AD-759 772

# WATERWAY EQUIPMENT-BOAT, BARGE, MOTOR

Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

18 August 1972

UNCLASSIFIED

Security Classification

AD-759772

## DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

| | |
|---|---|
| 1. ORIGINATING ACTIVITY (Corporate author)<br>U. S. Army Test and Evaluation Command<br>Aberdeen Proving Ground, Maryland 21005 | 2a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED<br>2b. GROUP |

3. REPORT TITLE

U. S. Army Test and Evaluation Command Test Operations Procedure "Waterway Equipment-Boat, Barge, Motor"

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final

5. AUTHOR(S) (First name, middle initial, last name)

| 6. REPORT DATE | 7a. TOTAL NO. OF PAGES | 7b. NO. OF REFS |
|---|---|---|
| 18 August 1972 | 42 | 41 |

| | |
|---|---|
| 8a. CONTRACT OR GRANT NO. | 9a. ORIGINATOR'S REPORT NUMBER(S) |
| b. PROJECT NO. | TOP 9-2-251 |
| c. AMCR 310-6 | 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) |
| d. | |

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

| 11. SUPPLEMENTARY NOTES | 12. SPONSORING MILITARY ACTIVITY |
|---|---|
| | Headquarters<br>U. S. Army Test and Evaluation Command<br>Aberdeen Proving Ground, Maryland 21005 |

13. ABSTRACT

The report

Describes a method for evaluation of waterway equipment performance and operational characteristics. Identifies facilities and equipment required. Discusses supporting tests. Provides procedures for watertight integrity, stability, static flotation, dynamic pitch and roll, dock trials, components and subsystems, bollard pull tests, sea trials, turning radius, towing and resistance, beaching, ramp operation, operational performance, communications and navigation equipment, inflation (inflatables), pressure (inflatables), and leakage (inflatables) tests. Applicable to barges and lighters; passenger, cargo, landing, assault, picket, patrol, tug, tow, and special purpose boats.



DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| Barge | | | | | | |
| Boat | | | | | | |
| Landing Craft | | | | | | |
| Marine Equipment | | | | | | |
| Motors | | | | | | |
| Waterway Equipment | | | | | | |

U. S. ARMY TEST AND EVALUATION COMMAND
ENGINEERING TEST - SYSTEM TEST OPERATIONS PROCEDURES

AMSTE-RP-702-108
*Test Operations Procedure 9-2-251 18 August 1972

# WATERWAY EQUIPMENT - BOAT, BARGE, MOTOR





AD-724083 AD-869847

*This TOP supersedes MTP's 9-2-251 (23 Apr 71), 9-2-253 (24 Mar 70), 9-2-254 (3 Aug 70), and 9-2-256 (30 Mar 70), including all changes.

AD-876406 AD-871912

## SECTION 1
## GENERAL

1. Purpose and Scope. This TOP provides guidance for planning tests of waterway equipment including harborcraft and floating equipment used in harbors, inland waters, and coastal operations. Items covered include barges and lighters, boats (passenger, cargo, landing, assault, picket and patrol, tug and tow, bridge erection, and special purpose), landing craft and amphibians, and outboard propelling units. Test objectives are to determine conformance of the test items with MN or other suitability criteria. The scope of testing will be selected from section II to satisfy the requirements for the particular test item and test type. For engineering tests, scope will be dependent on the criteria stated in the governing MN. For initial production tests, scope will be in accordance with the contractual provisions of the applicable military specification and suitability criteria as established by the test directive. This TOP is a basic guide for preparing actual test plans, and procedures may require modification to suit special items.

2. Background. The planning and executing of military operations, marine and amphibious in nature, requires a variety of waterway equipment for transporting personnel, equipment, and materiel over water barriers, ship-to-shore, through inland waterways, and within terminals, ports, and beach complexes. Included are the following:

a. Small Craft. Portable assault, landing, and reconnaissance boats (rigid and inflatable) carry combat personnel in river crossing and calm water operations. Boats may be oar, sail, or outboard engine propelled.

b. Passenger and Cargo, Utility, and Picket Boats. Passenger and cargo boats and utility boats move limited amounts of cargo or small groups of personnel between ship and shore or between two shore points. They are self-propelled and are capable of moderate speeds. Picket boats are used for command and inspection and for routine patrol missions in harbors and adjacent waters. They are capable of fairly high speeds and can make short trips to sea.

c. Harbor Tugs Harbor tugs berth and unberth large ships and move barges in harbors and adjacent waters. The predominant characteristics of harbor tugs are maneuverability, power, ample stability, and good cruising range. Limited firefighting equipment is provided on all harbor tugs.

d. Cargo Vessels. Cargo vessels transport dry, liquid, and refrigerated cargo. They have inboard machinery for propulsion of the vessel, and are equipped with gear suitable for loading and discharging the cargo they are designed to carry.

e. Nonpropelled Barges and Conversion Kits. Nonpropelled barges are of the dry, liquid, or refrigerated cargo type. Liquid or refrigerated cargo barges have installed machinery for their purpose. Dry cargo barges may be of hold, deck, or enclosed-deck types and may be used as breasting barges, work boats, or cargo lighters. Conversion kits for certain deck barge designs convert these vessels to covered barges for the protection of cargo.

f. Landing Craft. Landing craft are designed to beach, unload or load on the beach, and retract. Loading or discharging landing craft at the beach is expedited by the use of bow ramps. Landing craft are used in tactical and logistical operations, and for lighterage or utility work within harbors.

g. Amphibious Lighters. Amphibious lighters are used to:

(1) Transport troops, equipment, and supplies from ships offshore to inland dumps and transfer points in tactical and logistical operations.

(2) Supply outposts located on nearby islands or points inaccessible by land from the principal supply points.

(3) Evacuate casualties and prisoners of war in retrograde movements.

(4) Transfer material from inland sites directly to ships.

Amphibious lighters can traverse soft sand or rough terrain and can operate on hard, smooth surfaces at relatively high speed. The larger models have ramps similar to landing craft to expedite loading or discharge.

h. Special Purpose Craft. Included are boats for special tasks such as bridge erection and pipeline laying; barges for use as piledrivers, floating repair shops, or elevating piers; and floating cranes for heavy lifts, dredging, and salvage work. Barges may be sectionalized and nesting types.

i. Propelling Units. Separate propulsion units for boats and barges include conventional gasoline outboard engines and large diesel-engine-driven units for barge operation. Experimental craft may employ air propellers or waterjet propulsion.

3. Equipment and Facilities. Special test facilities are described in appendix B.

## SECTION II
## TEST PROCEDURES

4. Supporting Tests. Subtests (generally in the preferred order of completion with respect to optimum test sequence) to be considered in formulating an engineering test plan are listed below with applicable TOP/MTP, Military Standards, and other references.

| TEST SUBJECT TITLE | PUBLICATION NO. |
|---|---|
| a. Inspection (refer to para 8) | 10-3-500 |
| b. Physical Characteristics (refer to para 9) | 10-2-500 |
| c. Safety Evaluation (refer to para 10) | 10-2-508, USCG-256, 257, 258, 323 |
| d. Performance Tests: | |
| (1) Watertight Integrity (refer to para 11) | |
| (2) Stability (refer to para 12) | |
| (3) Static Flotation (refer to para 13) | |
| (4) Dynamic Pitch and Roll (refer to para 14) | |
| (5) Dock Trials (refer to para 15) | |
| (6) Components and Subsystems (refer to para 16) | |
| (7) Bollard Pull Tests (refer to para 17) | |
| (8) Sea Trials (refer to para 18) | |
| (9) Turning Radius (refer to para 19) | |
| (10) Towing Resistance (refer to para 20) | |
| (11) Beaching (Landing Craft) (refer to para 21) | |
| (12) Ramp Operation (Landing Craft and Amphibians) (refer to para 22) | |
| (13) Operational Performance (refer to para 23) | |
| (14) LOTS | 10-3-510* |
| (15) Communications, Electronic, and Navigation Equipment (refer to para 24) | |
| (16) Kits (refer to para 25) | |
| (17) Inflatables: | 10-2-200 |
| (a) Inflation (refer to para 26) | |
| (b) Pressure (refer to para 27) | |
| (c) Leakage (refer to para 28) | |

*To be superseded by TOP 1-2-510

| TEST SUBJECT TITLE (CONT) | PUBLICATION NO. (CONT) |
|---|---|
| (18) Initial Production Tests (refer to para 29) | |
| (a) Barges: | |
| Deck or Liquid Cargo | MIL-B-10122, 10527, 10586 |
| Sectionalized, Nesting | MIL-B-3596 |
| Crane | MIL-C-10776, 10309 |
| (b) Boat, Assault (Rigid): | |
| Plastic, 16-Foot | MIL-B-13592 |
| Plywood, M2 | MIL-B-52515 |
| Aluminum, 16-Foot | MIL-B-58003 |
| (c) Boat, Landing (Inflatable): | |
| 3-Man | MIL-B-13831 |
| 7-Man | MIL-B-17775 |
| 10-Man | MIL-B-18119 |
| 15-Man | MIL-B-58022 |
| (d) Boat, Bridge Erection | MIL-B-13994 |
| (e) Boat, Passenger and Cargo | MIL-B-10863 |
| (f) Boat, Picket (Patrol): | |
| Steel, Design 4003 | MIL-B-11746 |
| Wood, Design 4002 | MIL-B-11790 |
| (g) Landing Craft: | |
| LCM-8, 69-Foot to 74-Foot | Navy specification |
| LCU, 115-Foot | Navy specification |
| (h) Tug, Harbor: | |
| 45-Foot | MIL-T-10774 |
| 65-Foot | MIL-T-10920 |
| 100-Foot | MIL-T-10862 |
| (i) Propelling Units: | |
| Motor, Outboard | MIL-O-11585 |
| Diesel, 165 Horsepower | MIL-P-15916 |
| (j) Conversion Kit, Deckhouse | MIL-C-13746 |

| TEST SUBJECT TITLE (CONT) | PUBLICATION NO. (CONT) |
|---|---|
| (k) Lighters and Amphibians: | |
| LARC V | MIL-L-58048 |
| LARC XV | MIL-L-58063 |
| LARC LX | MIL-L-58017 |
| Beach Discharge Lighter | Navy specification |
| e. Environmental Tests (refer to para 30) | |
| Rough Handling Environment | 4-2-602 |
| f. Electromagnetic Interference: | MIL-STD-461, Notice 4<br>MIL-STD-462, Notice 3 |
| (1) All | Method RE 05 |
| (2) Assault Boats | Method CE 07 |
| g. Reliability | AMCP 702-3 |
| Confidence Intervals and Sample Size | 3-1-002 |
| h. Transportability | 1-2-500 |
| i. Endurance | 10-2-502 |
| j. Maintenance Evaluation | 1-2-501 |
| k. Human Factors Evaluation | 10-2-505, 3-2-811 |
| l. Value Engineering | AMCP 706-104 |

## SECTION III
## SUPPLEMENTARY INSTRUCTIONS

5. **Test Planning.**

a. Engineering test planning requires review of test guidance literature, familiarization with preceding development and test phases, study of test criteria,* and selection of appropriate samples, methods, sequence, facilities, and test equipment. Standards for the test phases outlined in this section are given in the applicable MN or test directive as indicated in paragraph 1. Risk/cost and safety provisions must be given prime consideration. Data from previous and similar tests should be considered in order to avoid duplication and reduce the scope of further testing. Background Document TOP 1-1-045 should be referred to.

b. Some marine items are procured for the Army by the Navy which conducts certain trials and acceptance tests prior to delivery to the Army. Such tests should be observed, and findings considered in planning further tests.

6. Preparation for Test. Test preparations include the selection of appropriate test facilities (app B), arrangement for support, review of the safety statement from the developer, and the selection and training of the test team which may involve attendance at new equipment training courses. Adequate leadtime should be planned in view of the extensive support and training required for some items.

7. Familiarization and Training. Members of the test team will be experienced in boat handling and be accomplished swimmers. For vessels requiring crew licensing in accordance with regulatory requirements, valid certification will be assured. The test director will make available copies of pertinent publications as required (app A). The test team will conduct practice drills and trials as necessary to assure crew proficiency.

8. Inspection. The initial inspection is conducted in a sequence that will insure that data, photographs, and damage assessment are obtained on the equipment as initially delivered, transported, crated or cradled; followed by inventory, technical inspection, assembly, and functional checkout, as appropriate. (See app C for a detailed procedure). Care is taken to obtain dimensions, weights, cubages, and component data required before unpacking or assembly. During the detailed inventory and inspection, note should be made of the use of standard components and accessories as may be required by the MN. Adequacy of the technical literature provided for training and servicing on receipt should be noted.

9. Physical Characteristics.

a. For much of marine procurement, whether by Army or Navy, certification of characteristics is required in accordance with such documents as the American Bureau of Shipping "Rules for Building and Classing of Steel Vessels" or U. S. Navy standards as incorporated in procurement specifications. Construction, arrangement, stability, lifesaving equipment, controls, components, and systems are required to conform to such documents as U. S. Coast Guard "Rules and Regulations for Cargo and Miscellaneous Vessels." Sanitation, ratproofing, and potable water systems must conform to requirements of the U. S. Public Health Service. In general, compliance is determined during construction and acceptance trials. Test personnel should observe and participate in the procedures for determining regulatory compliance when practical.

b. When previous testing has been accomplished (EDT, preproduction), data are reviewed and accepted where valid. Characteristics undetermined, in question, or subject to change are confirmed by actual measurement or analysis. Measurements will include all required configurations and may involve data collection in subsequent phases. Modular and component determinations are made at the appropriate stage of assembly. When required, separate samples of materials for laboratory analysis are obtained. Special tests are planned for determining strain, fatigue, and materials characteristics, such as the following:

Magnetic particle test (MIL-STD-271D, para 4; TOP 3-2-807).
Liquid penetrant (MIL-STD-271D, para 5; TOP 3-2-807).
Hardness (FED-STD-151B, TOP 3-2-806).
Material specifications (USCG 115).
Electrical installations (AIEEE No. 45).
Laminate properties (plastic) (MIL-B-13592B, para 4.6.2.4).
Seam strength (inflatables) (FED-STD-601, Method 8311).
Attachment strength (inflatables) (MIL-B-13831E, para 4.6.2.6).

10. Safety Evaluation. The safety subtest takes cognizance of the scope of marine operations and insures the incorporation of applicable marine safety provisions, including the conduct of firefighting and lifeboat drills, use of an accompanying safety boat when applicable, and particular emphasis on communications during at-sea and night operations. Reference is made, as necessary, to such guidance as U. S. Coast Guard regulations, rules of international convention for safety of life at sea, and applicable safety directives.

11. Watertight Integrity.

a. Objective. To evaluate the watertightness of the test item.

b. Method.

(1) Before being placed in the water the hull is inspected to insure that all bilge plugs are in place and tight, and all sea valves are closed. The vessel is launched in calm water of sufficient depth and secured to dock or pier. The vessel is loaded with deadweight cargo to design capacity or displacement properly distributed. At the end of a specified period or as stated in the MN or other criteria, hull, bilge areas, and piping below waterline are visually inspected for leaks.

(2) Deckhouses and areas above waterline are subjected to water hose tests. All doors, hatches, ports, and other hull openings are closed tightly or blanked (in case of vents). Water is applied at 50 psi pressure, -0 +5 psi, from a 1-1/2-inch inside diameter hose with a 1-inch nozzle full open, positioned not more than 10 feet from the surface being tested. The spray is applied at a rate of 1 minute per square yard of test surface. Visual inspection is made of internal areas opposite the applied stream of water.

(3) Inflatable items are loaded with sandbags or weights to simulate intended personnel seating, with at least 3 inches of freeboard

remaining, positioned so that the boat or raft remains level while afloat. The test item is left floating for the specified period and inspected periodically for leakage. Tests are run on multiple samples when specified.

(4) Some items may be placed directly on the Rain Course (TOP 10-2-021) and subjected to controlled rainfall conditions. Where a hose test is not practical, air under pressure may be applied, and a soap solution used on the opposite side of the structure at seams and closures. Internal tanks may be tested by filling to the top of the overflow with the liquid to be carried, allowing the item to stand for 24 hours, and inspecting for leakage. Small inflatables may be pressurized, weighted and submerged in water, and observed for bubbles as an indication of leakage.

12. Stability.

a. Objective. To determine the stability characteristics of the test item.

b. Method. Stability characteristics are determined by locating the center of gravity, metacentric height, and transverse radius of gyration of a craft. To determine center of gravity for small items capable of suspension with available lifting facilities, procedures in TOP/MTP 2-2-800 are used, either suspension or reaction methods, and the location is recorded in respect to the baseline, centerline, bow, and stern. For larger vessels, an inclining experiment is used to determine the vertical center of gravity and metacentric height. The experiment with the vessel afloat is accomplished by positioning a known weight at known distances on either side of the vessel's centerline producing various angles of heel. From these data, the metacentric height can be calculated. Using the metacentric height, vessel draft, and certain vessel design drawings, the center of gravity is computed.

(1) Preparing for Tests (Refer to USCG Circular 1-67).

(a) Drawings and Data. Vessel design data are obtained including the line's drawing, table of offsets, curves of form, hydrostatic curves, midship sections, profiles, arrangement and deck plans, tank tables, and sounding information. Data include calculated displacement, baseline identification, longitudinal and vertical center of buoyancy, tons per inch immersion, moment to trim one inch, and molded dimensions.

(b) Environment. Selected water should be calm and at slack tide. Inclement weather should be avoided. Wind can seriously affect the validity of the results. Rain, snow, and ice can result in added weight. The vessel should be moored in quiet, sheltered water free of current, propeller wash from passing craft, or sudden pump discharges. Depth of water must be sufficient to ensure that the hull will be entirely free of the bottom. Tide conditions, trim, and list of the vessel under test must be considered.

(c) Inclining Weight. The total weight used should be sufficient to give an inclination of 2° to 3° to each side with the larger inclinations necessary to get sufficient deflection of the pendulum on smaller vessels. The inclination should never exceed 4°. The weights should be compact and of such configuration that the vertical center of gravity may be accurately determined. (People are not acceptable as weights.) The weights must be capable of being moved rapidly once the test is started to reduce the likelihood of encountering changing wind or current conditions. The transfer of liquids between tanks is not acceptable. Precautions should be taken to ensure that the decks are not overloaded during weight movements. The weight and an identification number should be marked on each weight.

(d) Pendulums. Where possible, three pendulums should be used to allow for possible bad readings at any one pendulum station. They should be located in an area protected from the wind. The pendulums should be as long as possible to allow for maximum deflection at the batten. A typical satisfactory arrangement is shown in figure 1. The pendulums do not have to be on centerline. The battens as shown in figure 1 should be smooth, light-colored wood, 1/2- to 3/4-inch thick, and must be securely fixed in position so that an inadvertent shock will not cause them to shift. A weight should be attached at the end of the pendulum as shown in the sketch. The bucket is used to dampen the swinging of the pendulum thereby stabilizing the arrangement.

NOTE: It is possible to substitute inclinometers for the pendulums except that inclinometers are less desirable because of their rather short length of pivot arm.

(e) Condition of the Vessel. The craft must be fully equipped with all attachments, accessories, repair parts, and assigned tools. The test director should verify that all items are on board and stowed in their assigned locations. Movable weights must be lashed in place. Bilges must be dry and decks free of liquids. All wet machinery and piping should be at operating liquid level. All tanks should be either completely filled or completely empty. For purposes of the stability evaluation it is recommended that the tanks be completely filled with their assigned liquids. The vessel should not have a list at the start of the inclining experiment. Leveling weights may be used to correct list. It is essential that the exact status of the vessel be known as it exists at the time of inclining. A list should be prepared indicating the weight and location of the center of gravity of all heavy objects that are not considered part of the vessel attachments or accessories. This includes leveling weights, personnel, dunnage, stores, tankage, etc. To ensure satisfactory communications during the inclining experiment, it is recommended that a telephone system with headsets be furnished to allow for two-way communications between the central control station, the weight handlers, and each pendulum station.

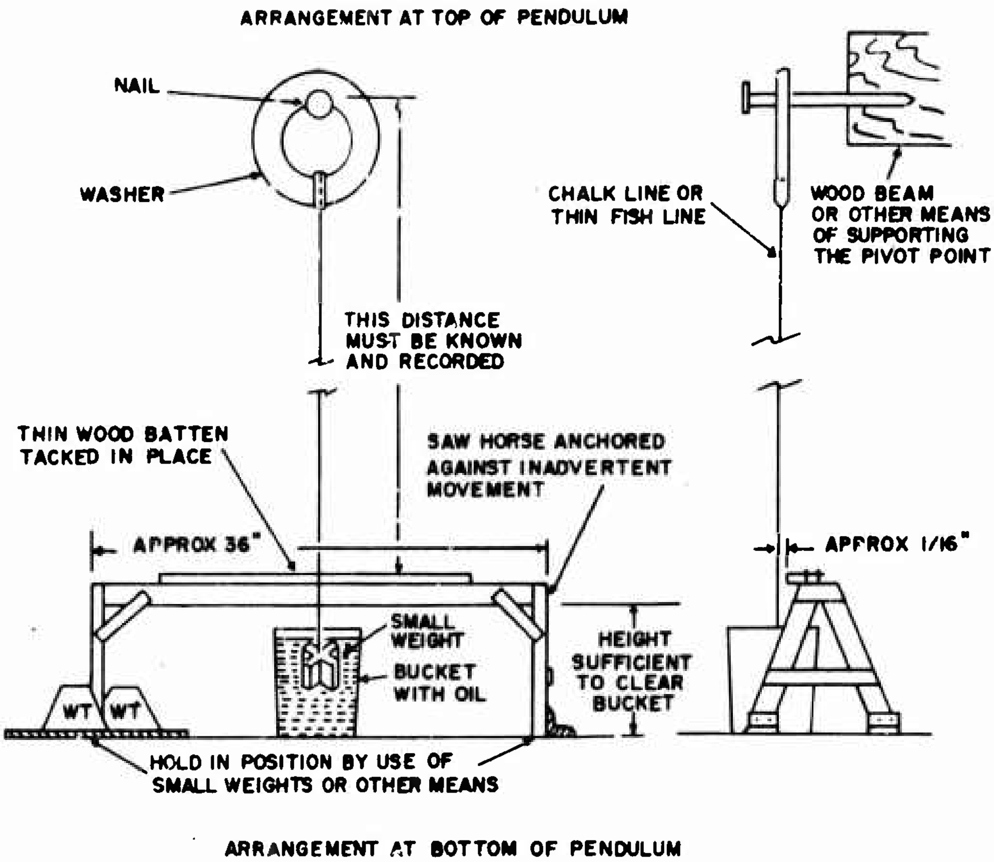



Figure 1. Pendulum Arrangement for Inclining Experiment.

(f) Trim, List, Draft and Freeboard. Drafts and/or freeboards are read immediately before or immediately after the inclining experiment. All persons who will be on board during the inclining experiment should be on board and in location during these readings. If read after the inclining test, the vessel must be maintained in the same condition as during the test. Lines will not be slacked, however, if the list is not significantly changed. Drafts are read at the forward and aft draft marks, and a freeboard measurement is taken amidships to determine hog or sag. As a check on draft marks and hog or sag, additional freeboards may be taken at the bow, stern, and other convenient locations near the fore and aft quarter lengths. All readings are taken both port and starboard except for bow and stern freeboards which are taken on centerline. The fore and aft distances of the readings from fixed reference points are recorded. It may be necessary to counterbalance the list and trim effect of freeboard measuring parties. Where possible, all readings should be taken from a boat; as indicated above, however, all persons (or equivalant weights) who will be on board for the test should be on board during the readings. A small boat must be available for use when taking drafts and freeboards. It should have a low freeboard to permit accurate observation of the readings.

(2) Inclining Experiment (fig. 2).

(a) The test director ensures that the vessel is ready for inclining and that no condition of list exists.

(b) The inclining weight is positioned on one side of the vessel centerline and the distance from centerline recorded.

(c) A check is made to ensure that all mooring lines are slack.

(d) A check is made to ensure that all personnel are at their assigned stations and that the communications system is functioning properly.

(e) The vessel is allowed to become still in the water.

(f) Upon the word "mark," all pendulum station attendants mark the batten with a soft pencil at a point corresponding to the location of the pendulum wire.

(g) The inclining weight is then positioned on the opposite side of the vessel centerline the same distance away as in (b) above.

(h) Steps (e) and (f) are repeated to obtain a second mark on each of the battens.

(i) Each pendulum attendant divides the distance between the two marks in half. This midpoint is labeled "0" (zero).

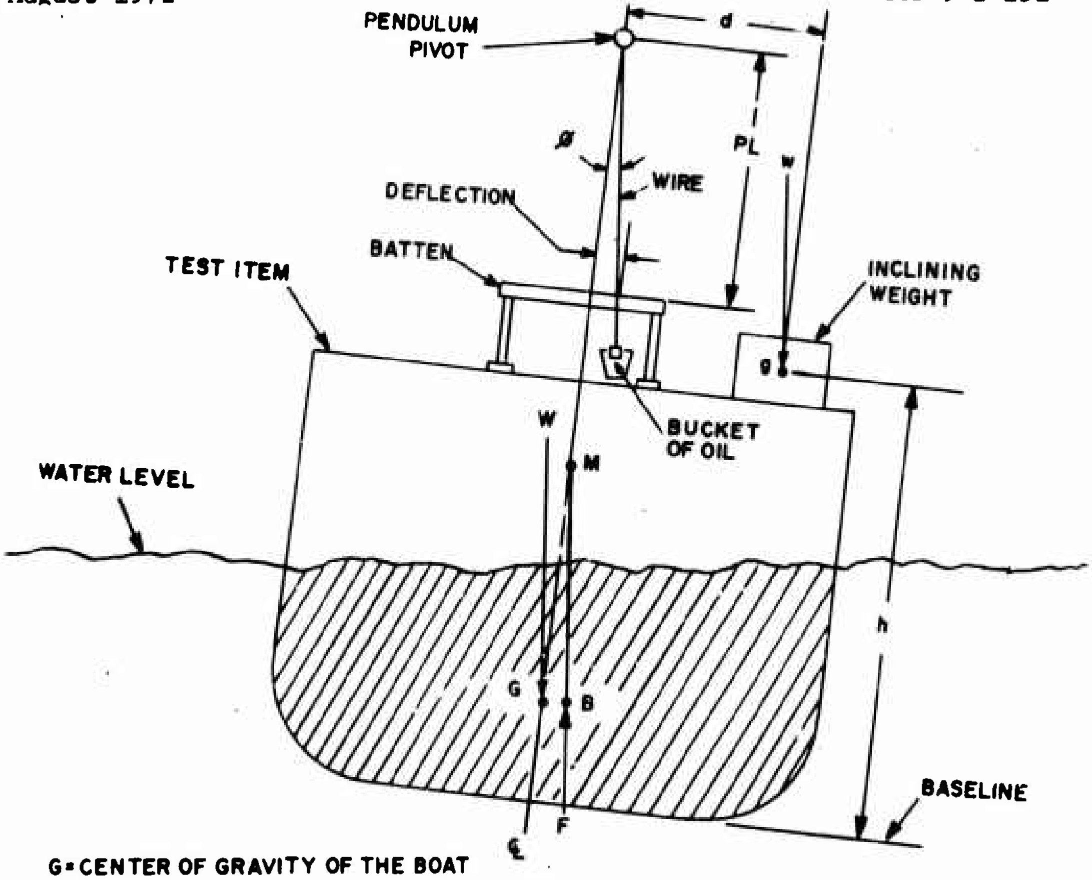
(j) The inclining weight is placed at a predetermined location approximately one-fourth the distance between the vessel centerline and the starboard gunwale. This distance is measured and recorded.

(k) The vessel again is allowed to become still in the water and at the word "mark" each pendulum station attendant marks the batten at a location corresponding to the position of the pendulum wire. The resultant mark is labeled "#1."

(l) The inclining weight is positioned at a predetermined location approximately one-fourth the distance between the vessel centerline and the port gunwale.

(m) The vessel is allowed to become still in the water and at the word "mark" each pendulum station attendant marks the batten at a location corresponding to the position of the pendulum wire. This mark is labeled "#2."

(n) The process is continued until marks are obtained for inclining weight positions at approximately one-half and three-fourths the distance between the vessel centerline and gunwale both port and starboard.




G= CENTER OF GRAVITY OF THE BOAT

B= CENTER OF BUOYANCY OF THE SUBMERGED PORTION

M= METACENTER

g= CENTER OF GRAVITY OF THE INCLINING WEIGHT

W= WEIGHT OF THE BOAT (IN POUNDS)

w= WEIGHT OF THE INCLINING WEIGHT (IN POUNDS)

F= FORCE OF FLOTATION

h= DISTANCE BETWEEN THE BASELINE AND THE CENTER OF GRAVITY OF THE INCLINING WEIGHT

d= DISTANCE BETWEEN THE CENTER OF GRAVITY OF THE BOAT AND THE CENTER OF GRAVITY OF THE INCLINING WEIGHT (IN FEET)

ø= ANGLE OF INCLINATION (IN DEGREES)

$\overline{GM}$= METACENTRIC HEIGHT— THE DISTANCE BETWEEN "G" AND "M"

PL= THE LENGTH OF THE PENDULUM MEASURED AT THE WOODEN BATTEN

INCLINING MOMENT = "d" MULTIPLIED BY "w"

Figure 2. Setup for Inclining Experiment.

(o) Before ending the inclining experiment a plot is made to determine whether satisfactory values have been obtained: the tangents of the angles of inclination are plotted against the movements of the inclining weights (see fig. 3 for a typical plot of tangents versus moments). Variations of the resultant plot from a straight line indicate that conditions are not favorable or that an error has been made. When only one point does not agree satisfactorily with the other readings, it may be appropriate to disregard it and accomplish the plot using the remaining information. When the plot does not result in a straight line, it may be necessary to repeat the experiment.

(p) Referring to figure 2 the following data are recorded:

w = amount of inclining weight used.
h = distance (height) of inclining weight above the baseline.
d = distance for each inclining weight position.
PL = length of pendulum measured at the wooden batten.
Amount of deflection for each inclining weight position.

(q) The value $\overline{GM}$ (the vessel metacentric height) is calculated using the following equation and the average of values obtained.

$$\overline{GM} = \frac{wd}{W \tan} \phi$$

(r) The wooden battens used during the inclining experiment (labeled station 1, 2, etc.) are retained for later use in confirming any doubtful values.

(3) Transverse Radius of Gyration. The transverse radius of gyration is represented by k in the following equation:

$$\text{Period} = \frac{1.108k}{\overline{GM}}, \text{ natural period of roll in seconds.}$$

$\overline{GM}$ = metacentric height in feet.

k = transverse radius of gyration in feet.

After the value k has been obtained, the approximate $\overline{GM}$ at any time can be determined by ascertaining the natural period of roll, as follows:

(a) A vertical downward force is applied on the gunwale of the vessel to incline it to approximately $10^{\circ}$.

(b) The downward force is removed and the vessel allowed to roll.

(c) The natural period of roll is determined by measuring the total elapsed time for a number of rolls and dividing by the number of rolls observed. The period of roll to be used in the equation is that of a full cycle.

(d) The value of the natural period of roll and the second transverse radius of gyration are calculated and recorded.

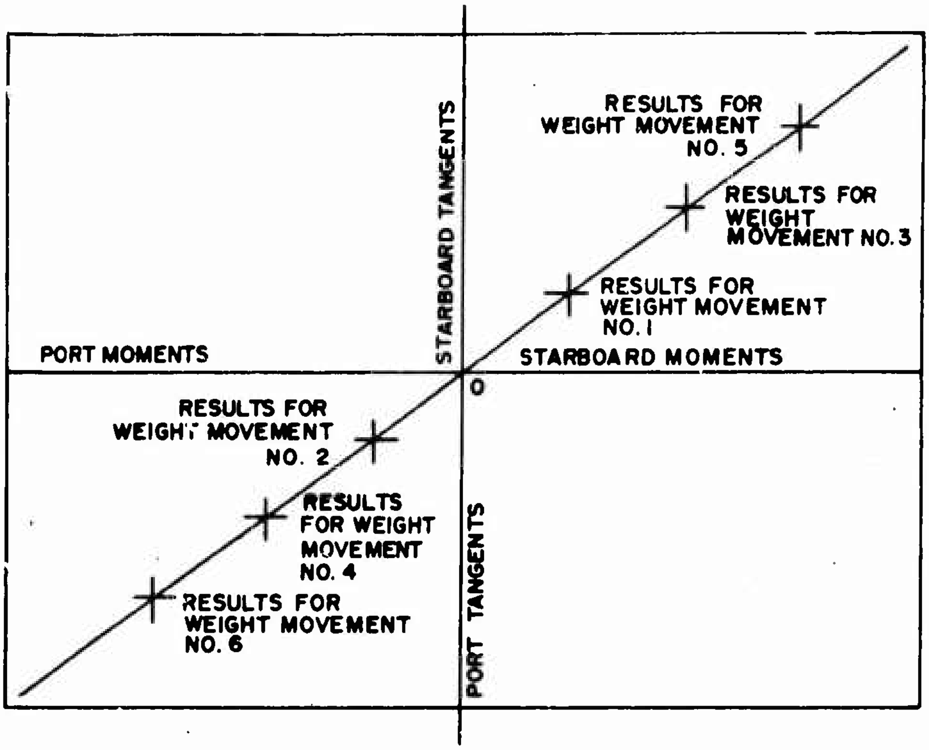



Figure 3. Typical Plot of Tangents vs Moments.

c. Data Required.

(1) Before the tests.

(a) Condition of vessel (b(1)(e) above).

(b) Draft of vessel, fore and aft.

(c) Condition of vessel trim and list at time of experiment.

(d) Wind direction and velocity.

(e) Set and drift of current.

(f) Specific gravity of the flotation water. (Indicate salt water or fresh water.)

(g) Depth of water at mooring location.

(h) Measured center of gravity.

(2) During the tests.

(a) Amount of corrective weight added to improve conditions of list. (Indicate location.)

(b) Amount of inclining weight (w) used.

(c) Height of inclining weight above baseline.

(d) Distance (d) for each inclining weight position.

(e) Length (PL) of pendulum measured at wooden batten.

(f) Amount of deflection for each inclining weight position.

(g) Calculated value of metacentric height.

(h) Natural period of roll.

(i) Force to produce 10° list.

(j) Transverse radius of gyration.

(k) Plot of tangents of angle of inclination versus inclining moments.

d. Analytical Plan. Theoretical design data are checked against the measured and computed test data for verification of characteristics. Arithmetic means are used for repetitive values. Computed results are compared with the stated requirements to determine whether acceptable limits are achieved.

13. Static Flotation.

a. Objective. To determine draft lines, trim, pitch and heel angles of the vessel under loaded and unloaded conditions.

b. Method.

(1) The vessel is prepared for launching, including check to see that all hull closures are tight. A clinometer is installed on the vessel centerline as near to the center of gravity as possible. The proper loading for various loading conditions is determined, including consideration of cargo, personnel, gear, stores, equipment, and tank contents. For wheeled amphibians, adjustments are made for proper tire inflation. Loading conditions will include light, full, and any intermediate conditions as specified.

(2) One-inch graduations are marked on the hull fore and aft, port and starboard covering the projected draft range. If hull configuration in the area of the waterline is too irregular, panels may be superimposed.

(3) The vessel is launched in very calm water. Minimum or no mooring attachment is used. Sufficient clear depth under the hull is assured. Ambient temperature and water and wind conditions are recorded. Various vessel attitudes are induced by the programmed loading conditions, and readings are taken after the vessel is completely stabilized at the test condition.

(4) Maximum roll and pitch angles are determined under static conditions by applying torsional forces to the floating vessel to points limited by specifications or design. Torsional forces may be induced by ballasting or shifting the cargo and determined by computing the resulting forces. Another method, applicable to small vessels, is shown in figure 4.

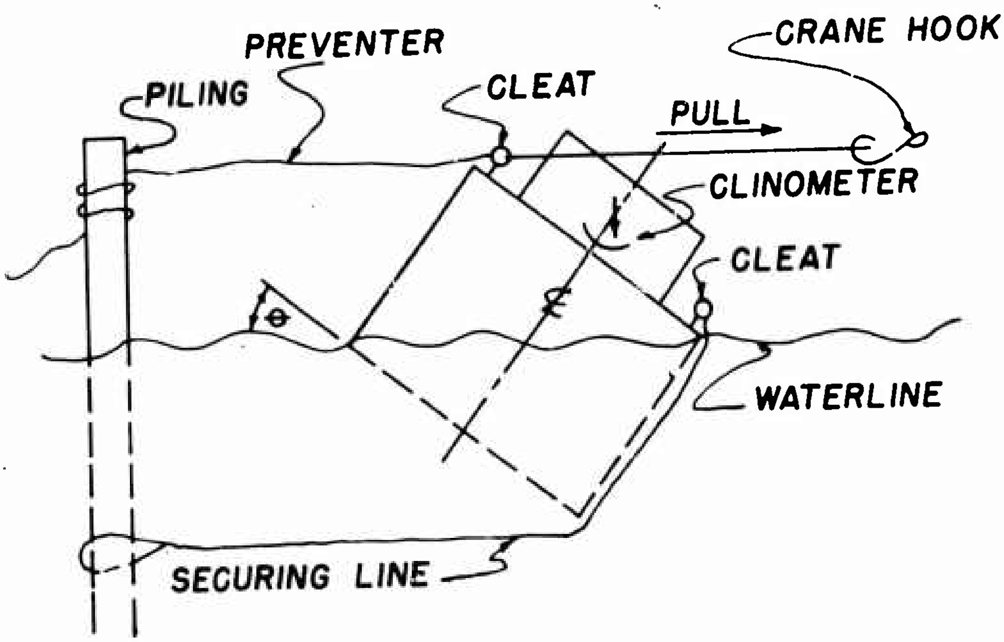



Figure 4. Maximum Roll Test.

Lines are secured to fore and aft mooring cleats and under the hull to piling or other anchorage. Lines from opposite athwartship cleats are run to a tensioning winch or crane. A dynamometer is placed in this line to determine the force of the moment. Padding or fenders are used between lines and structure to avoid chafing damage. Securing and tension lines should be parallel. The tension line should be equipped for quick release to determine vessel righting characteristics and for safety.

Safety preventer lines, left normally slack, are used if heeling is expected to approach capsizing condition. Due to symmetry, heel and list determination to one side only may be sufficient. Pitch angles fore and aft may be determined in similar manner by making line attachments at bow and stern of the vessel, or within crane capacity, by lifting bow or stern separately to limiting angles. For pitch angles the clinometer must by mounted longitudinally.

c. Data Required. Drafts in inches are recorded for light and loaded conditions, forward, midships, and aft. Resulting freeboard is computed. Roll and pitch angles, for different ballasting, and at maximum values, are measured in degrees. Righting force in pounds is read at the dynamometer.

d. Analytical Plan. Observed data are tabulated to indicate draft marks, angles, and righting moments for various conditions of loading. Results are compared with MN or other requirements and the degree of compliance determined.

14. Dynamic Pitch and Roll.

a. Objective. To determine the dynamic roll and pitch attitudes of the vessel.

b. Method.

(1) Using the method described in figure 4, and the quick-re release tension hook, the period of roll or pitch can be timed by stopwatch, observing a mark on the vessel as it completes its motion from the port or starboard limiting position to its return.

(2) When practical, determinations are made during actual operations, with surf and wave conditions to induce the vessel motions. The vessel in prescribed loading condition is operated through the water, and pitch and roll are monitored by a recording device. Less accurate readings can be obtained with clinometers and stopwatch. Maximum roll is produced when the vessel travels parallel to the waves; maximum pitch when head-on to the waves. Attitudes are measured as peak deviation from the normal plane of flotation of the vessel. Tests are rerun as required for different conditions of loading.

c. Data Required. Collected data include vessel loading condition including cargo, passengers, ballasting, tank capacities, and equippage; ambient conditions including wind velocity, wave heights and wave periods; degrees of roll and pitch; time in seconds of motion frequency cycles.

d. Analytical Plan. Readings are evaluated to show the average and maximum values for the different test conditions. Operators' views on vessel handling and response under extreme roll and pitch conditions are evaluated. Findings are compared with MN or other requirements and the degree of compliance determined.

15. Dock Trials.

a. Objective. To verify satisfactory operation of all machinery, equipment, appliances, and systems and to demonstrate proper working, alignment, and breaking-in while the vessel is secured in docked position.

b. Method.

(1) The vessel is securly moored to a pier using sufficient mooring lines, including bow, spring, and stern lines. The pier and lines are of adequate strength to hold the vessel during full-power operation of the propulsion plant. Proper depth of water and cleanliness of water for cooling system intake is assured. Prior to starting the propulsion engines, the propeller shaft and seals are bled to remove any entrapped air (required for initial start only).

(2) The propulsion engine(s) are started in accordance with prescribed instructions and brought up to idle speed. While the engines are warming, a check is made of the engine-driven auxiliaries - instruments, lights, etc. Other machinery or auxiliaries, such as generator sets, lights, and pumps, are started and checked. A thorough check is made of the hull and piping systems for leaks.

(3) The vessel is loaded or ballasted to the trim condition given in the specifications or trials agenda. After engine temperatures are stabilized and all preliminary functional checks are completed, the engines are operated through their ranges in accordance with the schedule provided in the trial agenda. Operation consists of running at selected engine rpm's for not less than 1 hour at each increment, in both forward and reverse gear ranges. During operation continuous inspection is made of cooling systems, fuel systems, components, and hull openings (e.g., shaft logs, rudder shafts, exhaust outlets) for leakage and all auxiliaries for proper operation. Gages and instruments are read and recorded, and operational features are checked against the criteria.

c. Data Required.

(1) Adequacy of starting and operating instructions for engine and auxiliaries.

(2) Readings of all engine, auxiliary, and system instruments and gages at the different operational ranges.

(3) Indication of proper operation of engines, auxiliaries, components, systems, and accessories (e.g., bilge pumps, fire pumps; cooling, fuel, and oil systems).

(4) Evidence of leakage, including description, location, and degre

(5) Adequacy of alignment and coupling (shafts, pump drives, engine couplings).

(6) Weather conditions, ambient air and water temperatures.

(7) Maintenance and servicing actions required to keep the vessel operational.

(8) Hours of operation; description of interruptions, deficiencies, repairs or adjustments required to sustain operations; and corrective measures instituted.

d. Analytical Plan. Data are presented in tabular and narrative form and analyzed to determine whether criteria are met. Performance data are compared with requirements of the specification or trials agenda. Experience and judgment of marine personnel are used in evaluating areas of overall marine performance.

16. <u>Components and Subsystems</u>.

a. Objective. To insure that all machinery, auxiliaries, systems, components, and accessories perform properly and as intended.

b. Method.

(1) The main propulsion machinery; electrical plant and system; auxiliary and emergency machinery; all piping, control, and service systems; deck and special machinery; hoisting gear and equipment are operated and monitored throughout the entire test period. Initial operability and acceptability are determined during the conduct of the dock and sea trials. Results of those trials serve as a reference in establishing further testing of questionable components, checking for subsequent changes in operating patterns, and in reviewing initial compliance with regulatory and specification requirements.

(2) In addition to the ordinary operation that occurs, controlled operations are arranged to check or determine particular characteristics, capacities, endurance, or trouble areas. Additional or special instrumentation is provided as required. For detailed tests of specific items, procedures such as those in the following TOP/MTP's may be used:

| | |
|---|---|
| Engines | 2-2-700 |
| Power train components | 2-2-703 |
| Electrical motors | 9-2-155 |
| Pumps | 9-2-181 |
| Generators | 9-2-286 |
| Blowers | 10-2-066 |
| Firefighting equipment | 10-2-050 |
| Lifesaving equipment | 10-2-200 |

(3) Systems and equipment not often used, such as the emergency generator set, firefighting system, and standby pumps, are operated periodically. Such auxiliaries are operated sufficiently to permit

valid judgment as to performance, reliability, durability, and maintainability. Firefighting equipment is checked out during regularly scheduled fire drills. During all operations, the electrical system is observed to insure that all circuits, switching, controls, and components are adequate for their designed functions. Similar observation is made for valving, manifolding, and components of piping systems. Under appropriate climatic conditions, components of heating, cooling, and ventilation systems are observed. During anchoring, beaching, docking, or cargo movement operations, proper operation of deck machinery and gear is checked.

(4) Vessels equipped with outboard engines, with engines installed, are subjected to tests as for other propelled craft.

c. Data Required. In addition to the usual gage and instrument data, recorded data include complete information on the occurrence of malfunctions; unusual temperature rise in bearings, motors, or cooling systems; deviations from recommended system parameters; and corrective actions taken. Narrative comments include assessment of capability of items to meet designed requirements.

d. Analytical Plan. Collected data are evaluated against the requirements of specifications or agenda, and the degree of compliance is determined.

17. Bollard Pull Tests. This test is limited to those powered vessels whose pull does not exceed damaging limits to piers or anchoring systems.

a. Objective. To determine the forward thrust characteristics at various engine speeds.

b. Method.

(1) The vessel is moored to a bollard or other securing device with a rope of sufficient strength to withstand the design pull of the vessel. The mooring line will include a dynamometer and will run horizontally from the pier to the vessel's stern towing bitt or cleats.

(2) With rudders set on center, engines are operated in forward gear for 5 minutes at each increment of engine speed up to and including the maximum engine rpm. Gage and instrument readings are taken, including engine and transmission oil and cooling system pressures and temperatures at the end of each engine speed period.

c. Data Required. A record is kept of weather conditions, ambient air and water temperatures, gage and instrument readings, and dynamometer readings at each specified engine speed.

d. Analytical Plan. Dynamometer readings are tabulated or plotted versus engine speeds and compared with requirements to determine the degree to which the criteria are met.

18. Sea Trials. These trials vary according to the size and type of vessel and to the contractual provisions of the procurement action. In some instances separate Builder's and Acceptance Trials may be required. Trials may be conducted by the contractor, under Navy supervision, with Army personnel in monitoring status only. For smaller vessels sea trials as such are not conducted, but appropriate portions (b(5) below) are conducted. The vessel normally is crewed by contractor personnel during Builder's and Preliminary Acceptance Trials, and by Government personnel during Final Acceptance Trials. For further details, see reference 37 (app. A).

a. Objective. To determine performance characteristics of the vessel and compliance with the performance requirements of the contract and procurement specifications.

b. Method.

(1) Preparation for Testing. Trial instrumentation and gear are installed including shaft revolution counters, torsion meters, flowmeters or weigh tanks, and other items required to conduct and document the trials. Cargo is adjusted to normal operating condition unless noted otherwise.

(2) Standardization Runs. The vessel is operated over an acceptable measured mile course (or over a course using an electronic system for accurate distance measuring). Speed runs are made at 2-knot increments from lowest specified to design full power operation. Runs are made for different conditions of cargo or displacement as specified. Shaft horsepower, propeller rpm, and fuel consumption are recorded.

(3) Full Power Ahead. The vessel is operated ahead in open water with the propulsion engines developing design full power for a continuous period of at least 2 hours. Shaft horsepower, propeller rpm, and fuel consumption are recorded.

(4) Astern Operation. The vessel is operated astern continuously for a period of at least 2 hours. Shaft horsepower, propeller rpm, and fuel consumption are recorded.

(5) Maneuvering Trials. Depending on the type vessel, maneuvers are selected from the following:

(a) Spiral. Runs are conducted in free route, the ahead runs at half and full ahead. The astern runs are conducted at one-third and two-thirds power. Steady turning rate is measured at 5° rudder angles from hardover-to-hardover positions. The helmsman holds the rudder at each angle until a steady heading is achieved before advancing to the next heading. Torsion meter readings are taken at the propeller shafts.

(b) Zigzag. Runs are made at half and full power ahead, alternating the rudder position from maximum port to maximum starboard. The rudder is held in each position until the vessel heading has been altered 25° either side of the original course heading.

(c) Figure-Eight. At maneuvering engine rpm, a tight figure-eight turn is executed. From full ahead position, the rudder is held hardover until the circle is closed, then hardover opposite until the figure is completed. The maneuver is completed a minimum of 10 times.

(d) Sudden Turns. A selection of runs are made such as the following:

Run straight for 5 minutes.
Execute a sudden 90° port turn and run 1 minute.
Execute a sudden 90° port turn and run 5 minutes.
Execute a sudden 90° port turn and run 1 minute.
Execute a sudden 90° port turn and run 5 minutes.
Execute a sudden 90° starboard turn and run 1 minute.
Execute a sudden 90° starboard turn and run 5 minutes.
Execute a sudden 90° starboard turn and run 1 minute.
Execute a sudden 90° starboard turn.
Repeat this series of maneuvers three times.
Execute a sudden hardover to starboard after maximum engine rpm has been reached on a straight run and continue in a circle for 5 minutes. Repeat with a hardover rudder.

(6) Sudden Stop. The vessel is operated at full throttle straightaway in the forward direction until the maximum forward speed is maintained at a constant rate. The transmission is shifted from full speed forward to full speed reverse as quickly as possible. Full reverse throttle is maintained until the relative motion of the vessel has stopped. The operation is repeated six times. After each operation hull connections, piping, and machinery are inspected for damage.

(7) Steering. With propulsion machinery developing full power ahead, full turning moment is applied to the rudder to starboard and held steady for 10 seconds. The maneuver is repeated with the rudder to port.

(8) Endurance. The vessel is operated under sustained conditions for the period specified and for the specified loading conditions. All vessel-installed and test instrumentation is read regularly and the information recorded. When endurance runs cover extended periods requiring plant shutdown and startup, prescribed operation and maintenance instructions are followed, including engine warmup prior to sustained operations and scheduled maintenance as required.

c. Data Required.

(1) Records of installed vessel instruments to include engine and other vessel logs and maintenance forms on a regular basis.

(2) Weather and sea conditions for each run, including ambient air and water temperatures, winds, currents, surf, and depths.

(3) Vessel course, headings, turns, speeds, and maneuvers, roll, pitch, and drafts.

(4) Vessel condition of loading or ballasting.

(5) Performance and handling characteristics during each operation.

(6) Evidence of excessive vibration, malfunction, leakage, inadequate performance, or limiting conditions.

(7) Readings of test intrumentation such as tachometers, torsion meters, weigh tanks, stopwatches, etc.

d. Analytical Plan. Collected data are used to compute vessel speeds, fuel consumption, shaft torques, and required performance characteristics. Data are tabulated and plotted, using averages for repetitive readings. Results are analyzed and compared with requirements and criteria to determine the extent to which requirements are met.

19. Turning Radius.

a. Objective. To determine the vessel's minimum turning radius.

b. Method.

(1) A site is selected with adequate open area and a minimum of current or other disruptive factors. The site should be opposite an on-shore or fixed anchorage observer position as shown in figure 5. Two buoys are moored, as indicated. The observer site is equipped with a pelorus or transit. The distance "y" is measured and is sufficient to permit the vessel to develop full speed prior to reaching the turn point.

(2) The vessel is positioned at the start point, is started, and is moved at full speed along the path indicated on figure 5.

(3) Upon reaching the turn point buoy, a sudden hard right rudder is immediately executed.

(4) The vessel continues in a tight circle until it has turned a full 180° and reached the signal point.

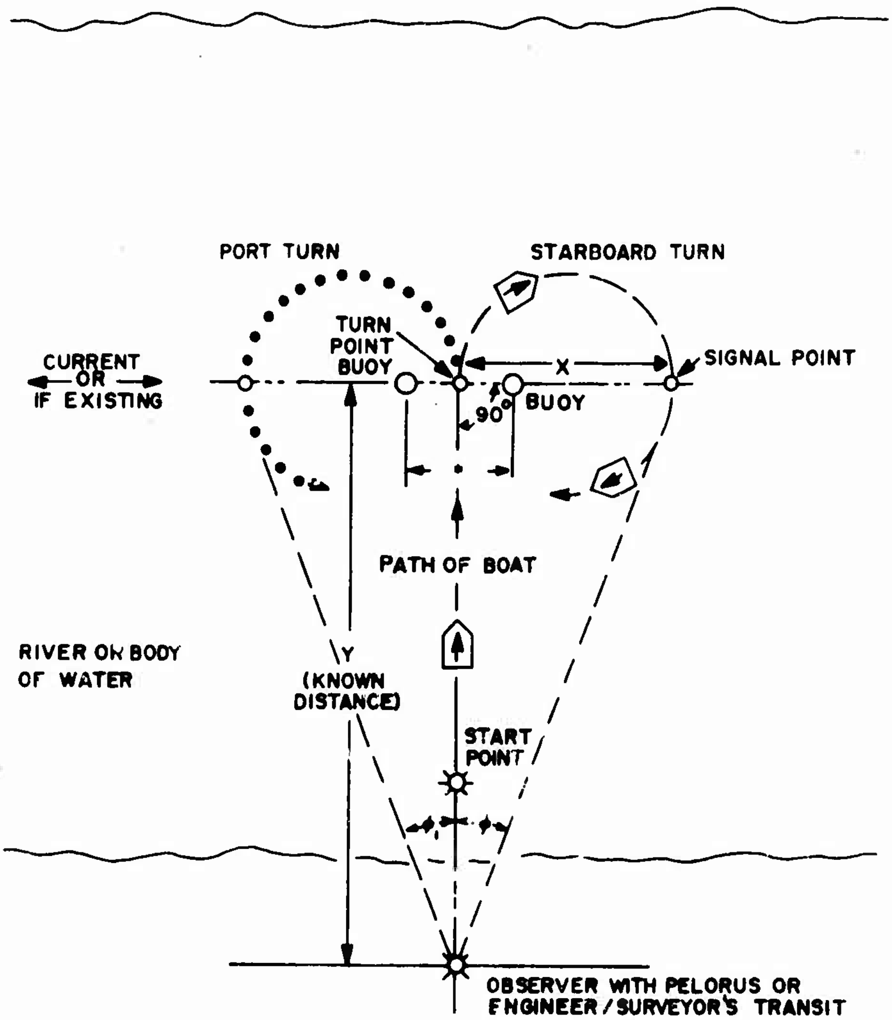
(5) The observer notes and records the angle read between the starting path and the signal point. To pinpoint time, a signal may be

transmitted from the vessel to the observer at the instant the two buoys are aligned, indicating the 180° point.

(6) The vessel is repositioned at the starting point and proceeds to accomplish a port turn.

(7) When required, the procedures are repeated with the vessel operating astern.

(8) Turning radii are computed using the formula shown in figure 5.




TURNING RADIUS = r = 1/2 X = 1/2 Y TAN ϕ

* – Distance between buoys to be equal to the craft's beam plus 12 feet.

Figure 5. Turning Radius Determination.

c. Data Required. For each turn, data include weather conditions (current, wind, and condition of water), engine rpm, times for executing turns, and angle from the observer's point.

d. Analytical Plan. Data are used to compute the turning radii.

20. Towing Resistance.

a. Objective. To determine the towing resistance presented by a nonpropelled vessel under tow.

b. Method.

(1) The vessel is loaded or ballasted to its specified trim condition. (As a minimum, conditions tested should include light and fully loaded.) A single line is attached to the towing vessel to permit the insertion of a dynomometer to read the towing force. The line is long enough to minimize the effect of wake of the towing vessel.

(2) The vessel is towed at slow, half, and full speeds, and the tension is read at each speed. Pileup of water at the bow and tendency of the vessel to dive are watched closely and the speed adjusted accordingly to not exceed safe limits.

c. Data Required. The vessel condition of loading is recorded. Dynamometer force is read at each speed (engine rpm). Water formation at the bow and wave formation at the sides are photographed where pertinent. Comments are made on indications of directional or pitch stability and trim angle at maximum towing speed.

d. Analytical Plan. Towing force is plotted as a function of towing speed. Performance is compared with specified requirements.

21. Beaching.

a. Objective. To determine the capability of the vessel to land and retract from beaches.

b. Method.

(1) The beaching site is selected to include the gradient, configuration, and surf conditions for which the craft is designed. The approach is surveyed to insure freedom from damaging underwater obstacles.

(2) Preliminary landings are made with the vessel in light condition and in minimum surf. All beaching is attempted with the craft heading perpendicular to the shoreline. Retraction is accomplished by reversal of the engines, watching closely the engine cooling temperatures.

(3) Landings are made under various loading and surf conditions. On landing, the ramp is lowered and cargo discharged. Dry ramp landings are made where practical. Retraction is accomplished with engines alone when practical, and by deballasting or use of stern anchor or tow as required.

c. Data Required. Recorded data for each landing include wind direction and velocity, vessel heading and loading, surf and current conditions, approach speed, and retraction time. Beach gradient and description are recorded. Observation is made of ability to maintain course and achieve intended landing site, tendency to broach, adequacy of power and control during retractions, and effects of propeller wash. Ramp angles and clearance for cargo egress are noted. Inspection is made for noticeable hull damage and adverse effects from vibration, impact, or overheating.

d. Analytical Plan. Performance is analyzed against requirements to determine whether limiting conditions have been met.

22. Ramp Operation.

a. Objective. To determine ramp performance characteristics.

b. Method.

(1) The ramp is checked for alignment before and after all tests. Seals are checked periodically for watertightness.

(2) The ramp is cycled continuously from fully closed to fully open position for a 1-hour period (or as specified by requirements) with periodic stops at partially open positions. All mechanisms are observed for proper functioning, including security of latching devices, ability of the brake to hold position without creep, and free motion of lines and pulleys. For hydraulic systems, maximum and steady state pressures are recorded, and oil temperatures at the start and end of tests.

(3) The ramp is placed in a horizontal position and loaded statically to 200 percent of the ramp design hoist condition. This load is held for a minimum of 3 minutes.

c. Data Required. Recorded data include times to lower and raise the ramp, hydraulic oil pressures and temperatures, weight of the static load, and comments as to response to controls, effectiveness of latching and braking, occurrence of leakage, and adequacy of alignment.

d. Analytical Plan. Performance is compared against requirements to determine whether the test criteria are met.

23. Operational Performance.

a. Objective. To determine performance characteristics of the vessel related to the conduct of its mission.

b. Method.

(1) The vessel is operated under simulated mission conditions, including docking, anchoring, and transporting and discharging cargo, in various seaways and channels and under various weather and sea conditions for the specified number of operational hours.

(2) Tests of special machinery, such as winches, anchor engines, and cargo gear, are arranged as required to determine characteristics.

c. Data Required. Data are recorded on vessel behavior and handling in seaways, congested areas, or limiting sea conditions. Also recorded are description of test environment, times vessel is operated, types of operations, and manner of performance.

d. Analytical Plan. Results are compared against the prescribed requirements to determine whether specified performance is achieved.

24. Communications, Electronic, and Navigation Equipment.

a. Objective. To determine whether equipment fulfills the requirements of the applicable specifications.

b. Method.

(1) During inspection (para 8) the provision, compliance with regulatory requirements, and adequacy of installation of equipment are assured.

(2) Equipment is used for its intended purpose throughout operational tests. Navigation equipment is used during the various conditions encountered under day, night, and all-weather operation. Radio communication equipment is used to communicate with various shipboard, aircraft, and shore installations. Audible and visible signals are checked during these communications. Equipment is evaluated as required by the applicable specification.

(3) Internal communication and control systems are checked out during continuous service. All equipment is observed for adequacy of operating instructions, accessibility and ease of servicing, and performance during various operations. Equipment is evaluated as required by the applicable specification.

c. Data Required. Recorded data reflect the adequacy of each individual system or equipment; extent of usage, limits or range of performance, and any instances of malfunctioning or unsuitability.

d. Analytical Plan. Performance characteristics are analyzed against the requirements as to whether operation meets the intended objectives.

25. Kits. Various kits may be furnished and are tested separately in accordance with their intended function, such as firefighting, winterization, deckhouse conversion, lighting, etc. In general, test procedures include the assembly and installation, operational tests, and tests for endurance through a specified period of use. Recorded data include the adequacy of instructions, times to assemble and install, adequacy of performance, and faults or difficulties experienced.

26. Inflation (Inflatables).

a. Objective. To determine the time and adequacy of provisions for inflation of inflatable boats and rafts.

b. Method.

(1) The item is prepared for test by checking the existence and proper assembly of the $CO_2$ cylinder, its valve, and pull cable assembly. The item is folded and inserted, with associated accessories, into its container, and the loops of the pull cable are properly attached. The packaged item is placed horizontally in a clear area.

(2) The item is inflated by triggering the inflation device in accordance with instructions.

(3) The item is observed as it exits its container and assumes its inflated configuration, and the pressure in each inflated compartment is measured after 1 hour.

(4) The item is inspected for any evidence of structural or material failure or weakness at seams, seals, or cemeted areas, and any twisting, distortion, or misfit of parts.

(5) The item is deflated and note made of any difficulty in gas discharge.

c. Data Required. Recorded data include inflation time, adequacy of assembly and inflation instructions, inflation pressures, deflation time, and description of any malfunctions or inadequacies.

d. Analytical Plan. Times and performance are compared against the specified requirements.

27. Pressure (Inflatables).

a. Objective. To determine the capability of inflatable items to withstand specified overpressures in their inflation compartments.

b. Method.

(1) The item is placed horizontally, and the relief valves are capped to prevent operation.

(2) Each inflation compartment is inflated with dry air to an overpressure as specified in the requirements document, or to 5.0 psi in primary tubes and 2.0 psi in secondary tubes, if unspecified.

(3) After 10 minutes, the pressure in each compartment is checked and adjusted if necessary to the specified value. After an additional 10 minutes, pressures are read and recorded.

(4) Inspection is made for signs of construction or material weakness; separation in seams, seals, or cemeted attachments; twisting, distortion, or misfit of parts.

(5) When extended periods of testing are required, pressures are read after 24 hours or when specified. Ambient temperatures and pressures are recorded to permit conversion of findings to standard conditions for comparison.

(6) The item is deflated and inspected for puckering of seams or attachments.

c. Data Required. Recorded data include pressures at the specified time intervals and identification of any leakage that occurs.

d. Analytical Plan. Findings are converted to standard conditions and compared against the tolerances specified in the requirements documents.

28. Leakage (Inflatables).

a. Objective. To determine the watertight integrity of the item in floating configuration.

b. Method.

(1) The inflated item is floated in calm water and loaded, leaving 3 inches of freeboard. Loading should simulate seated personnel and be distributed so that the item remains level while afloat.

(2) The item is allowed to remain floating for 24 hours, or the specified period, and is inspected periodically for leakage during this period.

c. Data Required. Evidence of leakage, including location and amount, is recorded.

d. Analytical Plan. Ability of the item to remain afloat for the specified period is stated in comparison to the required period.

29. Initial Production (IP) Tests. IP tests as required by AMCR 700-34 consist of specification tests to determine whether the item conforms to its procurement document, and suitability tests as prescribed by the test

directive to determine whether the item is suitable for issue. Military specifications referenced in section II contain test procedures for specific items; if used in test plans for other items, they must be reviewed for applicability and changed to suit those items. Available test data from preproduction tests (including trials agenda on items procured by the Navy) are reviewed to reduce the scope of further testing insofar as practicable. Test requirements are always in paragraph 4 of the military specification; the applicable revision or amendment of the specification should be used.

30. Environmental Tests. Tests are based on the requirements of the MN or other governing document. For governing criteria and conditions of environment, AR 70-38 (and MIL-STD-210 for certain marine environments) is consulted. Test procedures are detailed to suit the particular test item. Depending on the size of the item, tests may include on-site and chamber testing. Cognizance is taken of the fact that some extreme conditions applicable to waterway equipment occur only in a natural environment, and, with consideration of the costs and mission requirements involved, a coordinated test program may be appropriate, with tests conducted at the field environmental test site.

a. On-Site and Field Tests. For intermediate climatic conditions, the temperate zone locale of the assigned test agency may provide the required environment. For more extreme conditions, the environmental test sites are used. For specific procedures the applicable portions of the following references should be consulted: TOP/MTP 2-2-650 (cold starting and warmup), TOP/MTP 2-2-708 (personnel heating systems), and MIL-STD-810B (app. A).

b. Chamber Tests. Environmental chamber tests are entirely applicable to small items, such as inflatable boats, and are used when advantageous from a time or cost aspect. Following are references for specific procedures: TOP/MTP's 2-2-815 (rain), 4-2-818 (fungus), 4-2-820 (humidity), 4-2-826 (solar radiation), and 4-2-804 (vibration); MIL-STD-810B (salt fog, method 509 and shock, method 516.1).

Recommended changes to this publication should be forwarded to Commanding General, U.S. Army Test and Evaluation Command ATTN: AMSTE-ME, Aberdeen Proving Ground, Md, 21005. Technical information may be obtained from the preparing activity: Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md. 21005. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.) printed on the first page.

# APPENDIX A
# REFERENCES

1. AR 70-38, "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions."

2. AMCR 700-34, "Release of Materiel for Issue."

3. AMCPM 702-3, "Quality Assurance - Reliability Handbook."

4. AMCPM 706-104, "Engineering Design Handbook, Value Engineering."

5. FED-STD-151B, "Metal, Test Methods."

6. FED-STD-601, "Rubber, Sampling and Testing."

7. MIL-STD-210A, "Climatic Extremes for Military Equipment."

8. MIL-STD-271D, "Nondestructive Testing Requirements for Metals."

9. MIL-STD-461A, "Electromagnetic Interference Characteristics, Requirements for Equipment."

10. MIL-STD-462, "Electromagnetic Interference Characteristics, Measurement of."

11. MIL-STD-810B, "Environmental Test Methods."

12. MIL-B-3596B, "Barge, Deck Cargo, Nonpropelled, Steel, 130-Ton, 81-Ft, Design 7001, Sectionalized, Nesting."

13. MIL-B-10122C, "Barge, Deck or Liquid Cargo, Nonpropelled, Steel, 578-Ton or 4,160-Barrel, 120-Foot, Design 231C."

14. MIL-C-10309, "Crane, Barge, Diesel-Electric, Revolving, Steel, 100 Tons, Design 264B."

15. MIL-B-10527, "Barge, Deck Cargo, Nonpropelled, Steel, 585 Tons, 120-Foot, Design 231A."

16. MIL-B-10586, "Barge, Deck Cargo, Nonpropelled, Steel, 570 Tons, 110-Foot, Design 7005."

17. MIL-T-10774, "Tug, Harbor, Diesel, 200-Hp, Steel, 45-Foot, Design 320."

18. MIL-C-10776, "Crane, Barge, Diesel-Electric, Revolving, Steel, 60 Tons, Design 413D."

19. MIL-T-10862, "Tug, Harbor, Diesel, 1200-Hp, Steel, 100-Foot, Design 3006."

20. MIL-B-10863B, "Boat, Passenger and Cargo, Diesel, Steel, 65-Foot 6 Inches, Design 2001."

21. MIL-T-10920E, "Tug, Harbor, Diesel, 600-Hp, Steel, 65-Foot, Design 3004."

22. MIL-O-11585D, "Outboard Motor, Gasoline, With Carrying Chest."

23. MIL-B-11746B, "Boat, Picket, Diesel, Steel, 46-Foot, Design 4003A."

24. MIL-B-11790, "Boat, Picket, Diesel, Wood, 64-Foot 11 Inches, Design 4002."

25. MIL-B-13592B, "Boat, Assault, Plastic, 16-Foot."

26. MIL-C-13746, "Conversion Kit, Barge, Deck Enclosure, Design 7006."

27. MIL-B-13831E, "Boat, Reconnaissance, Pneumatic, 3-Man."

28. MIL-B-13994C, "Boat, Bridge Erection, Inboard Engine, Aluminum, 27-Foot."

29. MIL-P-15916D, "Propelling Unit, Outboard, Diesel-Engine-Driven, 165-Hp."

30. MIL-B-17775C, "Boat, Landing, Inflatable, $CO_2$, 7-Person Capacity,"

31. MIL-B-18119A, "Boat, Landing, Inflatable, $CO_2$, 10-Person Capacity."

32. MIL-B-52515, "Boat, Assault, M2, Plywood."

33. MIL-B-58003, "Boat, Assault, Aluminum, 16-Foot."

34. MIL-L-58017D, "Lighter, Amphibious (LARC LX), Self-Propelled, Diesel, Steel, 60-Ton, 62 Feet 5 Inches Long, Design 2303."

35. MIL-B-58022D, "Boat, Landing, Inflatable, Assault Craft, 15-Man."

36. MIL-L-58048A, "Lighter, Amphibious (LARC-V), Self-Propelled, Aluminum, 5-Ton, Design 8005."

37. MIL-L-58063, "Lighter, Amphibious (LARC-XV), Self-Propelled, Diesel, Aluminum, 15-Ton, Design 8004."

38. U. S. Coast Guard:

    a. CG-115, "Marine Engineering Regulations and Materiel Specifications."

    b. CG-256, "Rules and Regulations for Passenger Vessels."

    c. CG-257, "Rules and Regulations for Miscellaneous Vessels."

    d. CG-258, "Rules and Regulations for Uninspected Vessels."

e. CG-323, "Rules and Regulations for Small Passenger Vessels."

f. Inspection Circular 1-67, "Stability Test - Preparations and Procedures."

39. Society of Naval Architects and Marine Engineers (SNAME):

a. "Economy and Endurance Trials Code."

b. "Code on Instruments and Apparatus for Ship Trials and Tests."

c. "Code on Maneuvering and Special Trials and Tests."

d. "Standardization Trials Code."

40. U. S. Public Health Service:

a. "Handbook on Sanitation of Vessel Construction."

b. "Handbook on Sanitation of Vessels in Operation."

41. American Institute of Electrical and Electronic Engineers: Standard No. 45, "Recommended Practices for Electric Installations on Shipboard."

34

# APPENDIX B
# FACILITIES

Facilities for the testing of waterway equipment may be relatively simple or extensive depending on the item to be tested. Inflatable rafts and boats may be tested in indoor or outdoor pools. Most boats and craft require navigable waterways - rivers, lakes, bays, or coastal waters. Streams may be adequate for tests of small portable boats. Amphibians and landing craft require beaches and land tracts adjacent to waterways. For larger vessels, substantial piers, docking, and harbor facilities are required. Supporting watercraft, as well as marine servicing and maintenance facilities, are required for sustained tests.

Tests are arranged where adequate facilities for the scope of testing are economically practical. This includes the use of borrowed facilities when required, such as equipment with heavy lift capacity, other marine craft, marine railway, or cargo handling equipment.

In selecting facilities the need for (or freedom from) certain factors must be considered; for instance, open waters, wind, current, tide, surf, depth, obstacles, particular water bottom type and gradients, access, and certain shore configuration. On navigable waterways, channel width and depth must be considered as well as marking, lighting, bridging and obstructions, quarantine areas, and traffic lanes. Provisions for personnel safety, including provisions related to the weather, should be considered in all cases.

Aberdeen Proving Ground has facilities for small boats, up to the Design 4002 and 4003 Patrol Boats, and access to various rivers and the Chesapeake Bay. Through a detachment at Fort Story, Va., various facilities are available in the Hampton Roads, Va. area including ocean beaches and soft sand shorelines at Fort Story; the Third Port Terminal Facility at Fort Eustis, Va., with various marine support craft, railway, shops, landship and pier cranes, including dock facilities for oceangoing vessels; and naval vessels and facilities at the Little Creek Amphibious Base and Naval Operating Base, Norfolk, Va.

35

APPENDIX C
INSPECTION PROCEDURES

The preoperational inspection, assembly, and functional check is performed for assurance that the test item is safe, operable, and otherwise ready for testing and to verify that weights, dimensions, and similar characteristics conform to the technical literature. Following is an example of the steps that may be involved for some types of waterway equipment.

1. Literature. Review the draft technical manual(s) and other instructional material furnished with the test item. Throughout the inspection observe the procedures and precautions listed therein, keeping a record of any inadequacies in the instructions.

2. Condition on Arrival. Before the packaging is removed, obtain dimensions, weights, cubages, and component data and check against list received. Remove preservatives and protective materials and note any damage observed. Obtain dimensions and weights of components without packaging.

3. Assembly and Inspection. Assemble and install components and accessories and ensure that the craft is complete in all respects. Obtain characteristics photograph (TOP 1-2-504, Physical Characteristics). Note any condition of the test item, its attachments, or accessories that constitutes a potential hazard to personnel, the test item, or the test facilities and proceed as follows:

a. Engine and Engine Accessories.

(1) Check thoroughly for physical damage and loose parts and connections.

(2) Crank the engine by hand to make sure all moving parts operate freely. Repeat with the shift lever alternately in neutral, forward, and reverse.

b. Fuel System. Check for physical damage and loose connections.

c. Cooling System.

(1) Check the inboard components of the engine and exhaust cooling systems for physical damage and loose hose connections.

(2) Check the heat exchangers for physical damage, secure mounting to hull, and assure tightness of through-hull connections and drain plugs.

36

d. Propulsion System.

(1) Check for physical damage to the coupling shaft log, shaft, strut, and propeller.

(2) Check for tightness of propeller on the shaft and locknut on the shaft nut.

(3) With the shift lever in neutral, rotate the propeller by hand and check for binding and misalignment. The propeller should turn freely.

(4) Check the shaft coupling to be sure that keys are in place and bolts are tight.

(5) Check the shaft log hose clamps for tightness.

e. Steering System.

(1) Check for physical damage to the wheel, gearboxes, quadrant, and linkage.

(2) Check for loose mounting of components and loose setscrews.

(3) Swing the wheel through its complete range while an observer checks for corresponding free movement of the underwater steering mechanism.

(4) With the shift lever in neutral, carry the above check further by hand rotation of the propeller as the wheel is slowly moved from "hard aport" to "hard astarboard." (This test will establish proper clearance between propeller blades and the steering mechanism.)

f. Controls and Control Stand.

(1) Check all controls to see that they are not broken or jammed.

(2) Manipulate all mechanical controls and check for proper operation and tight connection of linkages.

(3) Manipulate all switches and place them in OFF position.

(4) Check the stand and all controls and instruments for physical damage and loss of parts.

g. Boat Electrical System and Electrical Accessories.

(1) Check the bow navigational light, stern navigational light, other running lights (as applicable), searchlight, floodlight, electric pump(s), blower(s), horn, and battery for physical damage.

(2) Check wiring for physical damage and loose connections.

(3) After servicing the battery, test all lights and electrical accessories.

h. Hull. The following inspections should be performed with the hull hoisted to convenient height and clear of the shipping skid:

(1) Carefully inspect the hull of the boat for loose or broken rivets, dents, punctures of the plating, chafing, or other physical damage. Check particularly the areas that were in contact with the shipping container during transit.

(2) Check the hull for warpage.

(3) Check the skeg and other underwater gear for physical damage and misalignment.

i. Fittings and Attachments. Inspect the deck hardware, hatch covers, towing bitt, and hull connectors for signs of damage.

j. Auxiliary Equipment. Ensure that the craft is equipped with the required life preservers, oars, tools, repair parts, kits, lines, anchors, boathook, firefighting equipment, and other items specified for use with the boat.

k. Plates. Record the presence and adequacy of nameplates, warning plates, and instruction plates.

4. Launching, Service, and Maintenance. Before operating the craft, perform the following:

a. Perform all prelaunching maintenance and service procedures as set forth in the draft technical manual(s).

b. Launch the craft in accordance with instructions furnished with the craft.

c. When the test item consists of two sections, join the sections as indicated in the furnished instructions.

d. Accomplish all post-launching maintenance and service procedures specified.

e. Make a record of the completion of each of the above tasks and of any difficulties encountered and any leakage of water into the craft.

5. Operational and Functional Check. Ensure that the craft is operational and perform the following:

a. Make the boat fast to dock or pier.

b. Check the alignment of the transmission flange coupling and the propeller shaft couplings with a feeler gage. (Refer to the draft technical manual(s) for appropriate procedure.)

c. Bleed the propeller shaft seals to remove entrapped air.

d. Ensure that all operating fluids are at their recommended levels.

e. Check to ensure that the vessel is positioned in water of adequate depth to allow unrestricted operation and that the propellers are not fouled by line or debris.

f. Start the engine(s) according to the procedures recommended in the instructional material. Allow the engine(s) to operate at idle speed.

g. While the engines are warming up, check the engine instruments, electric bilge pump(s), and vessel lighting.

h. Load the boat to obtain the maximum allowable draft as established by the draft technical manual(s). The weight should be loaded evenly about the vessel's center of gravity to avoid a condition of undesirable list or trim.

i. Visually inspect the craft for any condition of leakage.

j. After the engine has been warmed up and temperature readings are stable, place the shift lever in the forward operating position and increase the engine speed to 2,000 rpm (or as otherwise specified by the draft technical manual(s) or appropriate component specifications).

k. Allow the engine to operate for a period of 1 hour, during which the operator monitors all engine indicators and ensures that temperatures and pressures are within the specified safe operating ranges. At the end of the 1-hour run, inspect the following for any leaks, faults, malfunctions, or failures:

(1) Engine cooling system.

(2) Fuel systems.

(3) Lubrication systems.

(4) Belts or other drive arrangements.

(5) Hull seams and hull openings, including shaft logs, rudder shafts, propeller shaft seals, and exhaust outlets.

l. During the last 5 minutes of operation, check the engine oil temperatures and coolant temperatures.

m. Reduce the engine speed and verify astern operation by placing the shift lever in the astern operating position and increasing the engine speed to 1,500 rpm (or as otherwise specified by the draft technical manual(s)). Allow the engine to operate for a period of 30 minutes, then secure the engine.

n. Remove the weight previously added to the craft.

o. Record the following:

(1) Any misalignment in shafting and the measures taken to eliminate the condition.

(2) Satisfactory operation of the electric bilge pump, blower, and boat lighting system.

(3) Any difficulties encountered in starting the craft's engine(s).

(4) Amount of weight added and the draft obtained. (Record the draft forward and aft.)

(5) Any leakage of water into the craft.

(6) Lube oil temperature at the end of the 1-hour operating period.

(7) Cooling system temperature at the end of the 1-hour operating period.

(8) Any excessive vibration or noise.

(9) Satisfactory operation ahead and astern.

(10) Any fault, malfunction, failure, or discrepancy observed.

40