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POWERING CHARACTERISTICS OBTAINED
WITH VERTICAL AXIS PROPELLERS
FOR LCU(A) REPRESENTED BY MODEL 4952-1

by

Mary C. Dickerson

HYDROMECHANICS LABORATORY
RESEARCH AND DEVELOPMENT REPORT

February 1964

Report 1753-3
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S-F013 02 04
ABSTRACT

Powering tests, including investigation of bollard pull capabilities, were conducted on Model 4952-1, a modified version of Model 4952. This model represented the Utility Landing Craft, Assault LCU(A) FY 1963. The stern lines of Model 4952 were altered by dropping the chine, making a flatter bottom, and moving the propellers 2 inches inboard.

The altered stern lines resulted in a 3 percent increase in shp at 8 knots and a 15 percent increase in shp at 8 knots. The alterations also greatly improved the bollard pull astern capabilities.

INTRODUCTION

The Bureau of Ships requested the David Taylor Model Basin to obtain data, by means of model tests, which would assist in evaluation of a hull design for a Utility Landing Craft, Assault LCU(A) FY 1963. This craft is to be propelled by two vertical axis propellers with an installed horsepower of 680. The model test program was conducted to determine (1) resistance characteristics of the hull, (2) free-running powering characteristics, (3) bollard pull capabilities, and (4) turning and maneuvering qualities associated with the propeller arrangement. Model 4952 was constructed in accordance with BuShips Plan No. LCU (A) 802-1895763. The linear ratio of ship to model is 8.75. Resistance characteristics of the hull are reported in Reference 2; powering characteristics, both free running and bollard pull, in Reference 3. It was discovered that the astern bollard pull was adversely affected by the propellers drawing air when the model was trimmed to the attitude for backing off a beach. When the model was further trimmed by the stern until the chine was underwater, the bollard pull capabilities improved approximately 60 percent. Therefore, it was recommended that the stern lines be altered to ensure that the knuckle is immersed at this light draft condition. On the basis of this recommendation, the Bureau of Ships authorized that the model be altered and that the effects of the alteration on bollard pull and powering characteristics be determined. The results of this evaluation are presented in this report with a comparison of the two models.

References are listed on page 10.
The tests required to evaluate the turning and maneuvering characteristics of this LCU (A) have been held in abeyance pending a decision as to the correct stern configuration. When this decision is made, the tests will be run and the data will be published in a supplementary report.

TEST PROCEDURE

Model 4952 was altered according to plans furnished by the Bureau of Ships (BuShips proposed modification LCU 1625 afterbody lines, Code 442, dated 6/18/63), and the modified model was designated Model 4952-1. Figure 1 shows the type of change made in the section shape. It can be seen that the stern lines were altered by dropping the chine and making a flatter bottom. These changes resulted in only minor changes in total displacement. The propellers were moved 2 inches inboard.

Resistance and powering characteristics were obtained for the hull presented by Model 4952-1 at the 386-ton displacement trimmed 2.28 feet stern. Outward rotating vertical axis propellers operating with the propeller pitch ratio equal to 0.82 were used for the propulsion tests. Prior to conducting the powering test, the optimum steering or thrust angle was established in the manner described in Reference 3.

The bollard pull tests were conducted at the conditions corresponding to a 254-ton displacement trimmed 1.5 feet by the stern. Data were obtained for bollard pull ahead and astern with a propeller pitch ratio equal to 0.567. For the astern condition, the propeller units were rotated 180 degrees from the optimum steering angle.

The powering predictions given herein are for the ship operating in smooth, deep salt water having a temperature of 59°F. A correlation allowance (ΔC_f) of 0.0014 was used in predicting the full-scale power from the model data and was applied in the effective horsepower and shaft horsepower calculations. The test apparatus, experimental procedures, and methods of reducing data are described in References 2 and 3.
TEST RESULTS AND DISCUSSION

POWERING TESTS

The results of the optimum steering angle tests are given in Figure 2.

These data show that the optimum steering angle for the Model 4952-1 hull is 2 degrees inboard. (The angle obtained for the Model 4952 hull was 5 degrees inboard.) Thus the reduction in optimum steering angle is associated with the flatter stern sections and the moving of the propeller inboard.

Powering predictions are presented in Figure 3. A comparison of power requirements for the original and the altered model is given in Tables 1 and 2. The altered model, Model 4952-1, indicated a slight increase, less than 3 percent at 8 knots, in ehp over the original model and an increase in shp of 15 percent at 8 knots.

<table>
<thead>
<tr>
<th>Ship Speed knots</th>
<th>EHP Model 4952 (Disp = 385 tons)</th>
<th>EHP Model 4952-1 (Disp = 396 tons)</th>
<th>4952-1/4952</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>29</td>
<td>29</td>
<td>1.00</td>
</tr>
<tr>
<td>6.0</td>
<td>52</td>
<td>52</td>
<td>1.00</td>
</tr>
<tr>
<td>7.0</td>
<td>90</td>
<td>91</td>
<td>1.01</td>
</tr>
<tr>
<td>8.0</td>
<td>152</td>
<td>156</td>
<td>1.03</td>
</tr>
<tr>
<td>9.0</td>
<td>240</td>
<td>246</td>
<td>1.03</td>
</tr>
<tr>
<td>10.0</td>
<td>381</td>
<td>393</td>
<td>1.03</td>
</tr>
</tbody>
</table>
It is difficult to establish the principal contributor to the increased shp requirement in view of the multiple changes. However, some evidence indicates that the deadrise bottom is more efficient than the flat bottom. Table 3 gives results of experiments conducted at DTMB that suggest this effect.

**TABLE 3**

Tests of LCU 1620 Class Conducted at Ship Speed of 8 Knots

<table>
<thead>
<tr>
<th>Model</th>
<th>Type of Bottom</th>
<th>EHP</th>
<th>SHP</th>
<th>EHP/SHP</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>4586</td>
<td>Flat</td>
<td>110</td>
<td>353</td>
<td>0.31</td>
<td>140</td>
</tr>
<tr>
<td>4585</td>
<td>Deadrise</td>
<td>93</td>
<td>235</td>
<td>0.38</td>
<td>120</td>
</tr>
</tbody>
</table>
BOLLARD PULL TESTS

Bollard pull test results are presented in Figure 4. The photographs in Figure 5 show a trace of air being drawn into the propeller at 169 rpm; however, this amount is minute compared with air drawing on the original model. The data in Table 4 show that the alteration to the model improved the bollard pull astern capabilities immensely.

<table>
<thead>
<tr>
<th>SHP</th>
<th>Model 4952 Disp = 254 tons 1.4 ft Trim by Stern</th>
<th>Model 4952-1 Disp = 254 tons 1.5 ft Trim by Stern</th>
<th>4952-1 4952</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>3340</td>
<td>3,870</td>
<td>1.16</td>
</tr>
<tr>
<td>200</td>
<td>5050</td>
<td>6,200</td>
<td>1.23</td>
</tr>
<tr>
<td>300</td>
<td>6230</td>
<td>8,180</td>
<td>1.31</td>
</tr>
<tr>
<td>400</td>
<td>7110</td>
<td>9,950</td>
<td>1.40</td>
</tr>
<tr>
<td>500</td>
<td>7770</td>
<td>11,550</td>
<td>1.49</td>
</tr>
<tr>
<td>600</td>
<td>8310</td>
<td>13,050</td>
<td>1.57</td>
</tr>
<tr>
<td>680</td>
<td>8660</td>
<td>14,180</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>4952</td>
<td>4952-1</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td><strong>DISPLACEMENT</strong></td>
<td>385 TONS</td>
<td>386 TONS</td>
<td></td>
</tr>
<tr>
<td><strong>WETTED SURFACE</strong></td>
<td>4141 SQ FT</td>
<td>4165 SQ FT</td>
<td></td>
</tr>
<tr>
<td><strong>LONGITUDINAL LOCATION OF PROPELLER CENTERLINE</strong></td>
<td>STATION 18.5</td>
<td>STATION 18.5</td>
<td></td>
</tr>
<tr>
<td><strong>TRANSVERSE LOCATION OF PROPELLER CENTERLINE</strong></td>
<td>11 FT 2 IN BUTT</td>
<td>11 FT BUTT</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 - Comparison of LCU(A) Hulls Represented by Models 4952 and 4952-1

Figure 2 - Optimum Steering Angle
HORSEPOWER & RPM CURVES
FOR
L.C.S (3)
ESTIMATED FROM PROPULSION TESTS OF
MODEL A1.6-3
PROPELLER CYLINDRICAL
DIMENSIONS

<table>
<thead>
<tr>
<th>SHIP</th>
<th>PROPELLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH ABLG</td>
<td>103.5 FT</td>
</tr>
<tr>
<td>BSE</td>
<td>7.7 FT</td>
</tr>
<tr>
<td>DMI (SHEL)</td>
<td>1.35 FT</td>
</tr>
<tr>
<td>RPM TESTED</td>
<td>60 RPM</td>
</tr>
<tr>
<td>RPM, 50A TESTED</td>
<td>30 RPM</td>
</tr>
<tr>
<td>RPM, 30A TESTED</td>
<td>15 RPM</td>
</tr>
<tr>
<td>RPM, STEERING ANGLE</td>
<td>1.62 RPM</td>
</tr>
<tr>
<td>APPROPRIATE CENTER DEPTH</td>
<td>1.3 FT</td>
</tr>
<tr>
<td>RULES CURRENT POWER</td>
<td>100 HP</td>
</tr>
<tr>
<td>SHIP SPECIFICATIONS</td>
<td>300 HP</td>
</tr>
<tr>
<td>SPARK GAP</td>
<td>0.03 IN</td>
</tr>
</tbody>
</table>

NO TURBULENCE STIRRATOR USED

SHIPS TESTED AT 30, 50, 70, 100, 120, 150

TEST 19

DAVID TAYLOR MODEL BALT.
WASHINGTON, D.C.
JULY 1913

Figure 3
Figure 4
Figure 5 - Bollard Pull Astern, Model 4952-1
254-ton Displacement, 1.50-ft Trim by Stern
REFERENCES


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20 CDR, DDC
### Utility Landing Craft, Assault

**Powering Tests**

The Utility Landing Craft, Assault (LCU(A)) was represented by Model 4952, a modified version of Model 4922. This model was developed by the David Taylor Model Basin and was used for powering tests, including investigation of bollard pull capabilities. The tests were conducted on Model 4952-1, a modified version of Model 4952. The stern lines of Model 4952 were altered by dropping the chine, making a flatter bottom, and moving the propellers 2 inches inboard.

The altered stern lines resulted in a 3 percent increase in ship at 8 knots and a 15 percent increase in ship at 8 knots. The alterations also greatly improved the bollard pull astern capabilities.

**Propellers**

The propellers were vertical axis propellers for LCU(A) represented by Model 4952, designed by Mary C. Dickerson. The test data was published in February 1964, and includes graphs and references.

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Model Representation</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility landing craft (Assault)</td>
<td>Model 4952-1</td>
<td>Powered tests, including investigation of bollard pull capabilities, conducted on Model 4952-1, a modified version of Model 4952. The stern lines of Model 4952 were altered by dropping the chine, making a flatter bottom, and moving the propellers 2 inches inboard.</td>
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<td>Resistance</td>
<td>Model 4952-1</td>
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</tr>
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<td>LCU(A) FY 1963 (U.S. utility landing craft, Assault)</td>
<td>Model 4952-1</td>
<td>Powering tests, including investigation of bollard pull capabilities, conducted on Model 4952-1, a modified version of Model 4952. The stern lines of Model 4952 were altered by dropping the chine, making a flatter bottom, and moving the propellers 2 inches inboard.</td>
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<td>Model 4952-1</td>
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2. Utility landing craft (Assault)—Propulsion—Model tests
3. LCU(A) FY 1963 (U.S. utility landing craft, Assault)
4. Ship models—Model TBD 4952-1
5. Propellers—Vertical-axis

I. Dickerson, Mary C. II. S-POL 02 04

POWERING CHARACTERISTICS OBTAINED WITH VERTICAL AXIS PROPELLERS FOR LCU(A) REPRESENTED BY MODEL 4952-1, by Mary C. Dickerson. Feb 1964. 11p. Illus., graphs, refs.
UNCLASSIFIED

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