

NOTICE TO DEFENSE DOCUMENTATION CENTER USERS

* ? *

This document is being distributed by the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, as a result of a recent agreement between the Department of Defense (DOD) and the Department of Commerce (DOC).

The Clearinghouse is distributing unclassified, unlimited documents which are or have been announced in the Technical Abstract Bulletin (TAB) of the Defense Documentation Center.

The price does not apply for registered users of the DDC services.





Reproduced by the

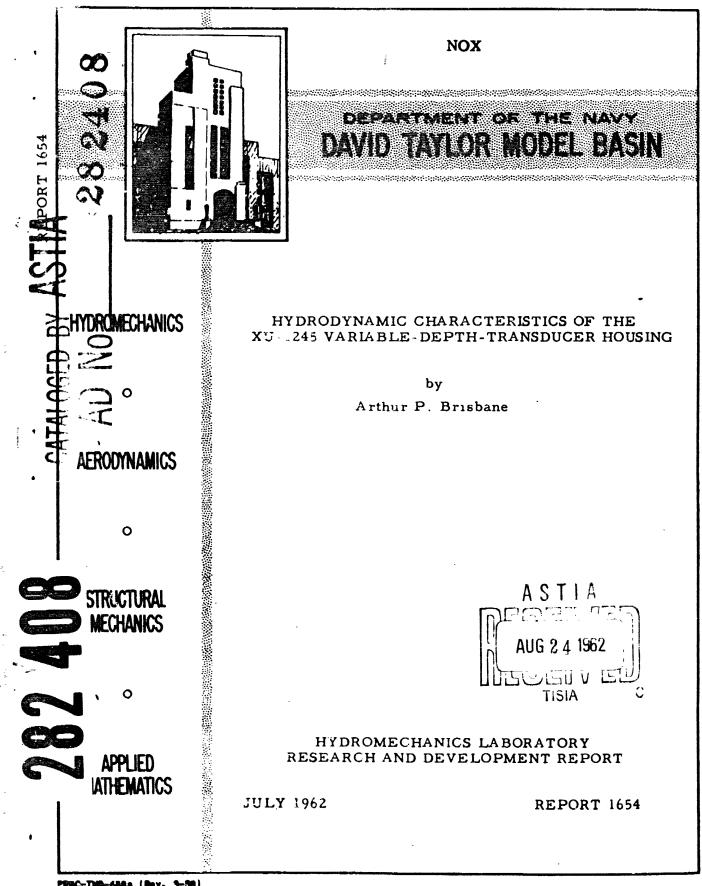
ARMED SERVICES TECHNICAL INFORMATION AGENCY ARLINGTON HALL STATION ARLINGTON 12, VIRGINIA





NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.





PRRC-THD-648a (Rev. 5-58)

HYDRODYNAMIC CHARACTERISTICS OF THE XU-1245 VARIABLE-DEPTH-TRANSDUCER HOUSING

by

Arthur P. Brisbane

.

.

JULY 1962

.

.

.

.

•

.

REPORT 1654

:

•

•

TABLE OF CONTENTS

.

.

٠

.

~

.

.

Page

.

ABSTRACT	1
INTRODUCTION	1
DESCRIPTION OF HOUSING	2
APPARATUS AND TEST PROCEDURES	5
RESULTS AND DISCUSSION	5
CONCLUSIONS AND RECOMMENDATIONS	14
REFERENCES	15

.

.

.

.

Page

ţ)

.

•

Figure	1 - The XU-1245 Variable-Depth-Transducer Housing 3
Figure	2 - The XU-1245 Housing without Transducer Cover \ldots . 4
Figure	3 - Schematic of Apparatus and Test Configuration 6
Figure	4 - Predicted Cable Configurations for Completely Assembled Housing 8
Figure	5 - Predicted Towline Tensions for Completely Assembled Housing
Figure	6 - Predicted Towline Angles for Completely Assembled Housing 10
Figure	7 - Predicted Cable Configurations for Housing without Transducer Cover 11
Figure	8 - Predicted Towline Tensions for Housing without Transducer Cover 12
Figure	9 - Predicted Towline Angles for Housing without Transducer Cover

iii

ABSTRACT

Tests were conducted to determine the hydrodynamic characteristics of a full-scale XU-1245 Variable-Depth-Transducer Housing designed by the U.S. Navy Underwater Sound Laboratory. The towing characteristics were observed to be satisfactory over a speed range from 0 to 12 knots. The pressure-compensating device provided for the transducer appeared to operate satisfactorily. Computer studies, based on measurements of towline angle and tension, indicate that the housing will meet the design requirements for speed and towing depth at sea.

INTRODUCTION

The David Taylor Model Basin was requested¹ by the U.S. Navy Underwater Sound Laboratory to determine the towline angle and tension of the XU-1245 Variable-Depth-Transducer Housing. The XU-1245 was designed by the Underwater Sound Laboratory to be used as a mobile sound source for calibration of the Project ARTEMIS array. As such, the housing is required to tow at a depth of 200 feet at 8 knots using 500 feet of 0.30-inch diameter cable. The 60 feet of cable nearest the housing is enclosed with continuous rubber fairing to reduce cable drag and vibration.

The Model Basin conducted a test program to determine the pertinent hydrodynamic characteristics needed to predict the operation of the housing at sea. At the verbal request of Underwater Sound Laboratory personnel, the operation of auxiliary devices on the housing was also determined. The following information was obtained in the complete test program:

- 1. The ability of a pressure compensating device to equalize the water pressure on the faces of the transducer.
- 2. Towline angle and tension in the speed range from 0 to 12 knots.
- 3. The proper towpoint location for acceptable towing characteristics.
- 4. The towing characteristics of the housing without the fiberglas transducer cover (on the remote chance that the cover has undesirable effects on the sonar and must be removed).
- 5. The ability of a trim tab on the vertical tail to eliminate kiting caused by asymmetries in construction of the housing.

This report presents the results of the test program and predicts, on the basis of studies with the IBM 7090 Computer, the operating characteristics of the housing at sea.

References are listed on page 15

DESCRIPTION OF HOUSING

The external configuration of the XU-1245 Variable-Depth-Transducer Housing is shown in Figure 1 and pertinent physical characteristics are listed in Table 1. The term "housing" refers to the complete assembly consisting of the transducer, the fiberglas cover enclosing the transducer, a compressed-air bottle, a pressure regulator, and a framework for supporting the component parts including tail fins and tow bracket.

TABLE 1

Physical Characteristics of the Housing

Length overall, inches	52.00
Height of tail, inches	36.75
Width of transducer cover, inches	7.00
Frontal area, square inches	135
Weight in air, pounds	347
Weight in salt water, at standard conditions, pounds	252
Weight in salt water, at standard conditions, pounds	252
Distance from nose to second tow position, inches	15.50
Towpoint spacing, inches	2.00

Figure 2 shows the housing with the fiberglas cover removed from the housing exposing the transducer. The "pie-shaped" transducer, approximately 18 inches in diameter, is fitted with a rubber diaphragm on each face to form an airtight chamber. The compressed-air bottle is connected to the transducer chamber through a "SCUBA" double-stage regulator. Thus, when the depth of submergence of the housing is increased, the regulator allows air to enter the chamber until the internal pressure balances the hydrostatic pressure acting on the transducer faces. When the depth of submergence is decreased, the relief valve allows air to escape to equalize the pressure on both sides of the diaphragms. The bleeding of air through the relief valve is accomplished in finite steps rather than continuously so that the compressed air supply will not be consumed when making small excursions in depth. The foregoing pressure compensating system has the advantage of keeping the transducer dry without a rugged container which could possibly interfere with the acoustic characteristics of the transducer.

Stabilization of the housing is accomplished by a large vertical tail fin. The fin is equipped with a full length trim tab which can be adjusted to compensate for any asymmetries which may occur in the construction process. The lead weights in the nose section which are shown in Figure 2 are provided to add ballast, increase the metacentric stability, and help maintain the proper pitch attitude.

The support structure consists of a series of aluminum plates and pipes welded together to form a framework in which to mount the transducer, air bottle, regulator, and transducer cover. The point of

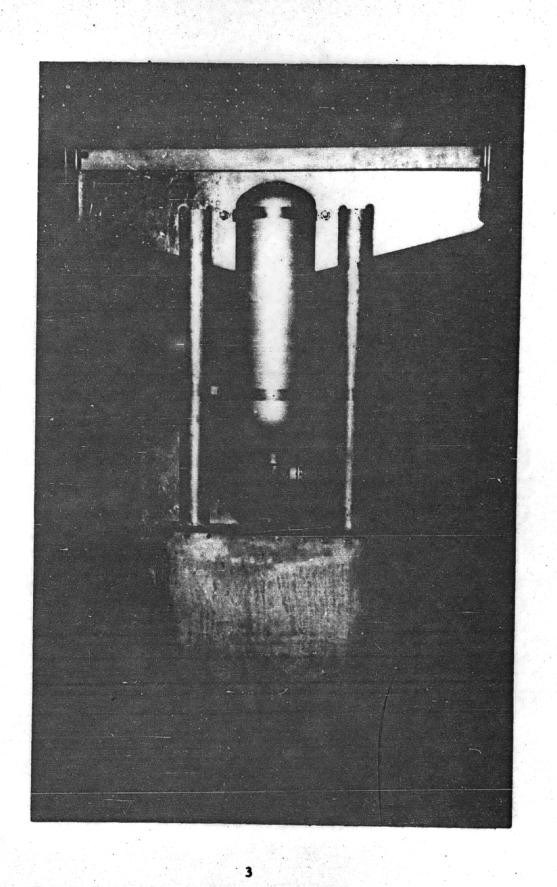


Figure 1 - The XU-1245 Variable-Depth-Transducer Housing

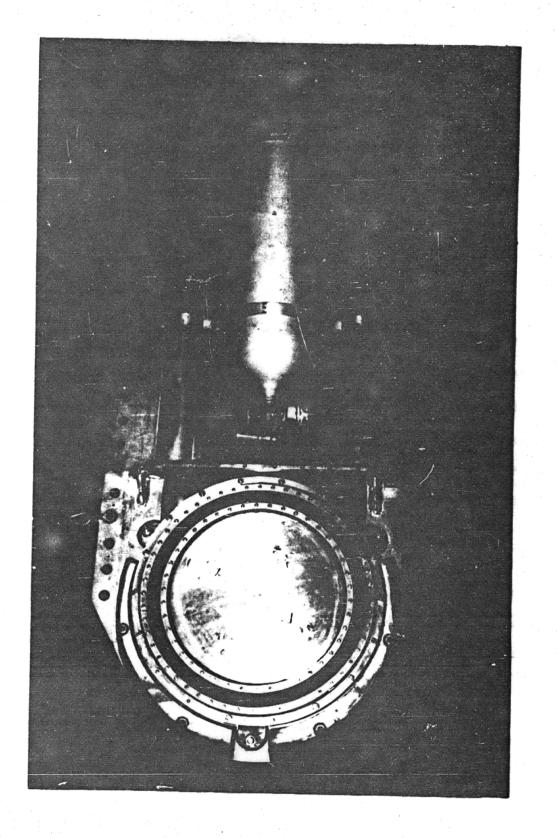


Figure 2 - The XU-1245 Housing without Transducer Cover

attachment for the towcable is provided by a plate which is welded to the top of the framework. The plate contains ten holes so that the longitudinal position of the towpoint can be changed as desired.

APPARATUS AND TEST PROCEDURES

Two general types of tests were performed with the housing; static tests and towing tests. The static tests were conducted to investigate the operation of the pressure-compensating system and to determine initial ballast and trim conditions. In these tests, the housing was suspended from a crane and lowered into the water to a depth of 22 feet, the maximum depth of the deep water basin, and then raised to the surface in 1-foot increments. Observations were made to determine the intervals at which air escaped from the relief valve. The weight of the housing in air and fresh water, and the pitch angle of the body at rest were also determined.

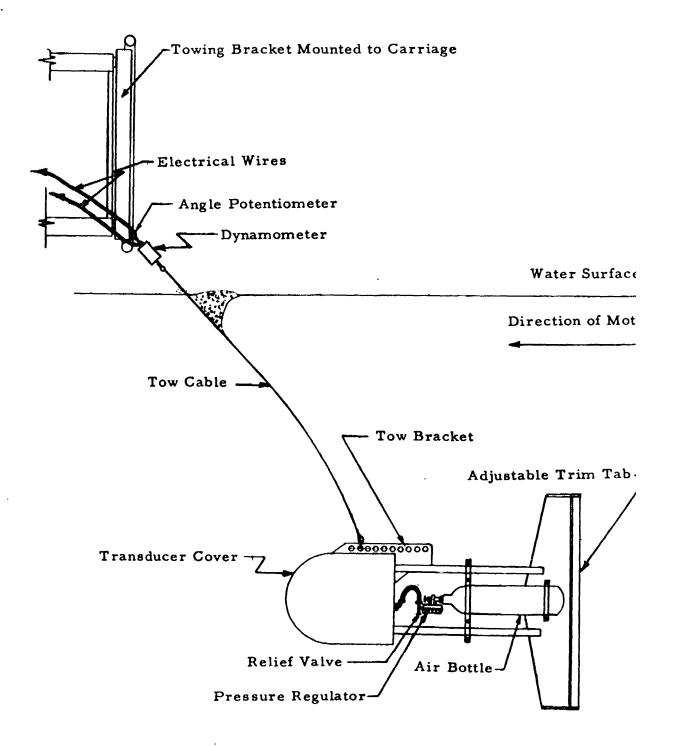
Figure 3 shows the apparatus and configuration used in the towing tests. The housing was towed with a 10 foot length of 1/8-inch-diameter cable which was secured to a tension dynamometer and an angle measuring potentiometer on the towing carriage. This small diameter cable was used to keep the curvature in the towcable and the difference in cable tension between the housing and measuring equipment to a minimum. The towline tension and angle were recorded in the speed range from 0 to 12 knots with the towcable attached at two different towpoint locations, e.g., the second and third holes from the nose. The tests were repeated at speeds from 0 to 10 knots with the transducer cover removed and the towcable attached in the second hole. Roll, pitch, and general towing performance were observed from the towing carriage during each test.

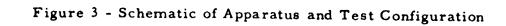
Additional towing tests were made over a speed range from 0 to 7 knots with the trim tab locked in the full left position to determine the effectiveness of the tab. The resulting kite of the housing was observed at 1-knot intervals throughout the speed range.

RESULTS AND DISCUSSION

The tests of the pressure compensating and relief device indicate that the system works satisfactorily It was noted that air escaped from the relief value at 7-foot intervals as the housing was raised to the water surface. The relief value setting, therefore, was approximately 3 pounds per square inch. The pitch angle with the body at rest was slightly nose up when the towcable was attached in the second hole from the nose and slightly nose down when in the third hole.

The roll and yaw angles of the housing, as observed during the towing tests, appeared to be zero. For both towpoint locations, an increasing nose-down pitch occurred as the towing speed was increased. However,





the pitch angle always remained within acceptable limits and the general towing performance was good. The tests showed that this particular housing needs no trim-tab corrections. However, with the tab locked in the full-left position, the housing kited progressively to port as the towing speed was increased. Thus, the tab should have enough effect to correct any normal construction asymmetries in future bodies.

Figure 4 shows the predicted cable configurations of the housing at sea as a function of cable scope and speed. Figure 5 shows the towline tensions and Figure 6 shows the towline angles. These curves, based on the data obtained during the test program with the towcable attached in the second hole, are the result of calculations made with the IBM 7090 computer using the equations for the configuration of a flexible cable in a uniform stream² and the loading functions assumed by Whicker.³ For this study, the test data were corrected to standard sea water conditions (45 degrees N. Latitude, $3\frac{1}{2}$ percent salinity, and 59 degrees F). It should be noted that the cable angle, as measured during the test program, was subject to an error due to the weight of the tension dynamometer acting to increase the angle. However, this error tends to compensate for the change in curvature of the cable which decreases the angle. Although these effects were neglected in the computation of the cable configuration, it is believed that the data of Figures 4, 5, and 6 are sufficiently accurate for the intended purpose. The curves indicate that the housing will tow at a depth of 205 feet at 8 knots with 500 feet of cable payed out.

Similar data with the towcable attached in the third hole from the nose differ by about 3 percent and are therefore not shown. Differences of this magnitude are within the experimental measurement error and the accuracy of the cable calculations.

Figures 7, 8, and 9 show the cable configurations, tensions, and angles for the housing without the transducer cover and with the towcable attached in the second hole. Comparing these figures with Figures 4, 5, and 6, it can be seen that the performance of the system is only slightly different and will still satisfy the depth and speed requirements.

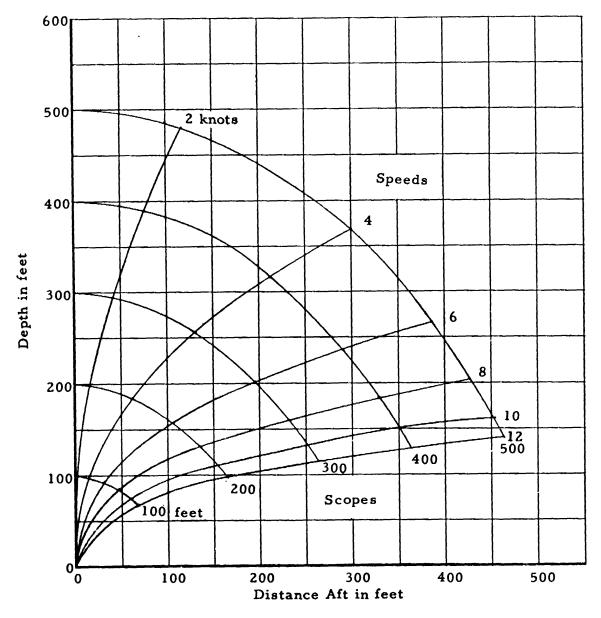
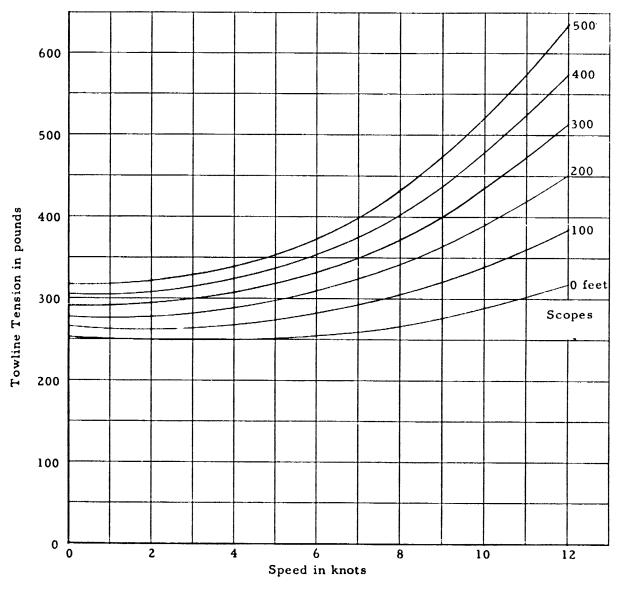


Figure 4 - Predicted Cable Configurations for Completely Assembled Housing

.

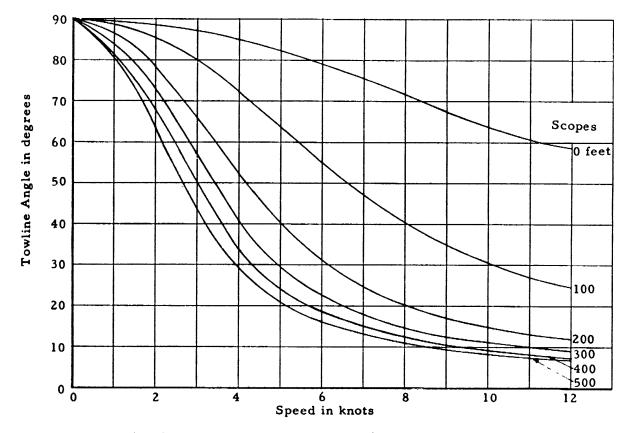
.

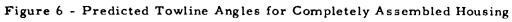


•

.

Figure 5 - Predicted Towline Tensions for Completely Assembled Housing





.

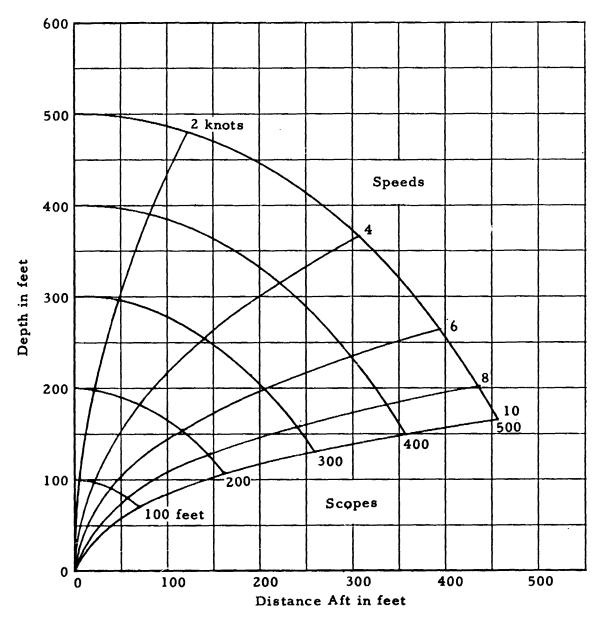


Figure 7 - Predicted Cable Configurations for Housing without Transducer Cover

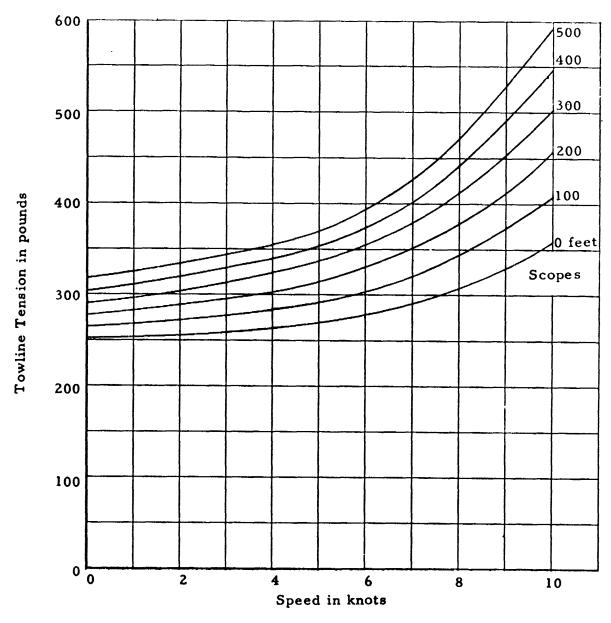


Figure 8 - Predicted Towline Tensions for Housing without Transducer Cover

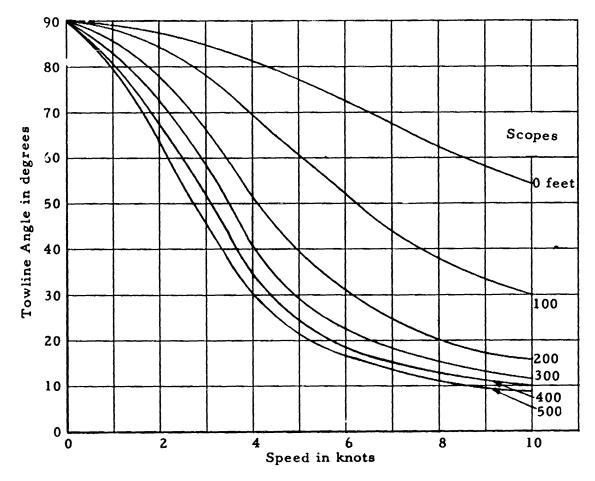


Figure 9 - Predicted Towline Angles for Housing without Transducer Cover

CONCLUSIONS AND RECOMMENDATIONS

The results of the tests and studies conducted at the Model Basin show that the XU-1245 Variable-Depth-Transducer Housing has satisfactory towing characteristics and should satisfy the design requirements of obtaining a 200-foot towing depth at 8 knots using a combination of bare and faired cable. The pressure-compensating and relief device appears to function satisfactorily. The trim tab appears adequate to compensate for asymmetries which may occur in future construction of housings of this design. The housing can be towed satisfactorily without the transducer cover if necessary. In general, the overall design of the XU-1245 is simple, functional, and economical; and no difficulty should be experienced in towing the body at sea.

It is recommended that the housing be towed from the second hole from the nose. The towing depth can be increased by at most 3 percent when the housing is towed from the third hole, but the housing will have a greater nose-down pitch angle.

REFERENCES

- 1. U.S. Navy Underwater Sound Laboratory speed ltr 1-151-00-00 over Ser 933-30 of 6 February 1961 to David Taylor Model Basin.
- 2. Pode, Leonard, "Table for Computing the Equilibrium Configuration of a Flexible Cable in a Uniform Stream," David Taylor Model Basin Report 687 (Mar 1951).
- Whicker, L.F., "The Oscillatory Motion of Cable-Towed Bodies," Institute of Engineering Research, University of California, Report Series 82, Issue 2 (May 1957).

INITIAL DISTRIBUTION

Copies	
5	Commanding Officer and Director U.S. Navy Underwater Sound Laboratory New London, Connecticut
5	Chief, Bureau of Ships 3 Technical Information Branch (Code 335) 1 Sound Ranges and Instrumentation (Code 375) 1 Sonar Branch (Code 688)
2	Chief of Naval Research 1 Undersea Programs (Code 466) 1 Ocean Surveillance Systems (Code 467)
1	Director, U.S. Naval Research Laboratory l Electrical Applications (Code 5560)
1	Commander U.S. Naval Ordnance Laboratory Silver Spring, Maryland
10	ASTIA

10 ASTIA

. • -

-

.

•

16

.

د

 Sonar housings Hydro-	 Sonar housings Hydro-
dynamic characteristics	dynamic characteristics
Full scale tests XU-1245 (variable-	Full scale tests XU-1245 (variable-
depth-transducer housing) Brisbane, Arthur P.	depth-transducer housing) Brisbane, Arthur P.
Devid Tayler Medel Basia. Report 1654. HYDRODYNAMIC CLARACTERISTICS OF THE XU-1245 VARIABLE-DEPTH-TRANSDUCER HOUSING, by Arthur P. Brisbane. Jul 1962. iii, 16p. illus., graphs, refs. UNCLASSIFIED Testa were conducted to determine the hydrodynamic charac- teristics of a full-scale XU-1345 Variable-Depth-Transducer Bousing designed by the U.S. Navy Underwater Sound Laboratory. The towing characteristics were observed to be satisfactory over a speed range from 0 to 12 knots. The pressure-compensating design requirements for speed and towing depth at sea.	Devid Teyler Model Basin. Report 1654. IIYDRODYNAMIC CEARACTERISTICS OF THE XU-1245 VARIABLE-DEPTH-TRANSDUCER HOUSING, by Arthur P. Brishane. Jul 1962. iii, 16p. iilus., graphs, refs. UNCLASSIFIED Tests were conducted to determine the hydrodynamic charac- teristics of a full-scale XU-1345 Variable-Depth-Transducer Housing designed by the U.S. Navy Underwater Sound Laboratory. The towing designed by the U.S. Navy Underwater Sound Laboratory device provided for the transducer appeared to operate satis- factority. Computer studies, based on measurements of towline angle and tension, indicate that the housing will meet the angle and tension, indicate that the housing depth at sea.
 Sonar bousings Bydro-	 Somar housingre- Hydro-
dynamic characteristics	dynamic obaracteristics
Full scale tests XU-1945 (writable-	Full scale tasts
depth-transdecer bousing) Bris base, Arthur P.	Gepth-transfercer housing) Brishase, Arthur P.
Devid Tayle Madal Baala. Raper 1654. Fronkovanic CitaracrEERBFICS OF THE XU-1946 VARLABLE-DEPTH-TRANGDUCER BOUSTNG, by Archar P. VARLABLE-DEPTH-TRANGDUCER BOUSTNG, by Archar P. Prishase. Jai 1969. 111, 16p. 111as., grapha, refs. UNCLASSIFTED Tests were conducted to determine the hydrodynamic observe- tion of a full-scale XU-1946 Variable-Depti-Transdoor UNCLASSIFTED Tests were conducted to determine the hydrodynamic observe- tion of a full-scale XU-1946 Variable-Depti-Transdoor UNCLASSIFTED The towing designed by the U.S. Navy Underwater Sound Laboratory. The towing designed by the U.S. Navy Underwater Sound Laboratory. The towing characteristics were observed to be satisfactory over a speed range from 0 to 13 know. The pressure compensating design requirements for speed and bowing depth at sea.	Devid Tayler Madel Basin. Report 1654. HYDRODYNAMIC CLARACTERISTICS OF THE XU-1245 HYDRODYNAMIC CLARACTERISTICS OF THE XU-1245 VARIARLE-DEPTH-TRANSDUCER HOUSING, by Arthur P. Briebane. Jei 1983. III, 16p. Illes., grupba, refs. UNCLASSIFIED Testa were conducted to determine the hydrodynamic charac- teristics of a full-scale XU-1945 Variable-Depth-Transdecer Breistics of a full-scale XU-1945 Variable-Depth-Transdecer Housing designed to determine the hydrodynamic charac- teristics of a full-scale XU-1945 Variable-Depth-Transdecer Breistics of a full-scale XU-1945 Variable-Depth-Transdecer Housing designed for the transdecer appeared to permise satis- factorily. Competer studies, has do on measurements of torline augle and tension, indicate that the housing will meet the design requirements for speed and torlag depth at sea.

David Taylas Madal Basia. Rapart 1654. HYDRODYNAMIC CEARACTERISTICS OF THE XU-1945 VARUBLE-DETB-TRANEDUCER HOUSENG, by Arthur P. Briahase. Jul 1969. III, 16p. IIIaa., graphs, refs. UNCLASSIFIED Tests were conducted to determine the hydrodynamic charac- teriation of a full-scela XU-1946 Variah's-Depth-Tranducer Bousing designed by the U.S. Nary Undervate Bound Laboratory. The torning designed by the U.S. Nary Undervate Bound Laboratory. The torning designed by the U.S. Nary Undervate Bound Laboratory. The torning designed by the U.S. Mary Undervate Bound Laboratory over a speed range from 0 to 13 Incota. The pressure-compensating design requirements for speed and bowing depth at sea.	 Scare housingr. Bydro- dyramic oharacteristics Full scale tests XU-1945 (veriable- depth-transdrose housing) Brishase, Arthur P. 	David Tayler Madel Basin. Repert 1654. HYDRODYNAMIC CLARACTERISTICS OF THE XU-1245 VARABLE-DEPTH-TRANSDUCER FOUSING, by Arthur F. Brisbane. Jul 1963. iii, 16p. illus., graphs, refs. UNCLASSIFIED Tests were conducted to determine the hydrodynamic charac- teristics of a full-scale XU-1365 Variable-Depth-Transducer Fousing designed by the U.S. Navy Underwister Sound Laboratory. The towing characteristics were observed to be satisfactory over a speed range from 0 to 12 kmots. And on measurements of towilise device provided for the transducer appeared to operate satis- factorily. Computer statiste, based on measurements of towilise angle and teamion, indicate that the housing depth at see.	 Somer housings Hydro dynamic characteristics- Full scale tests XU-1245 (variable- dopth-transducer housing) Brisbane, Arthur P.
Devid Tayler Madel Basin. Report 1654. HYDRODYNAMIC CI:ARACTERISTICS OF THE XU-1245 VARIABLE-DEPTH-TRANSDUCER BUUSING, by Archur P. Beistanse. Jeil 1963. iii, 16p. illuae, graphs, refs. UNCLASSIFIED 2 Frasts were conducted to determine the hydrodynamic charac- teristics of a full-scala XU-1365 Variable-Depth-Transducer Housing designed by the U.S. Nary Underwater Sound Laboratory. The towing chared by the U.S. Nary Underwater Sound Laboratory. The towing chared by the U.S. Nary Underwater Sound Laboratory as speed range from 0 to 12 knots. The pressure-compensating device provided for the transducer appeared to be sutisfactory over a speed range from 0 to 12 knots. The pressure-compensating device provided for the transducer appeared to be sutisfactory over a speed range from 0 to 12 knots. The pressure-compensating device provided for the transducer appeared to be sutisfactory over the towing chareder that the bousing will meet the design requirements for speed and bowing depth at sea.	 Sonar housings- Hydro- dynamic characteristics Full scale tests XU-1945 (variable- depth-transdecer housing) Briabase, Arthur P. 	Devid Taylor Model Basin. Report 1654. IIYDRODYNAMIC CI:ARACTERISTICS OF THE XU-1245 VARIABLE-DEPTH-TRANSDUCER HOUSING, by Arthur P. Beisbane. Jul 1962. III. 16p. Illue., graphs, refs. UNCLASSIFIED Tests were conducted to determine the hydrodynamic charac- teristics of a full-scale XU-1345 Variable-Depth-Transducer Housing designed by the U.S. Nuvy Ubderwater Sound Laboratory. The towing characteristics were observed to be satisfactory over a speed range from 0 to 12 knota. The pressure-compensating device provided for the transducer appeared to operate satis- factorily. Computer studies, based on measurements of towline angle and tension, indicate that the bousing will meet the design requirements for speed and towing depth at see.	 Somar housings Hydro dynamic characteristics Full scale tests XU-1245 (variable- depth-transducer housin, I. Brisbane, Arthur P.

UNCLASSIFIED

i

ł

٤

4

UNCLASSIFIED

