</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>- .496</td>
<td>3'</td>
</tr>
<tr>
<td>11/8/78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11/8/78</td>
<td></td>
</tr>
<tr>
<td>Mud Depth 20'</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>-.683</td>
<td></td>
</tr>
<tr>
<td>30'</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>-.632</td>
<td>-.621</td>
</tr>
<tr>
<td>Mud Point 40'</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>- .621</td>
<td></td>
</tr>
<tr>
<td>Other MUD 46'</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>46' Clear visibility</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**D:** Destroyed or broken  

**MI:** Not inspected, inaccessible.
# Inspection Reporting Form

**ARM 2 Hoisting**  
**Charleston, S. Carolina**

**Bearing to Anchor:**  
**Water depth:** 47'

**Date:** 11/7/78  
**Divers:** Dahl, Chitwood  
**Bottom Type:** Sandider, Mud X, Clay, Rock  
**Voltmeter 11/8/78**

<table>
<thead>
<tr>
<th>Extension</th>
<th>NI</th>
<th>Condition</th>
<th>Single Link %</th>
<th>Double Link %</th>
<th>D</th>
<th>U/W Voltmeter Readings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-583 - 584 - 584</td>
<td>Heavy marine growth along chain</td>
</tr>
<tr>
<td>10'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>2'</td>
<td></td>
</tr>
<tr>
<td>20'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-481 - 461 - 457</td>
<td>Bottom 47'</td>
</tr>
<tr>
<td>Other MUD</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Chain disappears into mud.</td>
</tr>
</tbody>
</table>

D - Destroyed or broken.  
NI - Not inspected, inaccessible.
## Inspection Reporting Form

**ARM-2 Mooring**  
CHARLESTON, S. CAROLINA

- Mooring Log: C
- Bearing to Anchor: \_
- Water depth: 45'

**Dated: 11/7/78**  
DIVERS: Dahl, Chitwood  
BOTTOM TYPE: SAND, MUD, CLAY, ROCK

**VU Meter, 11/8/78**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>WATER DEPTH</th>
<th>NI</th>
<th>SINGLE LINK %</th>
<th>DOUBLE LINK %</th>
<th>D</th>
<th>U/U VOLTMETER READINGS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>90+</td>
<td>60+</td>
<td>80-</td>
<td>90+</td>
<td>60+</td>
</tr>
<tr>
<td>NEAR-ARMH Surface</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
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<tr>
<td>MWD-DEPTH 10'</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>MWD-DEPTH 20'</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>MWD-DEPTH 30'</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>MWD-POINT 40'</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>OTHER MUD 45'</td>
<td></td>
<td>X</td>
<td>_</td>
<td>_</td>
<td>X</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- D - Destroyed or broken  
- NI - Not inspected, inaccessible
# Inspection Reporting Form
**Area: 2 Mooring**
**Charleston, S. Carolina**

<table>
<thead>
<tr>
<th>Location</th>
<th>Water Depth</th>
<th>NI</th>
<th>Single Link %</th>
<th>Double Link %</th>
<th>D</th>
<th>U/W Voltmeter Readings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Anchor</td>
<td>9'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-.873 -.874 -.869</td>
<td>Heavy Marine Growth along chain</td>
</tr>
<tr>
<td>Deep-Depth</td>
<td>21'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>12'</td>
<td>20'- Line wrapped around chain</td>
</tr>
<tr>
<td>Mid-Depth</td>
<td>30'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>30'-Current picking up No visibility</td>
</tr>
<tr>
<td>Mid-Depth</td>
<td>40'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>40'- Current strong; Growth lighter, line wrapped around chain</td>
</tr>
<tr>
<td>Mid-Depth</td>
<td>49'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-.590 -.575 -.549</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.656 -.645 -.606</td>
<td>Chain disappear into mud.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**D** - Destroyed or broken  
**NI** - Not inspected, inaccessible
## INSPECTION REPORTING FORM

**ARM-2 MOORING**

**CHARLESTON, S. CAROLINA**

Mooring Leg: E  
Bearing to Anchor:  
Water depth: 46'

**DATE:** 11/8/78  
**DIVERS:** Beckwith  
**BOTTOM TYPE:** SAND, MUD X, CLAY, ROCK

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>WATER DEPTH</th>
<th>NI</th>
<th>CONDITION</th>
<th>90+</th>
<th>60+</th>
<th>60-</th>
<th>90+</th>
<th>60+</th>
<th>60-</th>
<th>D</th>
<th>U/W VOLTAMETER READINGS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near Arch</td>
<td>10'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.240</td>
<td>-0.238</td>
<td>-0.239</td>
</tr>
<tr>
<td>Mid-Depth</td>
<td>20'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.100</td>
<td></td>
<td>10'</td>
</tr>
<tr>
<td>Mid-Depth</td>
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<td></td>
<td></td>
<td></td>
<td>-0.945</td>
<td>-0.930</td>
<td>-0.900</td>
</tr>
<tr>
<td>Mid-Depth</td>
<td>40'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.945</td>
<td>-0.930</td>
<td>-0.900</td>
</tr>
<tr>
<td>End Point</td>
<td>46'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.945</td>
<td>-0.930</td>
<td>-0.900</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28'</td>
</tr>
<tr>
<td>OTHER</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

**D:** Destroyed or broken  
**NI:** Not inspected, inaccessible
**INSPECTION REPORTING FORM**
ARCH-2 MOORING
CHARLESTON, S. CAROLINA

**Meeting Leg:**

**Bearing to Anchor:**

**Water depth:** 49'

**DATE:** 11/7/78

**DIVERS:** Venhaus, Chitwood

**BOTTOM TYPE:**
- SAND
- MUD X
- CLAY
- ROCK

**Voltmeter Measurements**
11/8/78

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>LOCATION WATER DEPTH</th>
<th>MI</th>
<th>SINGLE LINK</th>
<th>DOUBLE LINK</th>
<th>D</th>
<th>U/W VOLTMETER READINGS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>90+</td>
<td>80+</td>
<td>80-</td>
<td>90+</td>
<td>80+</td>
</tr>
<tr>
<td>MAST HEAD</td>
<td>14'</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINDL CREEK</td>
<td>22'</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINDL CREEK</td>
<td>30'</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINDL CREEK</td>
<td>40'</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUD</td>
<td>48'</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUD</td>
<td>49'</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**D- Destroyed or broken**

**MI- Not inspected, inaccessible**
**INSPECTION REPORTING FORM**

**ARDM-2 MOORING**

**CHARLESTON, S. CAROLINA**

**Mooring Leg:** G

**Bearing to Anchor:**

**Water depth:** 44'

**DATE:** 11/8/78

**DIVERS:** Beckwith

**BOTTOM TYPE:** SAND MUD CLAY

**LOCATION** | **WATER DEPTH** | **NI** | **CONDITION** | **U/W VOLTMETER READINGS** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NEAR ARDM</td>
<td>13'</td>
<td></td>
<td>X</td>
<td>.470 - .480 - .490</td>
</tr>
<tr>
<td>MED-DEPTH</td>
<td>20'</td>
<td></td>
<td>X</td>
<td>.550 - .560 - .590</td>
</tr>
<tr>
<td>MUD-DEPTH</td>
<td>30'</td>
<td></td>
<td>X</td>
<td>13'</td>
</tr>
<tr>
<td>MIB-DEPTH</td>
<td>44'</td>
<td></td>
<td>X</td>
<td>35'</td>
</tr>
<tr>
<td>WEAPPOINT</td>
<td></td>
<td></td>
<td>X</td>
<td>13'</td>
</tr>
</tbody>
</table>

**COMMENTS**

- 13' - Visibility 2'-3'
- 30' - Manila line around chain; minimal current
- Heavy Marine Growth to 30'; Lighter Growth beyond 30'
- Approximately 3' of mud on bottom
- Chain disappears into mud

D - Destroyed or broken  
NI - Not inspected, inaccessible
**INSPECTION REPORTING FORM**

**ARDM-2 MOORING**

**CHARLESTON, S. CAROLINA**

**Mooring Log:** H

**Bearing to Anchor:**

**Water depth:** 47'

**DATE:** 11/9/78

**DIVERS:** J. Reynolds

**BOTTOM TYPE:** SAND MUD X CLAY ROCK

Venhaus 10:40, single link measurement

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>NI</th>
<th>WATER DEPTH</th>
<th>CONDITION</th>
<th>U/V VOLTMETER READINGS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN ANCHOR</td>
<td>12'</td>
<td>12'</td>
<td>X X</td>
<td>-.829 -.820 -.824</td>
<td>Marine growth along chain</td>
</tr>
<tr>
<td>HDG DEPTH</td>
<td>20'</td>
<td>20'</td>
<td>X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDG DEPTH</td>
<td>30'</td>
<td>30'</td>
<td>X X</td>
<td>13'</td>
<td></td>
</tr>
<tr>
<td>HDG DEPTH</td>
<td>40'</td>
<td>40'</td>
<td>X X</td>
<td>-.758 -.757 -.759</td>
<td>Chain disappears into mud</td>
</tr>
<tr>
<td>MUD</td>
<td>47'</td>
<td>47'</td>
<td>X</td>
<td>44'</td>
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</tr>
<tr>
<td>MUD</td>
<td></td>
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<td></td>
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<tr>
<td>MUD</td>
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<td></td>
</tr>
</tbody>
</table>

D- Destroyed or broken

NI- Not inspected, inaccessible
### Inspection Reporting Form

**ARD 2 Mooring**  
**Charleston, S. Carolina**

**Mooring Log:** X  
**Bearing to Anchor:**  
**Water depth:** 45'

**Date:** 11/9/78  
**Divers:** J. Reynolds  
**Bottom Type:** Sand MUD X Clay Rock  
*Double link and volt meter measurements*

**Venhaus 11/10/78 - single link measurements**

<table>
<thead>
<tr>
<th>Location</th>
<th>NI</th>
<th>Single Link %</th>
<th>Double Link %</th>
<th>D</th>
<th>U/W Voltmeter Readings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near Ard 12'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-0.372 -0.378 -0.374</td>
<td>Heavy marine growth along chain</td>
</tr>
<tr>
<td>Med Depth 20'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>12'</td>
<td>20' - Manila line</td>
</tr>
<tr>
<td>Med Depth 30'</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>-0.649 -0.694 -0.694</td>
<td>35' - Wire pendant</td>
</tr>
<tr>
<td>Med Depth 40'</td>
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<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mullen Deeppoint</td>
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<td>X</td>
<td>X</td>
<td></td>
<td>41'</td>
<td>Chain disappears into mud</td>
</tr>
<tr>
<td>Other</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**D** - Destroyed or broken  
**NI** - Not inspected, inaccessible
INSPECTION REPORTING FORM  
ARM-2 MOORING  
CHARLESTON, S. CAROLINA  

Mooring Leg: M  
Bearing to Anchor:  
Water depth: 44'  

DATE: 11/9/78  
DIVERS: J. Reynolds.  
BOTTOM TYPE: SAND __ MUD X CLAY __ ROCK  
  double link and voltmeter measurements  
  Vonhaus 11/10/78 - single link measurement  

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>WATER DEPTH</th>
<th>NI</th>
<th>CONDITION</th>
<th>SINGLE LINK%</th>
<th>DOUBLE LINK%</th>
<th>D</th>
<th>U/W VOLTMETER READINGS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90+</td>
<td>80+</td>
<td>80-</td>
<td>90+</td>
<td>80+</td>
</tr>
<tr>
<td>NEAR ARM</td>
<td>15'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD-DEPTH</td>
<td>20'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD-DEPTH</td>
<td>30'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD-DEPTH</td>
<td>40'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIZMIZ</td>
<td>44'</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D- Destroyed or broken  
NI- Not inspected, inaccessible
APPENDIX 3
SUMMARY OF ORIGINAL DESIGN LOADS FOR ARDM-2 SPREAD MOORING

The following design loads were obtained from Mr. Don Potter and are based on the original design of the "ARDM-2 Spread Mooring" U.S. Naval Ammunition Depot, Charleston, S.C., Yards and Docks

Drawing No. 1046632:

9.5 Draft, Wind = 70 MPH @ 60°, Current = 3 Knots @ 0°

A = 10,400 lbs
B,C = 54,500 lbs
D,E = 57,800 lbs Used 60,000 lb design
F,G = 58,100 lbs
H,I = 56,000 lbs
J,K = 54,500 lbs
L,M = 34,600 lbs

20 Draft, Wind = 106 MPH @ 60°, Current = 3 Knots @ 0°

A = 22,900 lbs
B,C = 101,000 lbs
D,E = 105,000 lbs
F,G = 106,000 lbs
H,I = 101,200 lbs
J,K = 98,100 lbs
L,M = 60,000 lbs

(43)
20' Draft, Wind = 106 MPH @ 120°, Current = 2 Knots @ 180°

B,C = 60,900 lbs
D,E = 74,000 lbs
F,G = 80,000 lbs
H,I = 113,500 lbs
J,K = 119,500 lbs
L,M = 102,000 lbs

FINAL DESIGN
20' Draft, Wind = 106 MPH, Current 3-2 Knots

Max. Line Loads
A = 105,800 lbs
B,C = 101,000 lbs
D,E = 105,600 lbs
F,G = 106,100 lbs
H,I = 113,500 lbs
J,K = 119,500 lbs
L,M = 114,500 lbs

(All lines designed for 120,000 lb loads)
### AS-BUILT CONFIGURATION ARDM MOOR

<table>
<thead>
<tr>
<th>MOORING LINE</th>
<th>WEAKEST COMPONENT</th>
<th>Equivalent NEXT COMPONENT=Chain Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2-3/16” Chain</td>
<td>2-1/4 AJL 2-1/4”</td>
</tr>
<tr>
<td>B, C</td>
<td>2-3/16” Chain</td>
<td>2-1/4 AJL 2-1/4”</td>
</tr>
</tbody>
</table>

(46)
### DOWNGRADED STUD LINK CHAIN WORKING CAPACITY

<table>
<thead>
<tr>
<th>ORIGINAL DIAMETER (INCHES)</th>
<th>DOWNGRADED** DIAMETER (INCHES)</th>
<th>DOWNGRADED BREAKING STRENGTH (POUNDS)</th>
<th>DOWNGRADED WORKING CAPACITY* (POUNDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1-7/8</td>
<td>284,540</td>
<td>99,590</td>
</tr>
<tr>
<td>2-1/8</td>
<td>2</td>
<td>322,000</td>
<td>112,700</td>
</tr>
<tr>
<td>2-3/16**</td>
<td>2-1/8</td>
<td>361,530</td>
<td>126,540</td>
</tr>
<tr>
<td>2-1/4</td>
<td>2-1/8</td>
<td>361,530</td>
<td>126,540</td>
</tr>
<tr>
<td>2-3/8</td>
<td>2-1/4</td>
<td>403,100</td>
<td>141,090</td>
</tr>
<tr>
<td>2-1/2</td>
<td>2-3/8</td>
<td>446,660</td>
<td>156,330</td>
</tr>
<tr>
<td>2-5/8</td>
<td>2-1/2</td>
<td>492,190</td>
<td>172,270</td>
</tr>
<tr>
<td>2-3/4</td>
<td>2-5/8</td>
<td>539,620</td>
<td>188,870</td>
</tr>
<tr>
<td>2-7/8</td>
<td>2-3/4</td>
<td>588,930</td>
<td>206,130</td>
</tr>
<tr>
<td>3</td>
<td>2-7/8</td>
<td>640,070</td>
<td>224,020</td>
</tr>
<tr>
<td>3-1/8</td>
<td>3</td>
<td>693,000</td>
<td>242,550</td>
</tr>
<tr>
<td>3-1/4</td>
<td>3-1/8</td>
<td>747,680</td>
<td>261,690</td>
</tr>
</tbody>
</table>

* From Section 3, Part 7.b, PP. 2(c) Working Load for Used Chain
** Dowgraded size is next smaller size chain in Table 7-9, DM-26.
*** Size not listed in DM-26, listed as chain size in Baldt Stud Link Chain Dimensions
MAXIMUM CHAIN TENSION AND SCOPE

Mr. Andrew Del Collo performed the following calculations utilizing the maximum line loads from the final design calculations and the chain size and lengths specified in the as-built drawings for the ARDM-2 Moor. The following table is a summary of the results:

<table>
<thead>
<tr>
<th></th>
<th>2-3/4&quot; Chain (kips)</th>
<th>2-3/16&quot; Chain (kips)</th>
<th>Chain Lifted Off Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>105.8</td>
<td>107.4</td>
<td>0' of 2-3/4&quot;, 408' of 2-3/16&quot;</td>
</tr>
<tr>
<td>B</td>
<td>101.3</td>
<td>102.7</td>
<td>101' of 2-3/4&quot;, 250' of 2-3/16&quot;</td>
</tr>
<tr>
<td>C</td>
<td>101.2</td>
<td>102.6</td>
<td>88' of 2-3/4&quot;, 268' of 2-3/16&quot;</td>
</tr>
<tr>
<td>D</td>
<td>108.1</td>
<td>----</td>
<td>324.2' of 2-3/4&quot; Chain</td>
</tr>
<tr>
<td>E</td>
<td>108.1</td>
<td>----</td>
<td>324.2' &quot; &quot;</td>
</tr>
<tr>
<td>F</td>
<td>108.6</td>
<td>----</td>
<td>324.9' &quot; &quot;</td>
</tr>
<tr>
<td>G</td>
<td>108.6</td>
<td>----</td>
<td>324.9' &quot; &quot;</td>
</tr>
<tr>
<td>H</td>
<td>116.0</td>
<td>----</td>
<td>336.0' &quot; &quot;</td>
</tr>
<tr>
<td>I</td>
<td>116.0</td>
<td>----</td>
<td>336.0' &quot; &quot;</td>
</tr>
<tr>
<td>J</td>
<td>122.0</td>
<td>----</td>
<td>344.6' &quot; &quot;</td>
</tr>
<tr>
<td>K</td>
<td>122.0</td>
<td>----</td>
<td>344.6' &quot; &quot;</td>
</tr>
<tr>
<td>L</td>
<td>117.0</td>
<td>----</td>
<td>337.4' &quot; &quot;</td>
</tr>
<tr>
<td>M</td>
<td>117.0</td>
<td>----</td>
<td>337.4' &quot; &quot;</td>
</tr>
</tbody>
</table>
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