TACTICAL TRIALS OF
USS PLYMOUTH ROCK (LSD 29)

by

James A. Heffner

APPROVED FOR public release; distribution unlimited

RESEARCH AND DEVELOPMENT REPORT

August 1956

Report No. C-778
TACTICAL TRIALS OF
USS PLYMOUTH ROCK (LSD 29)

by

James A. Heffner

August 1956

Report No. C-778

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

UNCLASSIFIED
UNCLASSIFIED

- 1 -

INTRODUCTION

The USS PLYMOUTH ROCK (LSD 29) is a high speed, steam-turbine, twin-screw, twin rudder dock ship built by the Ingalls Shipbuilding Corporation, Pascagoula, Mississippi.

The tactical trials were authorized by the Bureau of Ships (1)*, and were conducted on 23, 24, and 25 September 1955, off Rockland, Maine. The tactical data were obtained by staff members of the Taylor Model Basin. The analysis of the data was prepared by M. Rosenblatt and Son, New York, New York, under Task Order 5, Contract NObs-50125. The results of the analysis are reproduced herein in the form of curves giving information on the turning characteristics of the PLYMOUTH ROCK. The ship dimensions and average conditions during the trials are listed in Table 1. Figure 1 shows the rudder and propeller locations for the PLYMOUTH ROCK.

METHODS AND PROCEDURES

Standard 540 degree turns were made using various approach speeds and rudder angles. Special turns were made while backing the inboard shaft. All turns were made with right rudder except for two check left turns.

Acceleration runs were made to determine the relationship between time, speed and reach. Other runs were made to determine the relationship of the above quantities in decelerating from several speeds with varying throttle settings. During the acceleration and deceleration runs the throttles were manipulated to change the RPM as rapidly as permissible, either ahead or astern, without reducing the main steam line pressure at the throttles below the minimum established operating pressure. Special deceleration runs were made with five second and ten second delays between closing the ahead throttle and opening the astern throttle.

The path of the ship was plotted by triangulation from two shore stations, one of which was located on Rockland Breakwater and the other 3270 yards away on Owls Head. The time required to change heading was recorded from the ship's gyro compass and the angles of heel were measured from the ship's inclinometer.

* Numbers in parenthesis indicate references on page 3.
All data refer to the foremast position which is located 83.5 feet aft of the forward perpendicular. All data concerning the paths traveled by the ship have been corrected for combined wind and stream drifts which varied from 0.2 to 0.8 knots.

PRESENTATION OF TRIAL RESULTS

Fairied curves of tactical diameter advance, and transfer plotted against speed at various rudder angles are shown in Figure 2. Fairied plots of the ship's turning paths are shown in Figures 3 through 7. These plots are presented in a manner to show a comparison of the effect of rudder angle. At the bottom of each of these plots is a tabulation of the speed in the turn, time to change heading, advance, transfer, and tactical diameter for the rudder angles and approach speed indicated. Figures 8 through 11 show the time required to change heading at various speeds and rudder angles. The maximum angles of heel at various speeds and rudder angles are given on Figure 12. On Figure 13 the results of three runs decelerating from 20 to 0 knots with various time delays in opening the astern throttles are presented. Figures 14, 15 and 16 are shown to present more detailed information on these time-delayed crash stop runs. Curves showing the relationship of time, speed, and reach for other acceleration and deceleration runs are presented in Figures 17 through 22.

DISCUSSION OF TRIAL RESULTS

An abnormal rudder rate of approximately 0.5 degrees/second was measured when laying the rudders to any desired angle from midship. When the rudders were eased to zero, or reversed during the special zig-zag tests, a rate of about 2.3 degrees/second was observed. The helmsman rotated the steering wheel at a normal rate for each maneuver, therefore, it is assumed that the low rate was caused by a malfunction in the steering gear. The rudders, being essentially an unbalanced type, assisted the steering gear when returning to zero, producing a more normal rate.

It will be noted from Figure 13 that the reach for nominal time delays in opening the astern throttles of zero and ten seconds was 7.4 ship lengths, while for a nominal five second delay it was 6.9 ship lengths. From Figures 14, 15, and 16 it is evident that the astern throttles were not opened until a considerable period of time had expired after the "Execute." Actual times for opening the astern throttles were 16 seconds, 22 seconds and 26 seconds. The ship performance during these
I, runs will be discussed in more detail in a forthcoming report on turbine performance, since they are considered to be of primary interest in that connection.

The turning characteristics of the PLYMOUTH ROCK were approximately the same in either a right or left turn.

CONCLUSIONS

The curves shown in Figure 2 indicate that the turning characteristics of the PLYMOUTH ROCK follow the normal pattern; namely, the tactical diameter, advance, and transfer increase with an increase in speed and decrease with an increase in rudder angle.

The abnormal rudder rate encountered undoubtedly had an effect on the turning characteristics although it would be somewhat difficult to determine how much. In particular the advance, as determined from the turns, appears to be excessive when compared with that for somewhat similar ships.

REFERENCES

(1) BuShips Instruction 9080 Ser 436-170 of 10 Jun 1955.
TABLE 1
USS PLYMOUTH ROCK (LSD 29)

Ship Dimensions

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length over-all (LOA)</td>
<td>510.0 feet</td>
</tr>
<tr>
<td>Length between perpendiculas (LBP)</td>
<td>500.0 feet</td>
</tr>
<tr>
<td>Beam (extreme)</td>
<td>84.0 feet</td>
</tr>
<tr>
<td>Rudder Area (per rudder)</td>
<td>134 square feet</td>
</tr>
</tbody>
</table>

Trial Conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>9,280 tons</td>
</tr>
<tr>
<td>Trim by the Stern</td>
<td>3 inches</td>
</tr>
<tr>
<td>Draft (mean)</td>
<td>15.3 feet</td>
</tr>
</tbody>
</table>
Figure 1 - Stern Profile and Section of USS PLYMOUTH ROCK (LSD 29) Showing Rudder and Propeller Arrangements.
Figure 2 - Curves of Tactical Diameter, Advance and Transfer for USS PLYMOUTH ROCK (LSD 29).
Figure 3 - Plots of Faired Turning Circles for the USS PLYMOUTH ROCK (LSD 29) With an Approach Speed of 8.0 Knots Using 15, 25, and 35 Degree Rudder Angles.
Figure 4 - Plots of Faired Turning Circles for the USS PLYMOUTH ROCK (LSD 29) With an Approach Speed of 14.0 Knots Using 10, 15, 25, and 35 Degree Rudder Angles.
Figure 5 - Plots of Paired Turning Circles for the USS PLYMOUTH ROCK (LSD 29) With an Approach Speed of 20.0 Knots Using 10, 15, 25, and 35 Degree Rudder Angles.
Figure 6 - Plots of Fairied Turning Circles for the USS PLYMOUTH ROCK (LSD 29) with an Approach Speed of 24.0 Knots Using 10, 15, 25, and 35 Degree Rudder Angles.
Figure 7 - Plots of Faired Turning Circles for the USS PLYMOUTH ROCK (LSD 29) With an Approach Speed of 17.0 Knots Using 35 Degree Rudder Angle With Starboard Engines Stopped, Backing 2/3, Backing Full, and Backing Full.
Figure 8 - Curves of Change of Heading for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 8.0, 14.0, 20.0, and 24.0 Knots Using 10 Degree Rudder Angle.
Figure 9 - Curves of Change of Heading for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 8.0, 14.0, 20.0, and 24.0 Knots Using 15 Degree Rudder Angle.
Figure 10 - Curves of Change of Heading for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 8.0, 14.0, 20.0, and 24.0 Knots Using 25 Degree Rudder Angle.
Figure 11 - Curves of Change of Heading for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 8.0, 14.0, 20.0, and 24.0 Knots Using 35 Degree Rudder Angle.
Figure 12 - Curves of Maximum Angle of Heel for USS PLYMOUTH ROCK (LSD 29) with Approach Speeds of 8.0, 14.0, 20.0, and 24.0 Knots.
Figure 13 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) With Approach Speed of 20.0 Knots Using Astern Steam Pressure of 270 PSIG.
Figure 14 - Performance Curves for USS PLYMOUTH ROCK (LSD 29) Decelerating From 20.0 Knots Using Astern Steam Pressure of 270 PSIG.
Figure 15 - Performance Curves for USS PLYMOUTH ROCK (LSD 29)
Decelerating From 20.0 Knots Using Astern Steam Pressure of 270 PSIG (astern throttles opening delayed 5 seconds).
Figure 16 - Performance Curves for USS PLYMOUTH ROCK (LSD 29) Decelerating From 20.0 Knots Using Astern Steam Pressure of 270 PSIG (astern throttles opening delayed 10 seconds).
Figure 17 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 17.0 and 20.0 Knots Using Astern Steam Pressure of 0 PSIG.

Figure 18 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 20.0 and 24.0 Knots Using Astern Steam Pressures of 400 and 505 PSIG.
Figure 19 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 20.0 and 24.0 Knots Using Astern Steam Pressure of 505 PSIG. Repeat Runs.

Figure 20 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) With Approach Speeds of 14.0 and 17.0 Knots Using Astern Steam Pressure of 270 PSIG. Repeat Runs.
Figure 21 - Curves of Deceleration for USS PLYMOUTH ROCK (LSD 29) with Approach Speeds of 10.0, 14.0, and 17.0 Knots using Astern Steam Pressure of 270 PSIG.

Figure 22 - Curves of Acceleration for USS PLYMOUTH ROCK (LSD 29) with Approach Speeds of 0.0 and 12.0 Knots.
INITIAL DISTRIBUTION

Serials

1 - 11  Chief, Bureau of Ships, Technical Library, Code 312, for distribution:

1 - 5   Technical Library, Code 312
6       Preliminary Design, Code 420
7       Performance and Scientific, Code 436
8       Hull Design, Code 440
9       Landing Ships and Craft, Code 529
10      Hull Machinery Branch, Code 532
11      Propellers and Shafting, Code 554

12      The Commandant, U. S. Coast Guard, Washington 25, D.C.
13 - 15 Office of Chief of Naval Operations, Department of the Navy, Washington 25, D.C.
16      Commander, Boston Naval Shipyard, Boston 29, Mass.
17 - 20 Supervisor of Shipbuilding, USN, and Naval Inspector of Ordnance, Pascagoula, Mississippi, for distribution:

17      Supervisor of Shipbuilding
18      LSD 33
19      LSD 34
20      LSD 35

INITIAL DISTRIBUTION (Concluded)

Serials

25  Commanding Officer, USS THOMASTON (LSD 28), Fleet Post Office, San Francisco, Calif.

26  Commanding Officer, USS PLYMOUTH ROCK (LSD 29), Fleet Post Office, New York, New York

27  Commanding Officer, USS FORT SNELLING (LSD 30), Fleet Post Office, New York, New York

28  Commanding Officer, USS POINT DEFIANCE (LSD 31), Fleet Post Office, San Francisco, Calif.

29  Commanding Officer, USS SPIFGIL GROVF (LSD 32), Fleet Post Office, New York, New York

30  Commander, Norfolk Naval Shipyard, Portsmouth, Va.

31  Commander, New York Naval Shipyard, Naval Base, Brooklyn 1, New York

32  Gibbs and Cox, Incorporated, 1 Broadway, New York 4, New York via Supervisor of Shipbuilding, USN, and Naval Inspector of Ordnance, 139 Centre Street, New York 13, New York

33  Head, Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts via Inspector of Naval Material, Boston, Mass.

34 - 42 British Joint Services Mission (Navy Staff), P. O. Box 165, Benjamin Franklin Station, Washington, D. C.

43 - 45 The Naval Member, Canadian Joint Staff, 2450 Massachusetts Avenue, N. W., Washington, D. C.
<table>
<thead>
<tr>
<th>Dock landing ships – Maneuverability – Trial</th>
<th>Dock landing ships – Maneuverability – Trial</th>
<th>Dock landing ships – Maneuverability – Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plymoutb Rock (LSD 29)</td>
<td>1. Plymoutb Rock (LSD 29)</td>
<td>1. Plymoutb Rock (LSD 29)</td>
</tr>
<tr>
<td>(U.S. dock landing ship LSD 29)</td>
<td>(U.S. dock landing ship LSD 29)</td>
<td>(U.S. dock landing ship LSD 29)</td>
</tr>
</tbody>
</table>

The USS Plymoutb Rock (LSD 29) is a high speed, steam-turbine, twin-screw, twin-rudder dock ship. Information on the turning characteristics are given.