[redacted]

NAVY DEPARTMENT

THE DAVID W. TAYLOR MODEL BASIN

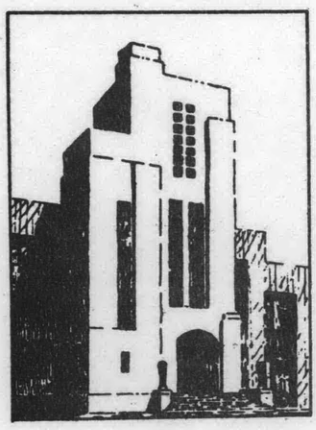
WASHINGTON 7, D.C.

VIBRATION GENERATOR TESTS ON LST 1156

by

Quentin R. Robinson

[redacted]



April 1954

Report 891

VIBRATION GENERATOR TESTS ON LST 1156

by

Quentin R. Robinson

ABSTRACT

The David Taylor Model Basin conducted a series of vibration generator tests on LST 1156 to determine the resonance frequencies of the gun-director structure for use in modification of the structure. In addition an attempt was made to vibrate the main superstructure to determine its resonance frequencies and also to vibrate the after part of the hull in the vicinity of the gun director to determine whether local vibratory conditions of the hull were the cause of excessive vibration of the director.

The data indicate that the resonance frequencies of the structure occur within the operating range of the ship when the magazine is loaded and that they fall just above the top operating speed when the magazine is empty. The force output of the vibration generator was not of sufficient magnitude to vibrate the main superstructure at amplitudes large enough to measure. The test results also indicated that there were no local vibratory conditions existing in the after section of the hull, apart from the hull itself, that would cause excessive vibration of the after gun director.

INTRODUCTION

Vibration measurements and observations made by Norfolk Naval Shipyard, David Taylor Model Basin, Bureau of Ships, and Gibbs and Cox, Inc., on vessels of the LST 1156 Class indicated that the after Mark 63 gun director vibrated excessively. It was determined that while the vibration of the hull was not considered abnormally large, there was considerable magnification of the motion from the main deck to the gun-director level. Gibbs and Cox, Inc., was authorized to modify the gun-director structure in order to reduce the vibration. In order to obtain data on the resonance frequencies of the structure, the Bureau of Ships authorized the Taylor Model Basin to conduct a series of vibration generator tests on the structure.[1]* The primary purpose of these tests was to determine the resonance frequencies in the vertical, longitudinal, and athwartship directions and to measure the motions at various locations on the structure.

---

* References are listed at the end of this report.

TEST PROCEDURE

The vibration generator tests were conducted on 19-23 November 1953 while the ship was in port at Little Creek, Virginia. In addition to tests on the structure of the after gun director, tests were conducted on the main superstructure at the pilot house (Frame 45, 03 level) and at the steering engine room (Bulkhead 61, second deck). However the greatest effort was concentrated on the after gun-director structure.

The gun-director structure was vibrated by means of a Lazan Oscillator[2] mounted at the 02 level near the center of the director base. Motions of the director platform and the associated structure were detected with Consolidated velocity pickups. The signals from the pickups were recorded on a Brush direct-inking recorder after being integrated and amplified.

The vibration generator was operated from a slow speed up to about 2000 RPM, and a continuous record of the motions at the center of the director was made. Upon completion of this test the records were examined, and the resonance frequencies were determined. The vibration generator was then run at the resonance frequency of the structure, and motions were measured at various locations (see Figure 4). The vibrations at each location were recorded simultaneously with the motions at the center of the director. The same procedure was followed with the vibration generator mounted to excite the structure in the vertical, longitudinal, and athwartship directions. A series of tests was conducted when the 3"/50-cal. ready-service magazine, located directly below the gun director at the 01 level, was empty and when this magazine was loaded with about 5 tons of ammunition.

Upon completion of the tests of the gun-director structure, the vibration generator was mounted at Frame 45 on the 03 level, and an attempt was made to vibrate the main superstructure. The machine was oriented to produce forces in the vertical direction and was operated at speeds up to about 2000 RPM. A similar test was made with the machine mounted to produce forces in the athwartship direction.

The final tests were conducted with the vibration generator mounted in the steering-engine room at Bulkhead 61 on the second deck. Both vertical and athwartship excitations were measured at vibration generator speeds up to about 2000 RPM. Visual observations also were made at the gun director on the 03 level while these tests were being conducted.

TEST RESULTS

The response of the after-gun-director structure to the application of a sinusoidal force has been plotted in

TABLE 1

VIBRATION AMPLITUDES MEASURED AT VARIOUS LOCATIONS AT THE RESONANCE FREQUENCIES OF THE AFTER MARK 63 GUN DIRECTOR STRUCTURE

Frequency CPM	Direction of Excitation	Load Condition of 3"/50 Cal. Mag.	Relative Values of Amplitude at Stations **															
			1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1272	Vertical	Empty	1.7V#	2.2V	2.3V	2.6V	1.2V	0.8V	2.2V	0.6V	-	1.1V	1.8V	-	-	0.5V	-	-
1040	Vertical	Loaded	0.9V	1.6V	1.5V	1.7V 1.3L 0.9A	1.5V	0.9V	1.5V	0.6V	-	0.2V	1.3V	0.1V	0.2V	-	0.1V	-
1500	Vertical	Loaded	Neg.V	0.1V	0.6V	1.3V 0.1A	0.6V	0.1V	0.7V	0.7V	-	0.4V	0.3V	0.4V	Neg.V	-	0.2V	-
1290	Longitudinal	Empty	8.4L	9.1L	10.0L	11.9L 4.1V	11.6L	11.6L	10.8L	11.3L	4.7V	3.5V	5.6V	1.3L 0.7V	2.1V	0.7V	-	0.8V
1020	Longitudinal	Loaded	3.2L	2.9L	3.8L	4.0L 2.7V 0.2A	4.4L	4.2L	4.7L	4.7L	-	0.2L 1.4V	0.2L 3.2V	Neg.L 0.2V	Neg.L 1.5V	- -	0.2L 0.5V	- -
1380	Longitudinal	Loaded	4.4L	4.8L	6.0L	6.0L 0.8V 0.8A	5.9L	5.7L	5.9L	5.32	-	0.8L 1.2V	0.8L 2.1V	0.9L 0.2V	0.2L 0.8V	- -	Neg.L 0.5V	- -
1020	Athwartships	Loaded	0.6A	0.6A	0.6A	0.6A 0.2V	0.6A	0.6A	0.7A	0.5A	-	0.3A 0.02V	0.3A 0.05V	0.2A Neg.V	0.02A	-	0.02A	-

* Station numbers refer to locations designated on Figures 4, 5, and 6.
** The relative amplitudes have been adjusted on the basis of the same exciting force at Station 4 for all cases.
\# Directions in which measurements were made are indicated next to amplitude values (V-vertical, L-longitudinal, A-athwartships).

relative values to indicate the motion at various frequencies. Since the force output of the vibration generator varies as the square of its speed, the amplitudes of motion indicated on the curves have been adjusted to a constant force of ±522 lb, which was the force generated at 1000 RPM. In Figure 1 relative amplitudes are plotted against frequency for vertical excitation with the magazine loaded and with the magazine empty. Similar curves for longitudinal excitation and for athwartship excitation are shown in Figures 2 and 3, respectively.

The results of surveys of the gun-director structure made at the various resonance frequencies are tabulated in Table 1. The data for the 16 stations were not obtained simultaneously, but the data at each station were recorded simultaneously with those at Station 4, which was the location of the vibration generator. The data obtained from the movable pickup have been adjusted to correct for any amplitude change occurring at the location of the stationary pickup during the survey.

Figures 1, 2, and 3 indicate that with the magazine loaded there are resonance frequencies below 1200 CPM in the three directions measured. These resonances, which could be excited by the propeller blades, fall within the operating range of the ship since the shafts can rotate up to about 300 RPM and the ship is equipped with 4-bladed propellers. The amplitudes in arbitrary units measured at various locations when the structure was excited vertically at 1040 CPM are shown graphically in Figure 4. Similar data for longitudinal excitation at 1020 CPM and for athwartship excitation at 1020 CPM are shown in Figures 5 and 6. The data shown in these three figures were obtained with the magazine loaded.

The motions obtained with the vibration generator located abaft the pilot house (Bulkhead 45, 03 level) were too small to detect with the equipment used. Observations made at the 03 level and 02 level indicated that there were no perceptible vibrations, and it was concluded that the force output of the machine was not sufficient to excite the structure.

Similar results were obtained with the vibration generator mounted at Bulkhead 61 on the second deck. There were no measurable motions recorded at that location with the machine oriented for vertical excitation. Observations made at the gun director during this test indicated that the amplitudes were very small. Some records were obtained with the vibration generator oriented for athwartship excitation. Since the amplitudes of motion were small, the integrator was removed from the circuit and velocity measurements were made. There were no measurable amplitudes recorded at frequencies up to 1300 CPM. The recorded data at frequencies between 1300 and 1750 CPM indicated that there were no amplitude peaks within that range. The purpose of this phase of the test was to determine whether or not local

resonance conditions existed in this section of the ship which might cause excessive vibrations at the gun director. No such conditions were found. It is probable that resonance frequencies of the hull fall within the frequency range explored, but the equipment used did not have the capacity to excite or detect these frequencies.

SUMMARY

The data indicate that the after Mark 63 gun-director structure vibrates at the following resonance frequencies within or near the operating range of the ship:

Direction	Load Condition of Magazine	Frequency CPM	Corresponding Shaft Speed RPM
Vertical	Loaded	1040	260
Vertical	Empty	1272	318
Longitudinal	Loaded	1020	255
Longitudinal	Empty	1290	322
Athwartships	Loaded	1020	255

With a loaded magazine the resonance frequencies occur within the operating range, but with the magazine empty the actual peak amplitudes are reached just above the top frequency of excitation expected from the ship's propulsion system. The amplitudes measured in the vertical and longitudinal directions were larger when the magazine was empty than when the magazine was loaded. Also of note is the fact that the amplitudes measured in the athwartship direction were much smaller than those measured for both vertical and longitudinal excitation.

It was not possible to vibrate the main superstructure at Bulkhead 45 on the 03 level in either the vertical or the athwartship direction.

With the vibration generator mounted at Bulkhead 61 on the second deck there was no indication of local resonances within the operating range of the ship.

PERSONNEL

The tests were conducted by the author and C. H. Kinsey of the David Taylor Model Basin. The assistance and cooperation of Messrs. B. B. Cook, Jr., and H. H. Binney of Gibbs and Cox, Inc., is gratefully acknowledged.

REFERENCES

1. BuShips Speedletter LST 1156 (519E) Ser 519-6017 to TMB dated 17 Nov 1953.

2. Robinson, Q.R., "Vibration Machines at the David W. Taylor Model Basin," TMB Report 821, July 1952.

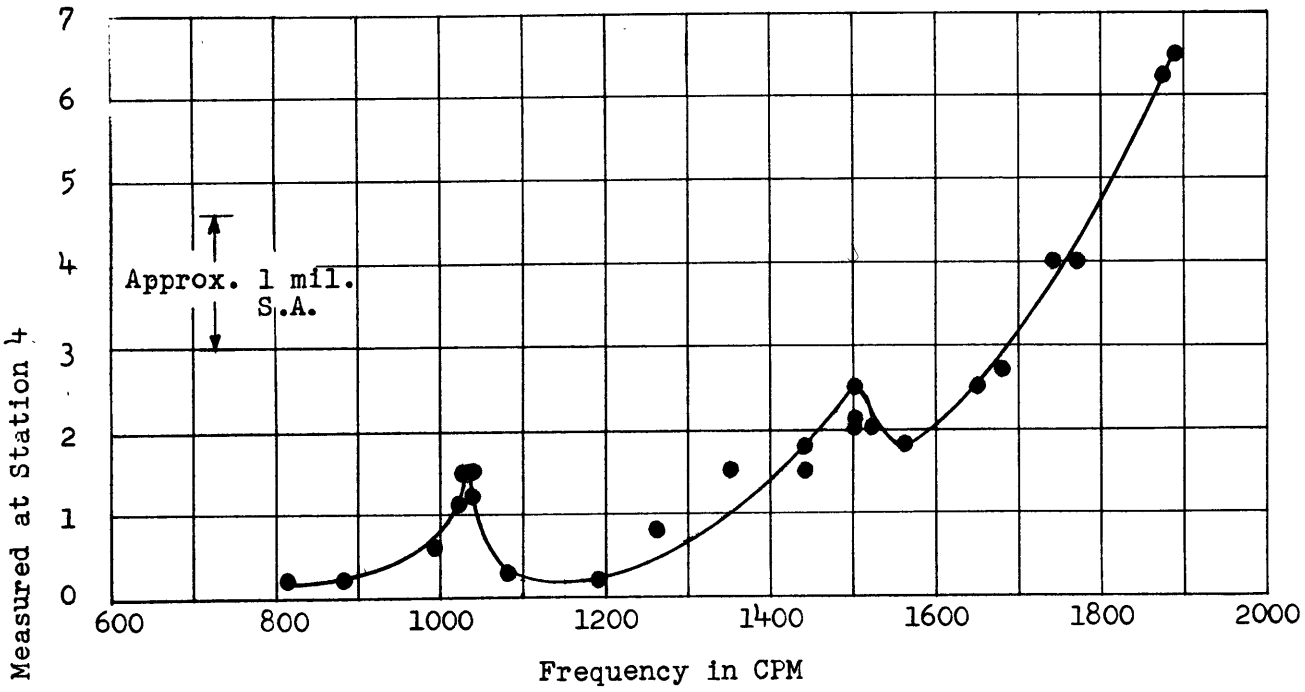


Figure 1a - 3"/50-Cal. Magazine Loaded

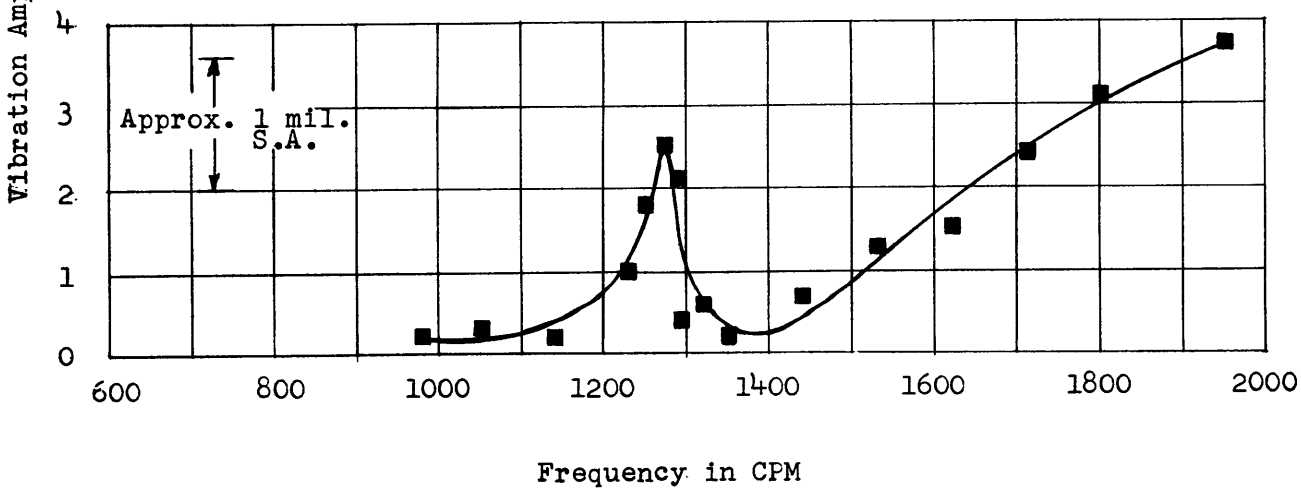


Figure 1b - 3"/50-Cal. Magazine Empty

Figure 1 - Resonance Curves for Vertical Vibration of After Gun Director Structure

Data plotted are results of force of ± 522 lb applied at Station 4.

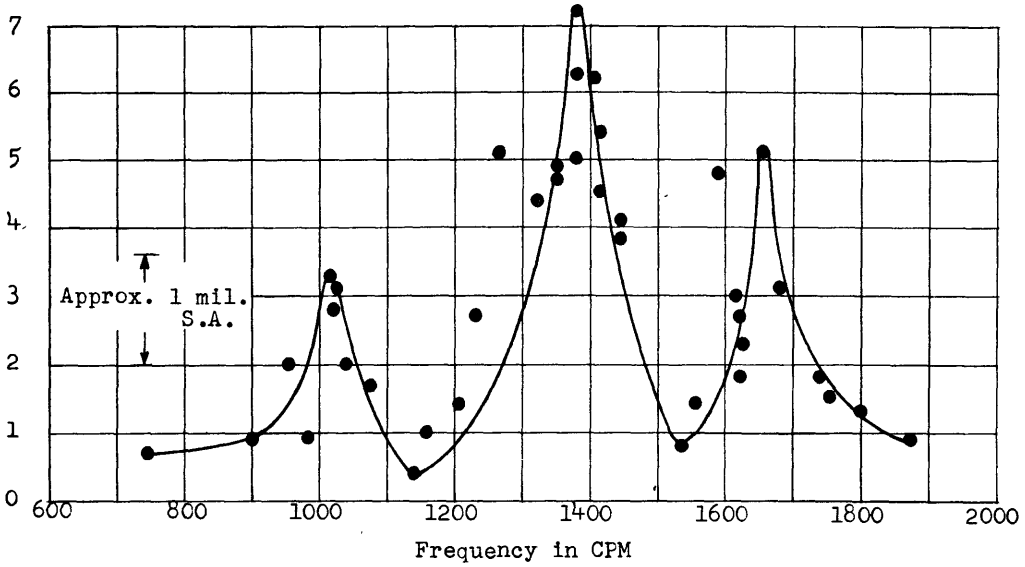


Figure 2a - 3"/50-Cal. Magazine Loaded

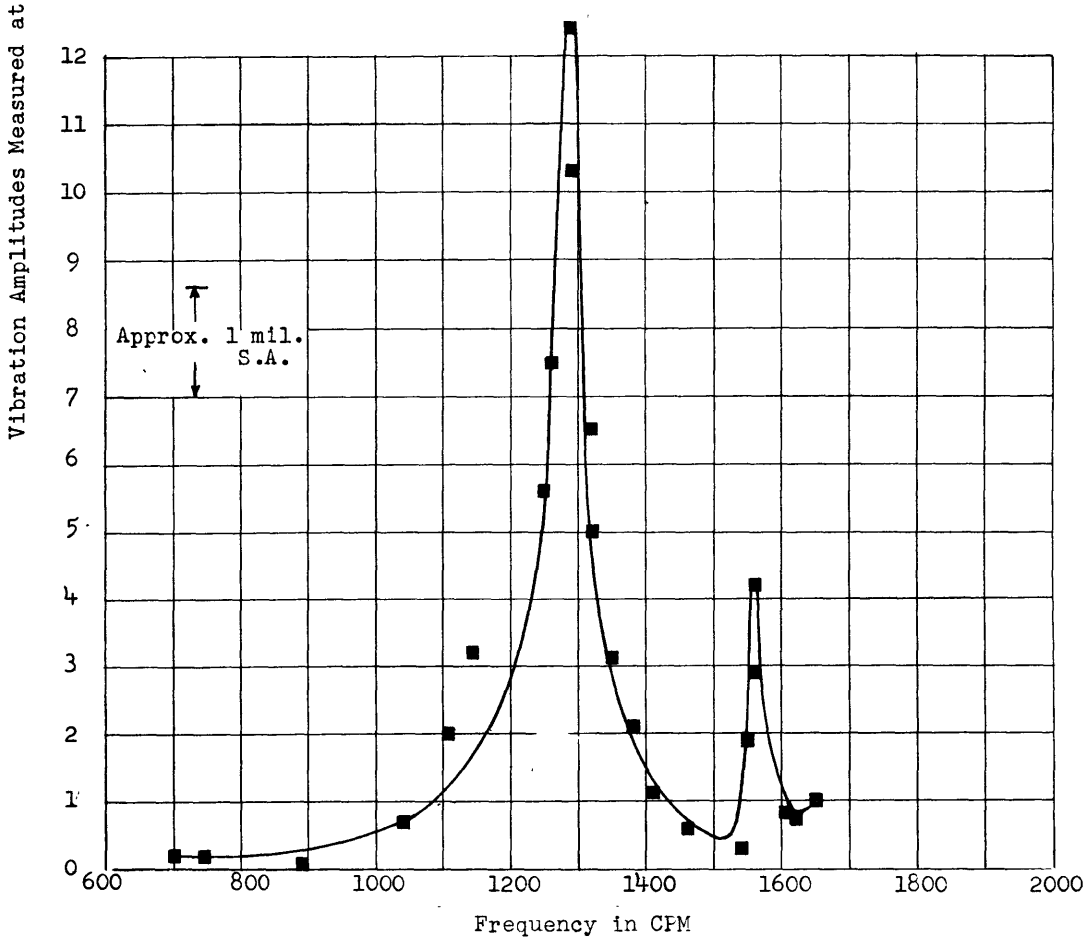


Figure 2b - 3"/50-Cal. Magazine Empty

Figure 2 - Resonance Curves for Longitudinal Vibration of After Gun Director Structure

Data plotted are results of force of ± 522 lb applied at Station 4.

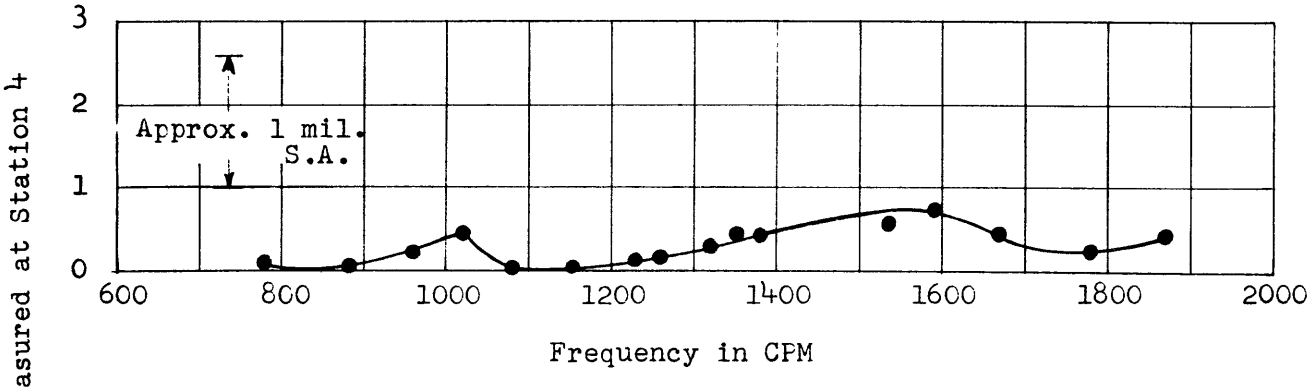


Figure 3a - 3"/50-Cal. Magazine Loaded

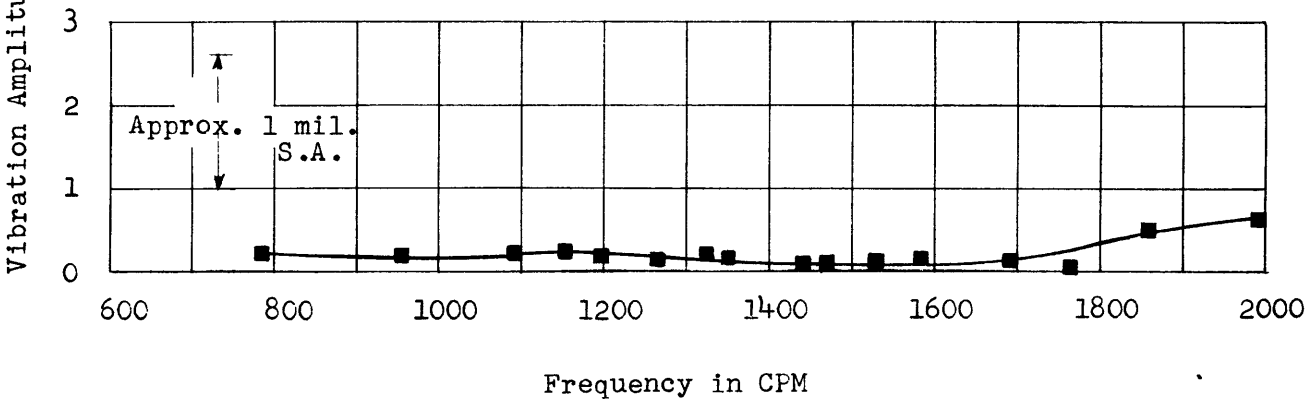
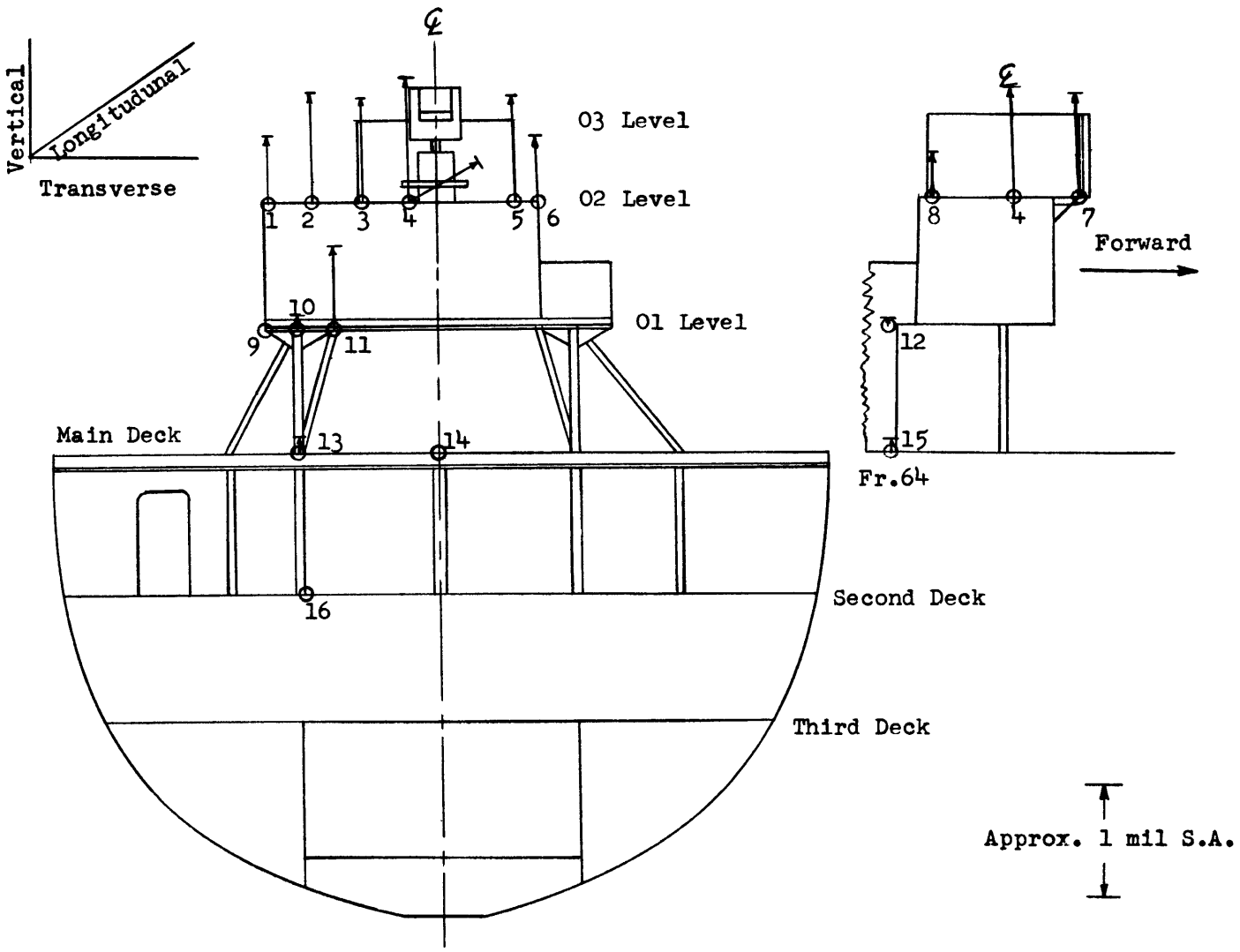


Figure 3b - 3"/50-Cal. Magazine Empty

Figure 3 - Resonance Curves for Athwartships Vibration of After Gun Director Structure

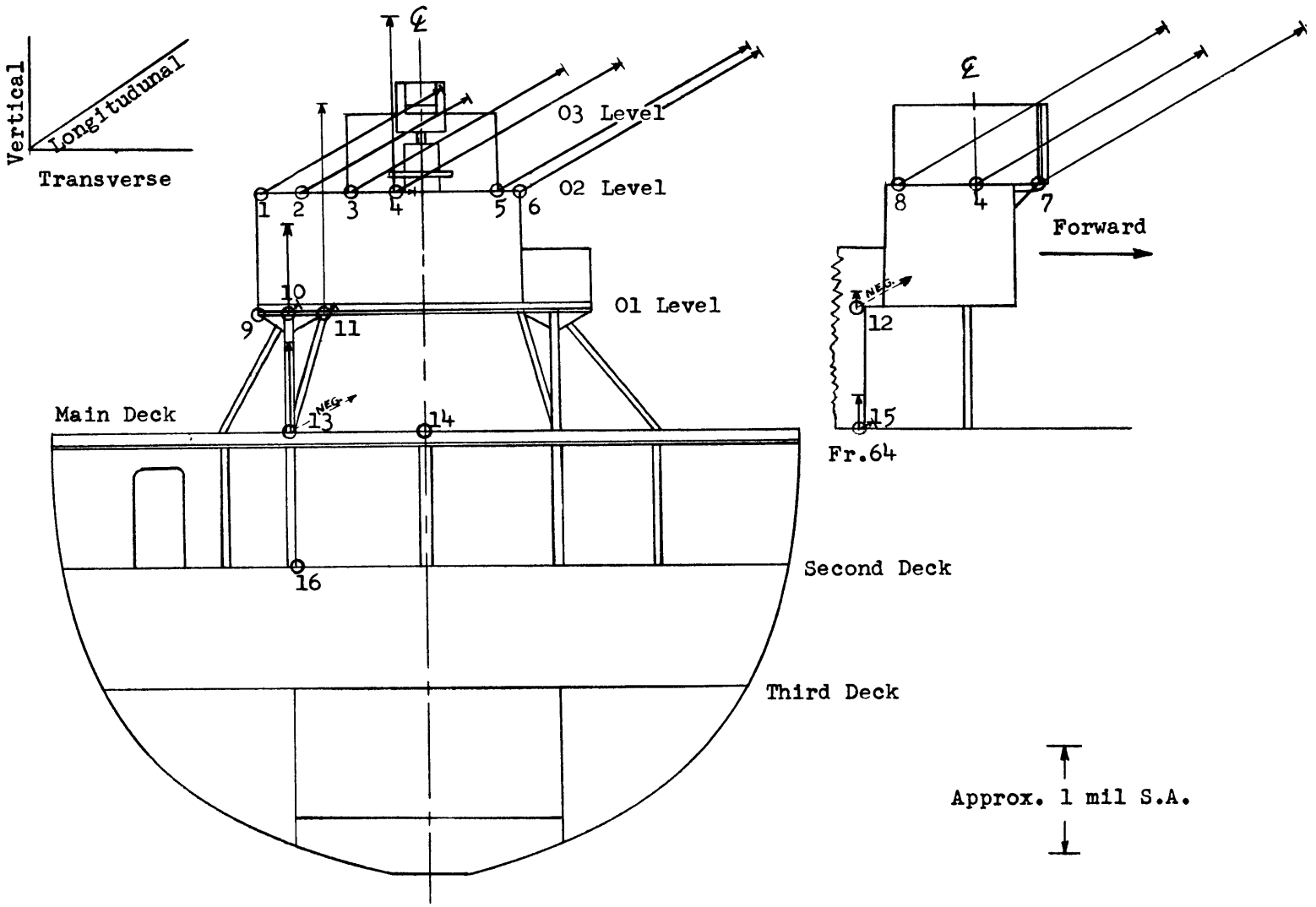
Data plotted are results of force of ±522 lb applied at Station 4.



Frame 61, Looking Aft

Figure 4 - Relative Amplitudes of Vertical Excitation Measured at 1040 CPM with Magazine Loaded

Data plotted are results of force of ± 522 lb applied at Station 4.



Frame 61, Looking Aft

Figure 5 - Relative Amplitudes of Longitudinal Excitation Measured at 1020 CPM with Magazine Loaded

Data plotted are results of force of ± 522 lb applied at Station 4.

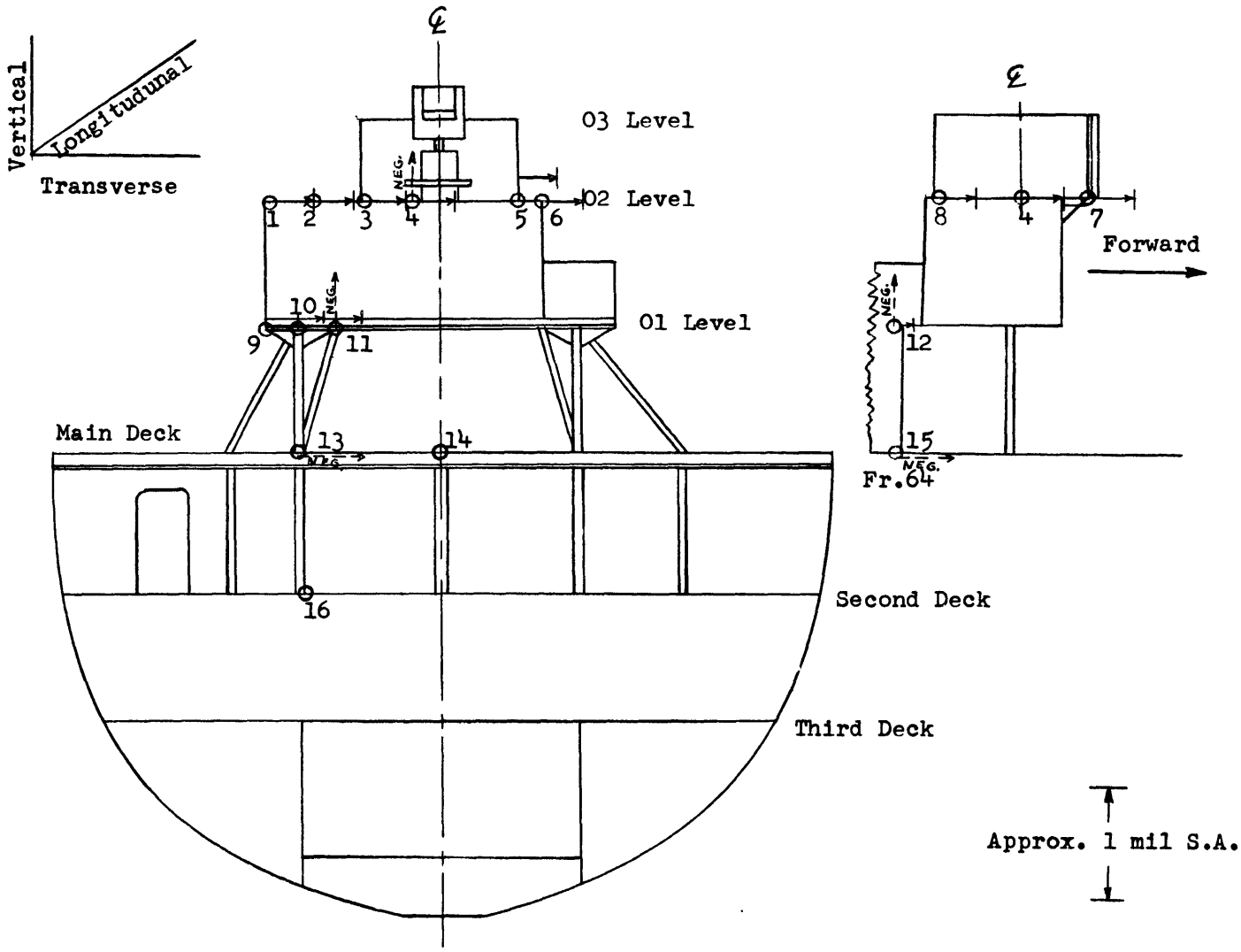


Figure 6 - Relative Amplitudes of Athwartship Excitation Measured at 1020 CPM with Magazine Loaded

Data plotted are results of force of ± 522 lb applied at Station 4.

INITIAL DISTRIBUTION

Copies	
9	Chief, Bureau of Ships, Technical Library (Code 362), for distribution: 5 Technical Library 1 Noise, Shock and Vibration (Code 371) 1 Hull Design (Code 440) 1 Assistant for Landing Ships (Code 519E) 1 Propellers and Shafting (Code 554)
1	Chief, Bureau of Ordnance
1	Commander, Norfolk Naval Shipyard
1	Commander, New York Naval Shipyard
1	Supervisor of Shipbuilding and NIO, New York
1	Supervisor of Shipbuilding and NIO, Bath, Maine
1	COMPHIBLANT
1	Gibbs and Cox, Inc.

David W. Taylor Model Basin. Rept. 891.
VIBRATION GENERATOR TESTS ON LST 1156, by Quentin R. Robinson. April 1954. 13 p. incl. table. figs. refs.
UNCLASSIFIED

The David Taylor Model Basin conducted a series of vibration tests on LST 1156 to determine the resonance frequencies of the gun-director structure for use in modification of the structure. In addition an attempt was made to vibrate the main superstructure to determine its resonance frequencies and also to vibrate the after part of the hull in the vicinity of the gun director to determine whether local vibratory conditions of the hull were the cause of excessive vibration of the director.

The data indicate that the resonance frequencies of the structure occur within the operating range of the ship when the magazine is loaded and that they fall just above the top

1. Vibration mechanisms
2. Gun directors - Vibration
3. Ship hulls - Vibration
4. LST 1156 (U.S. landing ship tank
I. Robinson, Quentin R.

David W. Taylor Model Basin. Rept. 891.
VIBRATION GENERATOR TESTS ON LST 1156, by Quentin R. Robinson. April 1954. 13 p. incl. table. figs. refs.
UNCLASSIFIED

The David Taylor Model Basin conducted a series of vibration tests on LST 1156 to determine the resonance frequencies of the gun-director structure for use in modification of the structure. In addition an attempt was made to vibrate the main superstructure to determine its resonance frequencies and also to vibrate the after part of the hull in the vicinity of the gun director to determine whether local vibratory conditions of the hull were the cause of excessive vibration of the director.

The data indicate that the resonance frequencies of the structure occur within the operating range of the ship when the magazine is loaded and that they fall just above the top

1. Vibration mechanisms
2. Gun directors - Vibration
3. Ship hulls - Vibration
4. LST 1156 (U.S. landing ship tank
I. Robinson, Quentin R.

David W. Taylor Model Basin. Rept. 891.
VIBRATION GENERATOR TESTS ON LST 1156, by Quentin R. Robinson. April 1954. 13 p. incl. table. figs. refs.
UNCLASSIFIED

The David Taylor Model Basin conducted a series of vibration tests on LST 1156 to determine the resonance frequencies of the gun-director structure for use in modification of the structure. In addition an attempt was made to vibrate the main superstructure to determine its resonance frequencies and also to vibrate the after part of the hull in the vicinity of the gun director to determine whether local vibratory conditions of the hull were the cause of excessive vibration of the director.

The data indicate that the resonance frequencies of the structure occur within the operating range of the ship when the magazine is loaded and that they fall just above the top

1. Vibration mechanisms
2. Gun directors - Vibration
3. Ship hulls - Vibration
4. LST 1156 (U.S. landing ship tank
I. Robinson, Quentin R.

David W. Taylor Model Basin. Rept. 891.
VIBRATION GENERATOR TESTS ON LST 1156, by Quentin R. Robinson. April 1954. 13 p. incl. table. figs. refs.
UNCLASSIFIED

The David Taylor Model Basin conducted a series of vibration tests on LST 1156 to determine the resonance frequencies of the gun-director structure for use in modification of the structure. In addition an attempt was made to vibrate the main superstructure to determine its resonance frequencies and also to vibrate the after part of the hull in the vicinity of the gun director to determine whether local vibratory conditions of the hull were the cause of excessive vibration of the director.

The data indicate that the resonance frequencies of the structure occur within the operating range of the ship when the magazine is loaded and that they fall just above the top

1. Vibration mechanisms
2. Gun directors - Vibration
3. Ship hulls - Vibration
4. LST 1156 (U.S. landing ship tank
I. Robinson, Quentin R.

operating speed when the magazine is empty. The force output of the vibration generator was not of sufficient magnitude to vibrate the main superstructure at amplitudes large enough to measure. The test results also indicated that there were no local vibratory conditions existing in the after section of the hull, apart from the hull itself, that would cause excessive vibration of the after gun director.

operating speed when the magazine is empty. The force output of the vibration generator was not of sufficient magnitude to vibrate the main superstructure at amplitudes large enough to measure. The test results also indicated that there were no local vibratory conditions existing in the after section of the hull, apart from the hull itself, that would cause excessive vibration of the after gun director.

operating speed when the magazine is empty. The force output of the vibration generator was not of sufficient magnitude to vibrate the main superstructure at amplitudes large enough to measure. The test results also indicated that there were no local vibratory conditions existing in the after section of the hull, apart from the hull itself, that would cause excessive vibration of the after gun director.

operating speed when the magazine is empty. The force output of the vibration generator was not of sufficient magnitude to vibrate the main superstructure at amplitudes large enough to measure. The test results also indicated that there were no local vibratory conditions existing in the after section of the hull, apart from the hull itself, that would cause excessive vibration of the after gun director.