BIBLIOGRAPHY ON POWER BOAT DESIGN

by Joseph G. Koelbel, Jr.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Prepared for:

Naval Ship Systems Command

Under Administration by:

Office of Naval Research

Joseph G. Koelbel, Jr.
Naval Architect
51 Biltmore Blvd.
Massapequa, New York 11768

Contract Number:

N00014-69-C-0257
BIBLIOGRAPHY ON POWER BOAT DESIGN

A partially annotated bibliography on the design and construction of commercial and military power boats. The prediction of performance and the structural design of planing hulls are emphasized, with some material on small displacement craft such as fishing vessels and coasters. References are arranged in subject categories useful to the design naval architect. Over 1000 references are listed.
1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (corporate author) issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. PROJECT NUMBER: Enter the appropriate departmental project number, military project code name, geographic location, may be used as index entries for cataloging the report. Key words must be technically meaningful terms as:...

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capital letters immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, middle name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b. ic. & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and cataloged by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers (either by the originator or by the sponsor), also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring (paying for) the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.
ACKNOWLEDGEMENT

The author wishes to acknowledge the assistance of Mr. G. Gordon Sammis, Naval Architect, in the compilation of the bibliography and in the preparation of the report.
CONTENTS

ABSTRACT

I. PROJECT HISTORY

II. SUBJECT MATERIAL
   A. INTENT
   B. EMPHASIS
   C. LIMITATIONS
   D. ABSTRACTS AND COMMENTS
   E. REVISIONS

III. DOCUMENT SOURCES
   A. ABBREVIATIONS AND SOURCE ADDRESSES
   B. DDC AND CLEARINGHOUSE DOCUMENTS

IV. USER'S GUIDE
   A. ARRANGEMENT
   B. ENTRY FORMAT
   C. SUBJECT CATEGORIES

V. BIBLIOGRAPHY
ABSTRACT

A partially annotated bibliography on the design and construction of commercial and military power boats. The prediction of performance and the structural design of planing hulls are emphasized, with some material on small displacement craft such as fishing vessels and coasters. References are arranged in subject categories useful to the design naval architect. Over 1000 references are listed.
I. PROJECT HISTORY

The concept of a small craft bibliography originated in the early 1960's with Panel H-12 (Planing Boats) of the Society of Naval Architects and Marine Engineers. Each of the Panel members submitted a list of references which had been found useful. The work of compiling these, eliminating duplication, adding new references, etc., was carried out on a voluntary, part-time basis over a period of years. It became apparent that completion of the bibliography would require a greater expenditure of man-hours than was possible on a voluntary basis. Because the bibliography and a companion document summarizing the present state-of-the-art would be of benefit to the Naval Ship Systems Command and to the Naval Ship Engineering Center in dealing with civilian designers, funds for this work were made available through the Office of Naval Research. The original project was intended to cover only the hydrodynamics of planing hulls. The present contract allowed for a broader coverage of material related to power boat design.
II. SUBJECT MATERIAL

A. Intent

The purpose of this bibliography is to provide the small craft naval architect with a current listing of reference material related to the design and prediction of performance of power boats. In accomplishing this objective within the limited resources allotted, certain overall guidelines have been followed.

1. Project funds have been directed primarily towards the collection and listing of references, with secondary consideration given to data retrieval techniques and editorial presentation.

2. In cases where objective decisions were borderline, a subjective decision has been made quickly to expedite completion of the work. This applies to assignment of subject categories and to groupings of material into Essential, Useful, and Background categories.

3. In anticipation that the above restrictions on project effort would eventually require revising the bibliography layout, the original material has been mechanically assembled in a way that allows easy revision.
B. Emphasis

The bibliography emphasizes the design and construction of planing and semi-planing craft, with special attention being given to the prediction of performance. At the suggestion of a number of contributors, a significant body of historical works on planing phenomena has been included. Some of this material is still applicable to the design of fast hulls. Most of the early work on impact loadings was accomplished by the seaplane designers and this contribution is adequately represented. The remaining material is of interest in tracing the development of the art. While emphasis is on planing craft, there is an ample listing of recent valuable work on the design of displacement craft such as trawlers and other small coastal vessels.

C. Limitations

The collection does not cover the entire field of small craft design as practiced today. Certain areas which were specifically excluded are:

1. Classified references
2. Sailboats
3. Hydrofoil craft, except for hull design
4. Air cushion or surface effect craft
5. Foreign sources, with some exceptions

The most difficult limitation to accept is that volume of material which was located and is not included for various reasons of the originators or repository agencies. Three reasons were given, the first and most frustrating being the lack of both secretarial and reproduction facilities to handle requests for data. The second concerns data which had not been reviewed satisfactorily for technical quality or which was not in a form for outside use. The third category is information which was proprietary or had restricted distribution limitations. Some of the latter material has been included.
anyhow for those users who are able to justify access. Most documents in these three categories have very limited use to the designer, but a few were of such value that they should be made available to the design community. Perhaps a worthwhile future effort would be to liberate them for general use.

D. Abstracts and Comments

The bibliography is partially annotated. Where abstracts of articles were given in the source documents or in reviews, they have been included verbatim. If the document's contents were known and no abstract given, appropriate comments have been added where they would augment the understanding provided by the title alone. Not all of the entries have been reviewed and therefore the user must use his own judgement and the Value Index as a guide for selecting documents for acquisition.

E. Revisions

Mechanically, the original copy is prepared in strips the same height as a 35mm film negative. These strips are inserted in pages of plastic sleeves used for storage of photographic negatives. This system allows for easy revision of the original and for rearrangement of material without massive retyping. Retyping of this kind of material leads to an accumulation of errors and eventual loss of utility. The number of entries does not at present justify a computerized method of retrieval but as the document is revised the point may be reached where this method becomes economically justifiable.
A. Abbreviations and Source Addresses

Many of the sources are self explanatory, but there are a number of sources which are indicated by abbreviations or acronyms. These are identified below, as are the addresses of sources appearing frequently enough to merit their listing. The user will find some of the documents difficult to obtain. It is the purpose of the bibliography to make their existence known. The tracing of their various supply histories is beyond the scope of the project. In particular there is the problem of the constant change in government organization, and specifically in the Department of Defense, which may make the securing of a limited distribution document of older vintage a difficult chore. While agencies change names, fortunately key people do not, and the best route to securing a document is to contact someone who is involved in the original work. It is hoped that users of this bibliography will exercise discretion in requesting the documents listed herein and that by so doing, the continued cooperation of key contributors will be maintained.

AEW
Admiralty Experiment Works
Haslar, Gosport, Hampshire
England

AIAA
American Institute of Aeronautics and Astronautics
1290 Avenue of the Americas
New York, N.Y. 10019

ARC
Aeronautical Research Committee
Advisory Committee for Aeronautics
England

ASME
American Society of Mechanical Engineers
345 East 47 Street
New York, N.Y. 10017

ASNE
American Society of Naval Engineers
Suite 507, Continental Building
1012 14 Street N.W.
Washington, D.C. 20005
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BuAer</td>
<td>Naval Air Systems Command</td>
</tr>
<tr>
<td>NavAir</td>
<td>Washington, D.C. 20360</td>
</tr>
<tr>
<td>BuShips</td>
<td>Naval Ship Systems Command</td>
</tr>
<tr>
<td>NavShips</td>
<td>Washington, D.C. 20360</td>
</tr>
<tr>
<td>EMB,TMB</td>
<td>Naval Ship Research and Development Center</td>
</tr>
<tr>
<td>DTMN</td>
<td>Washington, D.C. 20034</td>
</tr>
<tr>
<td>NSRDC</td>
<td>Naval Ship Research and Development Center</td>
</tr>
<tr>
<td>IAS</td>
<td>Institute of the Aeronautical Sciences (now AIAA)</td>
</tr>
<tr>
<td>ISIP</td>
<td>International Shipbuilding Progress</td>
</tr>
<tr>
<td></td>
<td>International Periodical Press</td>
</tr>
<tr>
<td></td>
<td>Haerstuiingssingle</td>
</tr>
<tr>
<td></td>
<td>Rotterdam, The Netherlands</td>
</tr>
<tr>
<td>DME</td>
<td>Institute of Marine Engineers</td>
</tr>
<tr>
<td></td>
<td>85, Minories</td>
</tr>
<tr>
<td>JAS</td>
<td>Journal of the Aeronautical Sciences</td>
</tr>
<tr>
<td></td>
<td>(Formerly a publication of IAS, now the AIAA Journal)</td>
</tr>
<tr>
<td>NACA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NASA</td>
<td>400 Maryland Avenue S.W.</td>
</tr>
<tr>
<td></td>
<td>Washington, D.C. 20360</td>
</tr>
<tr>
<td>NECl</td>
<td>North-East Coast Institution of Engineers and Shipbuilders</td>
</tr>
<tr>
<td></td>
<td>Bocbec Hall</td>
</tr>
<tr>
<td></td>
<td>Newcastle-upon-Tyne, England</td>
</tr>
<tr>
<td>NSMB</td>
<td>Netherlands Ship Model Basin</td>
</tr>
<tr>
<td></td>
<td>Haagsteeg 2</td>
</tr>
<tr>
<td></td>
<td>Wageningen, The Netherlands</td>
</tr>
<tr>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
</tr>
<tr>
<td></td>
<td>2 Pennsylvania Plaza</td>
</tr>
<tr>
<td></td>
<td>New York, N.Y. 10001</td>
</tr>
<tr>
<td>SBSR</td>
<td>Shipbuilding and Shipping Record</td>
</tr>
<tr>
<td></td>
<td>33, Tothill Street</td>
</tr>
<tr>
<td></td>
<td>Westminster, London S.W. 1, England</td>
</tr>
<tr>
<td>SIT</td>
<td>Davidson Laboratory</td>
</tr>
<tr>
<td>ETT</td>
<td>Stevens Institute of Technology</td>
</tr>
<tr>
<td>DL</td>
<td>71l Hudson Avenue</td>
</tr>
<tr>
<td></td>
<td>Hoboken, New Jersey 07030</td>
</tr>
<tr>
<td>SNAME</td>
<td>The Society of Naval Architects and Marine Engineers</td>
</tr>
<tr>
<td></td>
<td>74 Trinity Place</td>
</tr>
<tr>
<td></td>
<td>New York, N.Y. 10006</td>
</tr>
</tbody>
</table>
B. DDC and Clearinghouse Documents

Many publications of the government agencies are distributed through the Defense Documentation Center and The Clearinghouse for Federal Scientific and Technical Information. Documents handled by these agencies are identified by code numbers, of the form "AD-000 000". Wherever such a number is shown after an entry, the document may be obtained from one of these agencies. Normally, unclassified documents are supplied from the Clearinghouse by direct sale to the public. Defense Contractors or others eligible to receive AD documents at no charge order their documents through the DDC system. Requests for unclassified material received from these users are then passed on to the Clearinghouse. Classified material is supplied directly from DDC. An AD number suffixed with the letter "L" indicates a document having a limited distribution and will require the permission of the cognizant agency before it can be obtained from DDC or the Clearinghouse. Requests for AD documents should be forwarded to:

Clearinghouse for Federal Scientific and Technical Information
Sills Building
5285 Port Royal Road
Springfield, Virginia 22171

or, if applicable,

Defense Documentation Center
Cameron Station
Arlington, Virginia 22314

These agencies have special procedures and request forms which greatly expedite delivery of documents to users making regular requests.
A. Arrangement

The bibliography is separated into 28 subject categories. Within each subject, documents are arranged in four groups according to their judged value to the working designer, with the most essential material in the first group. The groups are identified by a Value Index. The Value Indices are defined as follows:

**Essential** - Document contains information essential to the understanding of the subject. It is considered that the user must be familiar with the material in order to remain abreast of the state of art. In some cases the document may not be the sole authority, but is considered one of the best.

**Useful** - Contains information of frequent value in design.

**Background** - Information which may be of occasional use to the designer or researcher, or may have historic value.

An entry which carries no Value Index is in a fourth category, which is one of indecision. It is important to note that articles in this category might be considered in any of the three above if its contents were known to the reviewer.

The assignment of a Value Index is not a measure of the technical quality of the document. It is simply an opinionated judgement of its "frequency of usefulness" to the naval architect engaged in the design of small craft and is given as an aid to the acquisition of library material. Therefore some of the basic works which established planing theory may appear as background papers simply because more recent investigators have expanded the concepts in later work.
Within each Value Index Group, the articles are arranged by alphabetical order according to the first listed author.

The procedure in locating material is then first to locate the applicable subject category. The first group of articles will be the Essential material; the second, Useful; and the third, Background. The undesignated articles will appear in the fourth group. Within each group the user can quickly scan the page if he is doing a general search, or may go immediately to the articles written by a specific author. If there is some doubt as to the subject category, the user will find that it is seldom possible for material to be located under more than two categories with the subject headings that have been selected. A listing is made only once in this bibliography. There is no multiple listing of articles. If there was doubt as to the original subject category which should be assigned, the most likely one was selected and the entry appears nowhere else.

B. Entry Format

Listings follow the following format:

Author's Last Name, First Initial, -- "TITLE OF ARTICLE IN CAPS" -- Date of Publication and Source. AD Number if Applicable.

SUBJECT CATEGORY, Value Index

C. Subject Categories

Subject categories were selected to minimize redundancy in assigning articles to a particular group. Categories are to be interpreted literally as defined in the listing which follows. The full name of the category is followed by the short form identifier which accompanies each entry.
SUBJECT CATEGORIES

Codes, Standards, and Regulations
General References and Basic Texts
Vessel Descriptions and Full Scale Performance Data
Hydrostatics and Weights
Resistance (Includes all multi-purpose model test data)
Propulsion
Steering (Including directional stability and maneuvering)
Seakeeping and Motions
Applied Loads (Including impact and hull vibration)
Strength Calculations (Stress, strain, deflection, buckling)
General Construction Methods (Includes drafting and lofting)
Aluminum
Ferro-Cement
Fiberglass
Steel
Wood
Composite and Miscellaneous
Engine Selection and Rating
Engine Installation and Control (Including engine vibration)
Shafting, Gears, and Propellers (Mechanical considerations)
Diesel Engines
Gasoline Engines
Gas Turbines
Steam Propulsion
Firefighting and Lifesaving
Electrical and Electronics
Piping and Hydraulics
Outfit and Rigging

REGS, Useful

Anonymous, "FIRE PROTECTION STANDARD FOR MOTOR CRAFT (Pleasure and Commercial)" NFPA 302, National Fire Protection Association, 60 Batterymarch Street, Boston, Mass. 02110 (Issued periodically)

REGS, Useful


REGS, Useful


REGS, Useful


REGS, Useful


REGS, Useful

Anonymous, "RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF WOOD AND COMPOSITE YACHTS," Lloyds Register of Shipping, 17 Battery Place, New York, $10.00.

REGS, Useful
Anonymous, "RULES FOR THE CONSTRUCTION OF REINFORCED PLASTIC YACHTS," Lloyds Register of Shipping, 17 Battery Place, New York, $10.00.

REGS, Useful

Anonymous, "RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL YACHTS," Lloyds Register of Shipping, 17 Battery Place, New York. $10.00.

REGS, Useful


REGS, Useful

Anonymous, "RULES AND REGULATIONS FOR UNINSPECTED VESSELS," U.S. Coast Guard, CG 258, Issued periodically.

REGS, Useful


REGS, Useful

Anonymous, "RULES AND REGULATIONS FOR SMALL PASSENGER VESSELS (SUBCHAPTER T)," CG-323 U.S. Coast Guard, Issued Periodically.

REGS, Useful


REGS, Useful

REGS, Useful


Reviews latest recommendations of the Intergovernmental Maritime Organization of U.N. Safety Committee regarding intact stability. Will be printed as USCG guide.

REGS, Useful

REGS, Background


REGS, Background


REGS, Background


REGS, Background

Anonymous, "RULES FOR BUILDING AND CLASSING WOOD VESSELS," American Bureau of Shipping. Unserviced since 1921, limited applicability to construction today.

REGS, Background


REGS, Background


REGS, Background

An excellent guide to rules and regulations covering marine communications.

REGS, Background

Robertson, J.B., Jr., "SOME OBSERVATIONS ON THE SAFETY OF LIFE AT SEA CONVENTION 1960."
SNAME Southern California, January 12, 1961.

REGS, Background


REGS,
Barnaby, K.C., BASIC NAVAL ARCHITECTURE, John de Graff, Inc. New York, N.Y.

GENERAL, Essential


Probably the foremost textbook on the subject.

GENERAL, Essential

Hoerner, S.F., FLUID DYNAMIC DRAG, Book available only from author, 148 Busteed Dr. Midland Park, N.J.

The best single source of data for appendage drag estimates.

GENERAL, Essential

Saunders, Capt. H.E., "HYDRODYNAMICS IN SHIP DESIGN", 3 Volumes, Society of Naval Architects and Marine Engineers.

GENERAL, Essential


GENERAL, Essential


GENERAL, Essential

**GENERAL, Useful**


**GENERAL, Useful**


**GENERAL, Useful**


**GENERAL, Useful**

Baader, J., *CRUCEROS Y LANCHAS VELOCES; SU DINAMICA, PROPULSION Y NAVEGACION (CRUISERS AND FAST LAUNCHES; THEIR HYDRODYNAMICS, PROPULSION AND OPERATION)*, Buenos Aires, 1951 (in Spanish, English translation available.)

**GENERAL, Useful**


Excellent reference.

**GENERAL, Useful**

Benford, H., "ECONOMIC CRITERIA IN FISH BOAT DESIGN", Presented at the Conference on Fishing Vessel Construction Materials, Montreal, October 1968, also Univ. of Michigan Department of Naval Architecture and Marine Engineering, Report No. 009.

**GENERAL, Useful**

GENERAL, Useful


Practical approach to yacht design with good discussion of traditional wood construction, much detail and practical information with sketches.

GENERAL, Useful


An excellent basic reference for the planing boat designer.

GENERAL, Useful


GENERAL, Useful


15 E. 40th St. N.Y., N.Y. 10016.


One of the more useful texts. Contains scantling rules for wood construction.

POWER BOAT BIBLIOGRAPHY

General References and Basic Texts


GENERAL, Useful


"This paper gives a number of nomograms and other data useful for the designer of small craft." Saunders.

GENERAL, Useful


A valuable collection of papers containing a wealth of information on applied naval architecture.

GENERAL, Useful


GENERAL, Useful

(Various) "SMALL CRAFT DESIGN, AN INTENSIVE SHORT COURSE," 2 Volumes, University of Michigan, October 6-10, 1969, (Limited availability).

A comprehensive review of the state of the art of small craft design. A series of lecture notes by prominent authorities covering the engineering fundamentals involved in the hydrodynamic machinery and structural aspects of the design of small commercial, pleasure and government vessels. Hydrodynamics and structural sections emphasize planing craft while the machinery section is more generally applicable to all small craft.

GENERAL, Useful

GENERAL, Background


GENERAL, Background


GENERAL, Background


GENERAL, Background

Anonymous, "INTERIM DOCTRINE FOR RIVERINE OPERATIONS," HQ, Marine Corps, FMFM-3-1, April 1966, AD 481 135.

GENERAL, Background


GENERAL, Background


A FORTRAN IV computer program is described, which given a parent form described by offsets on stations, derives a new form that simultaneously satisfies stated values of the prismatic coefficient, longitudinal center of buoyancy, maximum section coefficient, breadth, and draft. The program produces a new body plan and printed and/or punched offsets. Formulas, input and output formats, FORTRAN listing, and sample problems are included.

An outline for the non-technician on the use of computers in design in modern practice.

GENERAL, Background

Davidson, K.S.M., "WHAT PRICE SPEED? - LONG RANGE TRENDS IN OVERSEAS TRANSPORTATION."
SNAME Bulletin, February, 1955, also Chesapeake Section, SNAME, October 14, 1954.

GENERAL, Background


GENERAL, Background

Gabrielli, G. and Von Karman, Th., "WHAT PRICE SPEED? SPECIFIC POWER REQUIRED FOR PRO-
PULSION OF VEHICLES," Mechanical Engineering, October 1950.

GENERAL, Background


GENERAL, Background

Very interesting and colorful description of traditional wood construction, principally of sailing craft.


Killgore, U., "On Uniform Meanings of Coefficients," The Planimeter SSCD, 10/64.


Korvin-Kroukovsky, B.V., THEORY OF SEAKEEPING, Published by SNAME (1961).


Excellent work on basic philosophy of the designing process.

POWER BOAT BIBLIOGRAPHY

General References and Basic Texts

Shipbuilding at the present time (1961) may be regarded partly as an art and partly as a science. This report is concerned with the scientific aspects of shipbuilding and, particularly, with certain fundamental physical concepts which play a major role in the scientific methods now in use. These concepts pertain chiefly to three branches of applied mechanics; namely, fluid dynamics, elasticity, and hydroelasticity, which deal chiefly with ideal physical systems.


Nowacki, H., "CLASS NOTES ON COMPUTER AIDED SHIP DESIGN", used for graduate course NA 574, April 1969, Univ. of Michigan.


Design requirements, Speed and power. Power and hull proportions, Hull form, Principles of engine installation, Seaworthiness and stability.

"This article gives a large amount of technical information and some design rules, all in an amazingly small space. The following subjects are covered: Planing, Round Bilge or Chine? Displacement and shape of section, Beam, The Planing Angle, Calculating the power required, Stepped hulls." - Saunders.


Volume 10 of the Prior Craft review is a complete bibliography for the report and includes update material which was arranged or classified after the publication dates on most of the vehicle data volumes. Volume 10 consists of three parts, separately bound:

Part I, Description of the AALCP Library and Aids to Data Management and Retrieval;
Part II, Bibliography, Document Source, and Authors Lists; and Part III, General Subject Classification Lists and Indexes.


POWER BOAT BIBLIOGRAPHY General References and Basic Texts 32

This paper examines some of the principal features of the main types of high speed marine craft as an aid to assessing their present effectiveness. It is largely based on information from published reports and articles, but includes some data not previously available. The craft considered are those which have service speeds greater than 30 knots and which are large enough to serve a practical commercial or naval purpose: the three main types are high speed displacement or planing craft, hydrofoil ships, and hovercraft.

Subjects studied are Speed and Power, Ride Comfort, Structural Efficiency, Economic Factors, Operational Features.


Van Manen, J.D., "FUNDAMENTALS OF SHIP RESISTANCE AND PROPULSION, PART A, RESISTANCE; PART B, PROPULSION", 2 Vols. Publication No. 132a of the N.S.M.B., Notes from Course held before the Netherlands Society of Engineers and Shipbuilders. Also reprinted from ISP, Rotterdam.

GENERAL, Background


GENERAL, Background

GENERAL,


GENERAL,


Useful general reference.

GENERAL,


GENERAL
Price $2.75.

VESSELS, Useful

Adamson, G. and Van Patten, D., "MOTOR TORPEDO BOATS: A TECHNICAL STUDY," USNI, July 1940
Vol. 66, Pp 976 - 996.

VESSELS, Background

Anonymous, "BRAVE CLASS FAST PATROL BOATS. RESISTANCE, RUNNING RISE AND TRIM WITH AND
WITHOUT TRANSOM FLAP. FURTHER EXPERIMENTS", Admiralty Experiment Works, Report No. 44/60

VESSELS, Background

Anonymous, "BOLD PIONEER. RESISTANCE, RUNNING RISE AND TRIM WITH TRANSOM FLAP. ALSO
FULL SCALE TRIALS", Admiralty Experiment Works Report No. 35/55.

VESSELS, Background

Anonymous, "DARK CLASS FAST PATROL BOATS. RESISTANCE, RUNNING RISE AND TRIM WITH AND

VESSELS, Background

Some references to Waterjets, etc.


Anonymous, "LIGHT ALLOY PATROL LAUNCH," Engineer, April 1953.


"Containing detailed designs and descriptions of 101 interesting boats created by 53 American and Canadian naval architects." - Saunders.


VESSELS, Background

Baier, L.A., "AMERICAN RIVER TOWBOATS", ISP, (Date Unknown)

VESSELS, Background


"This is an excellent resume of seven typical modern powerboat forms, represented by lines drawings in each case, with the hydrodynamic and practical reasons for their various features and characteristics". Saunders

VESSELS, Background


Small craft in Vietnam.

VESSELS, Background


VESSELS, Background


Discussed design, construction and testing of a 68 ft. high speed (40KT) air/sea rescue boat. Trials included measurement of planing pressures and stresses, and craft accelerations. Construction was basically aluminum but side panels were FRP.


U.S.N. Counterinsurgency craft.

Fox, U., THOUGHTS ON YACHTS AND YACHTING, PART 3, Charles Schribners, London 1939.

Garden, W., "THE SEAGOING POWER BOAT," Yachting, October 1957.
Radeler, W., "MOTOR TORPEDO BOATS - SCHNELLBOOTE (MOTOR PEDOBOOTE - SCHNELLBOOTE)," VDI-Zeitschrift, Vol 83, No. 32, 12 August, 1939. DTMB Translation No. 88 by M.C. Roemer, January 1940.


Hanson, H.C., "FISHING VESSELS OF THE PACIFIC COAST OF AMERICA", Transaction, SNAME 1954.


This report contains the results of standardization trials conducted on the LCVP(K) within the period 6 August through 12 November 1963. The data contained herein include trial results that show the powering characteristics of the craft as originally built.

In addition, some data on the modified hull, as a planing craft, are included. Trials conducted subsequent to 12 November 1963, all of which were with the modified hull, will be contained in a supplemental report.

POWER BOAT BIBLIOGRAPHY Vessel Descriptions and Full Scale Performance Data 40
Huet, G.O., "DEVELOPMENT OF A HIGH SPEED MOTOR BOAT FOR USE IN ROUGH WATERS", Paper Presented at SNAME Gulf Coast Section, April 1959.

VESSELS, Background

Hugli, W.C. Jr., "A MOTOR TORPEDO BOAT COMPARISON", ETT (Davidson Laboratory) Report No. 54, November 12, 1940.

VESSELS, Background

Kendall, W.M., "STANDARDIZATION AND ROUGH WATER RESULTS FROM TRIALS OF AN EXPERIMENTAL PLANING BOAT EQUIPPED WITH A STABILIZER FOR TRIM CONTROL", DTMB Test Report P-016-H-O1, September 1964. Distributed only upon BuShips authorization.

VESSELS, Background


VESSELS, Background


VESSELS, Background

Long, D.M., "PROGRESS REPORT - PLANNING HULL AMPHIBIAN," Dair M. Long, Naval Architects and Marine Engineers, P.O. Box 385, Newport Beach, Calif.


Meese, G., "RESEARCH CATAMARANS," The Planimeter, November 1961, SSCD.


"Full scale trial results including an inverted Vee hull. Inverted Vee design was heavily loaded and not an optimum design." - J.E. Bowker Assoc.


Coastal Forces in W.W. II. Patrol Boats.

POWER BOAT BIBLIOGRAPHY    Vessel Descriptions and Full Scale Performance Data
An evaluation was conducted at the U.S. Navy Mine Defense Laboratory on six proposed swimmer support boats by evaluators from various Navy commands in an effort to select one boat that would satisfy operational requirements of Explosive Ordnance Disposal (EOD) divers. None of the boats evaluated satisfy all of the desired requirements for EOD operations. It is presently planned to procure three new craft fabricated in accordance with evaluation results and perform comparative tests at the U.S. Navy Mine Defense Laboratory.


Revans, J.T. & Gentry, A.A.C., "THE 'BRAVE' CLASS FAST PATROL BOAT", INA, VOL 102, 1960.


VESSELS, Background


VESSELS, Background

Schuller, R.E., "RESEARCH VESSEL DESIGN," The Planimeter, February 1965, SSCD.

VESSELS, Background


VESSELS, Background


VESSELS, Background


VESSELS, Background
Thornycroft, J.E. and Bremner, "COASTAL MOTOR BOATS," INA, October, 1925.


Standardization trials were conducted on LCVP(K), modified to a planing hull, as part of a study of partial air support craft. Speed, RPM and shaft horsepower were determined under controlled conditions on a measured course. The data in this report are supplemental to information previously reported on the performance of LCVP(K) as originally designed.

Winter, R., "PROBLEMS INVOLVED IN THE DESIGN OF 3 RECENT FISHING VESSELS," The Planimeter, July and August, 1967, SSCD.

VESSELS, Background


VESSELS, Background


VESSELS, Background

VESSELS


VESSELS


VESSELS,

Methods and criteria used in assessing stability and buoyancy for naval ships. Methods could be applied and criteria adjusted, for small craft.

STATICS, Essential


STATICS, Useful

Cloyd, C.E., "FLOODABLE LENGTH CURVE, METHOD OF INTEGRAL CURVES", SNAME, Hampton Roads Section, 6 December 1957.

STATICS, Useful
Killgore, U., "FLOODABLE LENGTH OF NON-PRISMATIC HULLS", The Planimeter, April, May, June 1963, SSCD.

STATICS, Useful


STATICS, Useful


The author gives typical percentages for ten weight groups in the hull only of V-bottom and round bottom hulls, as well as percentages for 12 groups in the total weight of an "average cruiser".

STATICS, Useful


STATICS, Useful

Rahola, J., "THE JUDGING OF THE STABILITY OF SHIPS," (in English) Printed in Finland, 1939 YHTEISKIRJAPAINO OSAKEYHTIO.

Original paper difficult to obtain. Material is included in various articles in Fishing Boats of the World.

STATICS, Useful


STATICS, Useful

STATICS, Background

Bhattacharyya, R. "COMPUTER APPLICATIONS IN HULL FORM AND STABILITY CALCULATIONS", September, 1969, Report No. 033 University of Michigan, Department of Naval Architecture also SNAME, Great Lakes and Great Rivers Section, October 2, 1969.

STATICS, Background


STATICS, Background

Colvin, T.E., "THE IMPORTANCE OF WEIGHT IN SMALL CRAFT DESIGN AND CONSTRUCTION," Paper No. 666, Society of Aeronautical Weight Engineers Inc., P.O. Box 60024, Terminal Annex, Los Angeles, Calif., 90054.

STATICS, Background


STATICS, Background
Miller, W.C., "CONSTRUCTION OF A MODEL AND ITS USE IN AN INVESTIGATION OF DAMAGED STABILITY", SNAME, Northern Calif., February 14, 1957.

STATICS, Background


STATICS, Background


STATICS, Background


STATICS, Background


STATICS, Background


STATICS, Background

Wright, C.L., "THE SIGNIFICANCE OF METACENTRIC HEIGHT", January 1969, New England Section, SNAME.

STATICS, Background

This report gives methods of presenting and using information on the hull forms and model performance of planing boats to guide the design of future boats. The effect on performance of variations in some of the primary planing boat parameters are illustrated and discussed. A design method is proposed, and data are presented to assist in making correct design decisions.

RES, Essential

Savitsky, D., "HYDRODYNAMIC DESIGN OF PLANING HULLS", Davidson Laboratory Report 1000, December 1963, Also Marine Technology, Vol. 1, No. 1, October 1964, SNAME.

The elemental hydrodynamic characteristics of prismatic planing surfaces are discussed and empirical planing equations are given which describe the lift, drag, wetted area, center of pressure, and porpoising stability limits of planing surfaces as a function of speed, trim angle, deadrise angle, and loading. These results are combined to formulate simple computational procedures to predict the horsepower requirements, running trim, draft, and porpoising stability of prismatic planing hulls. Illustrative examples are included to demonstrate the application of the computational procedures.

RES, Essential


"This report is generously illustrated with excellent photographs of both models and full-scale motorboats, showing the spray formation very clearly. The appendix contains useful design comments, with sketches—a rather unusual feature for a report of this kind." - Saunders.


This report gives the resistance and propulsion characteristics of the TMB Series 63 parent form. The data cover the effects of displacement, initial trim, and appendages. An example of the procedure to be followed in making a horsepower estimate using these data is included.
Three round-bottom models and three hard-chine models with length-beam ratios of 3, 4, and 5 in each group and with constant displacement, were tested in smooth water and in irregular waves of Sea States 3 and 5. The Hard-chine model and the round-bottom model of length-beam ratio 4 were used to evaluate relative broaching tendencies in regular following waves.

The resistance data in smooth and rough water were expanded to boat weights of 55,000 pounds. The measured values of accelerations at the forward quarter point and LCG position and of heave, are presented. In the evaluation of relative broaching tendencies in regular following waves, experimental results were combined with theoretical results to derive indices of broaching.

RES, Useful


Experiments were made to determine the effects on planing boat resistance of several configurations of longitudinal bottom spray strips. It was found that such strips extending aft from the bow about 70 percent of the hull length decreased the resistance somewhat at high speed but increased the resistance at low speed. The performance was noticeably improved by shortening the edges of the spray strips. An experiment was also made with bottom spray strips extending only forward of the high-speed stagnation line. This arrangement gave a 6-percent reduction in resistance at high speed with no increase in resistance at low speed.

RES, Useful


A previous report by H.F. Nordstrom gives comprehensive information about the hull forms and resistances of a considerable number of round-bottom boats. This report also shows that the resistance of these craft is determined mainly by the value of the hull form parameter, L/1/3. Data on round-bottom boats from a number of other sources were examined to see if they could be correlated with the Nordstrom data. It was hoped thereby to produce graphs which would be useful for design and for the prediction of boat performance for a wider range of speeds. A report by Marwood and Silverleaf was found to contain data which could be used to prepare a series of graphs useful for predicting the resistances of boats of a wide range of sizes up to quite high speeds.

The data from the other sources examined was found to be of little value for the present purpose. Generally this was either because of the evident presence of laminar flow on the models, or because the models were fitted with skegs of unknown size and of unknown influence on the resistance.

RES, Useful

RES, Useful


Models of a number of different planing boat designs were towed in smooth water to provide data for guidance in designing aircraft rescue boats and similar high-speed craft. Resistance, trim, rise, and wetted surface were determined for each design for either standard or comparable conditions of hull loading and center of gravity location. The test data, lines, and hull form characteristics for each design are presented in a design data sheet. Resistance of the different designs are compared, and reasons given for significant differences.

RES, Useful


Graphs are presented for predicting the resistance of stepless planing hulls at high speeds. These graphs were developed from semiempirical equations derived by the National Aeronautics and Space Administration for the pure planing lift and center-of-pressure on flat and V-bottom planing surfaces. The development of the graphs is explained, and an example is presented to show the process of estimating the resistance of a typical large planing boat. A comparison of the resistance curves determined from model tests with the values of high-speed resistance obtained from these graphs shows good agreement.

RES, Useful


This report presents graphs by means of which the high-speed resistance and trim of conventional and stepped planing boats of a wide range of sizes and proportions can be determined. Graphs which give guidance in selecting parameters which will result in optimum planing performance are also presented. Values for the graphs were obtained from equations for the lift, center of pressure, and resistance of prismatic planing bottoms which were previously developed by the National Aeronautics and Space Administration and the David Taylor Model Basin.

RES, Useful

This paper presents the results of resistance tests of five planing boat models of different length-beam ratio. Each model was tested at a number of loads and LCG locations. The results are presented as curves of angle of attack and resistance-weight ratio versus Froude number. The resistance data have been corrected to boat weights of 10,000 and 100,000 lb. The measured values of wetted lengths, wetted surface, and rise of CG are also presented in tabular form. The conditions at which the models porpoised at high speed were determined and a graph defining the stable and unstable regions is included. A method was ascertained of collapsing the high-speed resistance data from the tests of the series into a single graph. A simplified prediction method was then developed which can be used to determine the high-speed resistance of planing hulls of a wide range of proportions, and of any gross weight from 1,000 to 100,000 lb. RES, Useful


This report presents graphs by means of which the high-speed resistance and trim of catamaran planing hulls of a wide range of sizes and proportions can be determined. Graphs which give guidance in selecting parameters which will result in optimum planing performance are also presented. Values for the graphs were obtained from equations for the lift, center of pressure, and resistance of prismatic planing bottoms which were previously developed by the National Aeronautics and Space Administration and the David Taylor Model Basin. RES, Useful


The procedure is given for designing cambered and swept planing surfaces for small stepped motorboats of the dynaplane type. A design example is included in the report. RES, Useful


The theory of Johnson was used to calculate the performance characteristics of cambered planing surfaces having a three-term camber section, rectangular planform, and zero deadrise. These characteristics are presented in a series of graphs which are suitable for design purposes. RES, Useful


RES, Useful

Values of residuary resistance from model tests were previously presented for a methodical series of slender displacement hull forms which had been tested up to high speeds. The present report gives values of total resistance for the hull forms of the series so that their relative merits can be readily seen. The value of total resistance were calculated for boats of 200-ton displacement to facilitate comparison with resistance data for U.S. Navy hydrofoil boats. The Form of the data presentation is such as to provide guidance for the design of high-speed displacement and catamaran hull forms.

RES, Useful


Additional experimental verification is presented of the reduction of planing boat drag which can be achieved by using longitudinal strips forward of the stagnation line to deflect the whisker spray from the hull surface. In addition, graphs for determining the high-speed positions of the spray boundary and stagnation lines are given, to assist designers in locating spray deflectors on planing boats in the most effective positions.

RES, Useful


Geometrically similar models of a set of planing boat appendages were manufactured in four different sizes, and tested to determine the scale effect error involved in predicting appendage drag. Data from the test of the smallest appendage set when mounted on a hull model were fairly consistent with data from the three larger appendage sets when mounted on a friction plane. The results indicate that use of an extrapolator which is appreciably steeper than Schoenherr's line at Reynolds numbers below about $10^5$ would give more nearly correct predictions of full scale appendage resistance.

RES, Useful


RES, Useful

Performance characteristics in smooth and rough water are presented for a round bottom patrol boat, based on tests conducted on a 1/16 scale model (No. 5016). Comparison is made with another model of smaller length/beam ratio (Model No. 4927).

RES, Useful


RES, Useful


RES, Useful

RES, Useful


Comparison of several power prediction formulas with results of model and full scale tests of a number of craft.

RES, Useful


RES, Useful


"Data are given with body plans and graphs embodying test results on 27 different models of round bottom and V-bottom boats (with chines). On pages 15 and 16 the report gives data as to the resistance of appendages and the probable values of propulsive coefficients."-Saunders.

RES, Useful

RES, Useful


RES, Useful


RES, Useful


RES, Useful


RES, Useful

RES, Useful

Toro, A.I., "SHALLOW-WATER PERFORMANCE OF A PLANING BOAT," Southeastern Section, SNAME, April 1969. Also University of Michigan, Department of Naval Architecture and Marine Engineering Report No. 019, April 1969.

RES, Useful

Traung, Jan-Olof, Compiler, "FISHING BOAT TANK TESTS", Technology Branch FAO Fisheries Division.

RES, Useful

Van Mater, P.R. Jr., "BEHAVIOR OF THREE PLANING BOAT DESIGNS IN CALM AND ROUGH WATER", August 1963, Davidson Laboratory Report No. 854, AD 422 495.

RES, Useful

Yeh, H.Y.H., "SERIES 64, RESISTANCE EXPERIMENTS ON HIGH-SPEED DISPLACEMENT FORMS," SNAME, Chesapeake Section, 9 December 1964. Also Marine Technology, July 1965, SNAME.

RES, Useful

The purpose of the present paper is to provide Planing Boat Designers with a straightforward method for the comparison of boat performance, whatever the displacement and speed might be, and similarly, to evaluate the probable merit of a project at an early stage of the design.


Model Test of 116' X 24' Boat.


Model Test of 66 ft. X 18 ft. Boat.


POWER BOAT BIBLIOGRAPHY

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance

RES, Background


Model test of 29 foot planing boat.

RES, Background


Model Tests of a 97.5 Foot V-Bottom Boat.

RES, Background


RES, Background


RES, Background

Baker, G.S., and Millar, G.H., "EXPERIMENTS WITH MODELS OF HYDROAEROPLANE FLOATS, 2ND AND 3RD SERIES", Advisory Committee for Aeronautics (England), Aeronautical Research Committee Reports and Memoranda No. 98, November 1913.

RES, Background


RES, Background

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

RES, Background


RES, Background


RES, Background


RES, Background


Tests, using TMB Model 4990, were made in Langley Tank No. 1 to determine the performance characteristics of a 36-Foot River Patrol Craft Model 4990 is a revision of Model 4974 which had a deep tunnel forward. This tunnel was instrumental in collecting air under the hull, lowering the effectiveness of the propulsion screws. Model 4990 had the forward tunnel removed and replaced by a convex section terminating in a blunt bow. The tests indicate that no air was entrained under the bow of the modified model, but that EHP at the design operating conditions was increased. Spray over the bow and side of the model was eliminated by use of spray strips. Test results for two displacements with and without spray strips are presented.

RES, Background


RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance 68
Benen, L., "GENERAL RESISTANCE TEST OF A STEPLESS PLANING HULL WITH APPLICATION TO A HYDROFOIL CONFIGURATION", DTMB 2006, July 1965, AD 619-646.

RES, Background


RES, Background


RES, Background

Benen, L., "GENERAL RESISTANCE TEST OF A STEPPED PLANING HULL WITH APPLICATION TO A HYDROFOIL CONFIGURATION", (Model No. 4776) NSRDC 2320, May 1967, AD 654-900.

RES, Background


The principal planing characteristics of a surface having an angle of dead rise of 40° and horizontal chine flare are presented. The data indicate that at a given trim the important planing characteristics depend mainly on lift coefficient. The effects of increasing the basic angle of dead rise from 20° (NACA TN 2804) to 40° are to decrease the ratio of the center-of-pressure location to the mean wetted length, to decrease the extent of pile-up of water at the keel, and to increase the friction drag.

RES, Background


Resistance characteristics of the LCM-A vehicle were determined by tests conducted at the David Taylor Model Basin with Model 4746. This report describes the special procedures employed and gives the results of the tests.

RES, Background

Model tests conducted at the Naval Academy towing tank with 2 ft. models.


Carter, A.W. and Weinstein, I., "EFFECT OF FOREBODY WARP ON THE HYDRODYNAMIC QUALITIES OF A HYPOTHETICAL FLYING BOAT HAVING A HULL LENGTH-BEAM RATIO OF 15", Tech. Note No. 1828 NACA.

RES, Background

Cavanaugh, M.G., "EFFECT OF TRANSOM WEDGES ON TRIM AND POWERING FOR 83 AND 95 FOOT COAST GUARD PATROL BOATS REPRESENTED BY MODEL 4429", DTMB Report No. 1471, September 1960. Requires Coast Guard approval for distribution.

RES, Background


An investigation was conducted to determine the principal characteristics of two V-shaped surfaces having angles of dead rise of 20° and 40°. The data indicate that, for a given condition of load, speed, and trim, the wetted length, distance of center of pressure from trailing edge, and drag increase with an increase in the angle of dead rise.

RES, Background

Cheng, H.M., "PERFORMANCE COMPARISONS OF MARINE VEHICLES", September 12, 1958, New York Metropolitan Section SNAME.

RES, Background


An experimental investigation was made in the Langley high-speed hydrodynamics facility to determine whether the planing lift coefficient of a flat-bottom planing surface remains constant with increasing speed at the high towing speeds of this facility. No effect of speed was noted for the range of speeds tested. In addition, the data agreed well with that recently obtained in lower speed towing tanks. A brief description of the facility is included.

RES, Background

POWER BOAT BIBLIOGRAPHY

RES, Resistance 71
Christopher, K.W., "EFFECT OF SHALLOW WATER IN THE HYDRODYNAMIC CHARACTERISTICS OF A

The effects on the planing characteristics of the clearance between a flat-bottom
planing surface and the tank bottom are presented. The range of trims investigated was
from 4° to 20° for wetted-length-beam ratios of 0.4 to 6.4. Each condition was investigat-
ed over a range of clearance of from 0.2 to 1.6 beams. All the measured values increased
with decreasing clearance. A description of the monorail and its associated apparatus
is included.

Clement, E.P., "EXPERIMENTAL BOAT-HULL FORM TEST PROGRAM, BASIC FORM, MODEL 4300,
RESISTANCE CHARACTERISTICS", NSRDC Report No. 740, November 1950. Distribution only
upon authorization of Bureau of Ships Codes 452, 422.

Clement, E.P., "MODEL TEST RESULTS AND PREDICTED EHP FOR SCHEME I, EXPERIMENTAL BOAT-
Distributed only upon authorization of BuSHIPS, Code 452,422.

Clement, E.P., "MODEL TEST RESULTS AND PREDICTED EHP FOR HACKER FORM, EXPERIMENTAL BOAT-
Distributed only upon authorization of Bureau of Ships.

Clement, E.P., "MODEL TEST RESULTS AND PREDICTED EHP FOR THE HURON-EDDY COMPANY 85 FOOT
Distributed only upon authorization of the Bureau of Ships.

Clement, E.P., "MODEL TEST RESULTS AND PREDICTED EHP FOR THE HURON-EDDY COMPANY REVISED
upon authorization of Bureau of Ships.

Clement, E.P., "HULL FORM OF STEPLESS PLANING BOATS", SNAME Chesapeake Section 12 Jan.
1955.

RES, Background


Four existing models of planing craft were retested at "standard conditions" for planing boat models. The test results for each model are presented in a design data sheet. The data are compared to show the effects of differences in hull form. These comparisons are independent of differences in hull loading, in LCG location, or in size of boat. Auxiliary graphs are included to assist in making estimates of speed and power for new designs.

RES, Background

Clement, E.P. and Tate, C.W., "MODEL TEST RESULTS AND PREDICTED EHP FOR AN 86 FT. PERSONNEL BOAT, FROM TESTS OF MODEL 4675," DTMB Report 1288, December 1958, AD 610-137.

Smooth-water model tests were made of an 86 ft. personnel boat designed for "all-weather" operation. The model was tested for ehp at full-scale displacements of 130,000 lb., 140,000 lb., and 150,000 lb. In addition, at one speed and displacement, the lines of flow were determined by the acid-trace method, in order to find the appropriate location for the bilge keels.

RES, Background


A hull form for a stepless planing boat was designed, based upon an analysis of the results of resistance tests of a number of previous designs, and also taking into consideration the features desirable for good steering qualities and good rough-water performance. A model was built and tested, and the results were compared with the resistance data from designs which had been previously tested at the Model Basin. This comparison showed that the new design has appreciably less resistance than the earlier designs at all except very low speeds. The new design was also tested at a wide range of hull loading and LCG locations, and these results are presented.

RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance

RES, Background


The utilization of a design approach for a planing boat similar to that followed in the design of a hydrofoil boat or an airplane leads to a new, more efficient type of planing boat configuration. The lift-drag ratio of the new configuration is approximately 50 percent greater than that of the conventional stepless planing boat.

RES, Background


RES, Background


RES, Background


RES, Background


A planing surface with 15-deg deadrise, circular-arc camber, and a moderate amount of trailing edge sweep was designed as the main lifting surface for an existing experimental stepped planing boat. A model of the planing surface was then built and tested in the towing basin. The tests results indicate that the lift/drag ratio of the main planing surface of the boat will be increased 10 percent by utilization of this design. Also, the performance in head seas should be significantly improved since the cambered surface will develop the necessary lift at approximately one-half the forebody angle of attack at which the boat now operates.

RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance 74
Clement, E.P., "MODEL TESTS OF A STEPPED PLANING BOAT WITH AN ADJUSTABLE STERN STABILIZER" NSRDC Report 2414, May 1967. AD 661-792.

The Naval Ship Research and Development Center is developing a stepped hull having an adjustable planing stabilizer at the stern for balance, stability, and control of trim. At high speed, this craft planes on a small area forward of the step (which is located approximately at midlength), with the stern supported by the adjustable stabilizer. Since the afterbody wetted area is eliminated at high speed, the frictional resistance, and accordingly the total drag also are considerably lower than for the conventional planing boat. Furthermore, at high speed the trim angle of the main forebody planing surface can be adjusted to the value for minimum drag by adjusting the vertical position of the stabilizer. This report gives the results of tests of several variations of the first model of this type of craft which was designed and extensively tested at the Center. The effects on performance are shown of changes in the following: spray strip configuration, LCG location, weight, step depth, and afterbody shape. RES, Background


Two models of stepped planing boats were tested to determine the effect of change in length-beam ratio. The models were tested with the same adjustable stern stabilizer at several loads and LCG locations. The model with the lower length beam ratio ($\frac{Lp}{Bp} \times 3.4$) had considerably more resistance than the other stepped model ($\frac{Lp}{Bp} \times 4.7$) at low speed and slightly less resistance at high speed. The resistance of both stepped designs at high speed was considerably less than that of a representative unstepped planing boat design. RES, Background


RES, Background


RES, Background


RES, Background
Model tests were made to determine the powering characteristics for a catamaran-type hull. Wetted lengths, running trims, and resistances were measured on the model for a number of speeds, displacements, and initial trims. In addition, the effect on performance of changes in hull spacing, planing area, and spray rails was determined. A test was also made with a step on the roof of the tunnel. The results are presented in dimensionless form and also in the form of ehp curves for 70 ft, 105,400-lb. boat.

The data obtained from the tests indicated that for this hull a wide spacing is of no advantage from a resistance point of view. The spray rails on the final configuration increased the drag slightly on the full-sized boat. The best configuration was not as good as a good conventional planing hull, and this is thought to be primarily due to a large amount of air drag.

Model test results for heavily loaded inverted-vee hull forms at moderate speeds.

RES, Background


"Unfortunately the parent form for this series has a chine that is considered too low forward, by modern standards. There are indications that the observed resistances are too low, because of laminar flow on many of the models. The data are plotted as contours of $Rt/W$, as contours of running trim angle in deg. of model wetted surface, and of other factors." - Saunders.

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


Contains results from tank landing and take-off tests with a dynamic model of a hypothetical jet-propelled airplane equipped with NACA hydro-skis. These results show stable take-offs and landings for the model, although the resistance is high. The high resistance, which is not considered necessarily inherent, appears to be acceptable for airplanes equipped with rocket motors. It is concluded that hydro-skis suitable for flush retraction into streamline fuselages offer a practicable means for taking off and landing high-speed airplanes on the water.


POWER BOAT BIBLIOGRAPHY

Resistance 78

RES, Background


RES, Background


RES, Background


RES, Background

Diehl, W.S., "TESTS ON AERONAUTICAL FUSELAGES AND HULLS," NACA Report 236, 1926

"This paper gives drag and moment data on a great variety of airplane fuselages, seaplane and flying-boat hulls, airship cabins, nacelles, and the like." - Saunders.

RES, Background


RES, Background


RES, Background
Diehl, W.S., "THE APPLICATION OF BASIC DATA ON PLAINING SURFACES TO THE DESIGN OF FLYING
BOAT HULLS", NACA Report No. 694, 16 December 1939, 1940 reports, pp 287-293.


Doust, D.J., "SHIP DESIGN AND POWER ESTIMATING USING STATISTICAL METHODS", December, 1962,
Publication No. 70. Norwegian Ship Model Experiment Tank, The Technical University of
Norway.

Doust, D.J., et.al., "A STATISTICAL ANALYSIS OF FAO RESISTANCE DATA FOR FISHING CRAFT,"
Third FAO Technical Meeting on Fishing Boats, Goteborg, October 1965. Ship Report 93,
February 1967, National Physical Laboratory.

Drisko, J.B., "RESISTANCE OF V-BOTTOM HULLS AT SPEEL-LENGTH RATIOS UP TO 5," Davidson

DuCane, P., "A CONSIDERATION OF SOME OF THE PRINCIPLES UNDERLYING THE PERFORMANCE

POWER BOAT BIBLIOGRAPHY

Resistance

80


Everest, J.T., "SOME RESEARCH ON THE HYDRODYNAMICS OF CATAMARANS AND MULTI-HULLED VESSELS IN CALM WATER", NECI, March 18, 1968.


Fridsme, G., "COMPARATIVE TESTS ON MODEL 238/ WITH AND WITHOUT BOTTOM CAMBER IN SMOOTH AND ROUGH WATER", Davidson Laboratory LR-1153, June 1966, for DTMB, AD 639-093. Performance characteristics in smooth and rough water are presented for a 52 ft., 55,000 lb. displacement, hard chine patrol boat, with and without bottom camber; based on tests conducted on a 1/16 scale model.


RES, Background

Goodwin, "SEAPLANES TAKING OFF AND ALIGHTING," Advisory Committee for Aeronautics, Aeronautical Research Committee Reports and Memoranda No. 784, December 1921.

RES, Background


RES, Background

Grigg, A.D., "EXPERIMENTS WITH MODELS OF SEAPLANE FLOATS, 5th SERIES", Advisory Committee for Aeronautics (England), Aeronautical Research Committee Reports and Memoranda No.188, December 1915.

RES, Background


RES, Background

Tests of a bare-hull model of a landing craft (LCVP) were conducted at the heavy and light conditions over a speed range from 0 to 36 knots. The results indicated that the resistance requirement at the heavy displacement was higher at 21 knots than at 28 knots. Attempts were then made to lower this "hump" in the resistance by equipping the model with stern flaps and spray rails. These minor hull changes definitely lowered the effective horsepower required at the 20 knot speed, but the 5-deg flaps were detrimental at speeds above 23 knots. Accordingly, it is recommended that stern flaps be adjustable in order to vary the angle to an optimum for a specified speed.


Tests, using TMB Model 4943, were conducted in Langley Tank No.1 to determine the performance characteristics of a round bilge 41-foot Personnel Boat. Model resistance, trim, wetted length, and CG rise were measured throughout the speed range for a number of hull loadings, initial trim conditions, and appendage configurations. Comparisons are made with the design condition. Results are presented in dimensionless form.


Tests using TMB Model 4958 were made in Langley Tank No.1 to determine the performance characteristics of a V-bottom 63-foot Aircraft Rescue Boat. Model speed, resistance, trim, and wetted length were measured throughout the speed range for a number of hull loadings, initial trim conditions, and with all appendages. Tests with and without appendages were conducted for the DTMB standard condition for planing boats and test data for that condition are presented in nondimensional form. Change in trim and ehp are presented in terms of full-scale speed in knots.

Hatch, G.N., "PERFORMANCE AND HULL FORM OF FAST PLANING CRAFT," Articles 1, 2, 3, 4, & 5, Ship and Boat Builder, Feb., March, April, May and June 1963.

RES, Background

Helm, K. "SYSTEMATIC (MODEL) INVESTIGATIONS ON THE INFLUENCE OF (HULL) FORM UPON RESISTANCE AND POWER REQUIREMENTS, IN INLAND-WATERWAYS PASSENGER SHIPS," (in German) Schiff u Hagen, 15 February, 1963, P 98.

RES, Background

Henschke, W., "SYSTEMATIC RESISTANCE EXPERIMENTS WITH MODELS OF MOTOR FISHING VESSELS," Schiffstechnik, Bd. 4, 1957.

RES, Background


RES, Background

Hobbs, R., "FASTER BOATS", The Planimeter, July 1965, SSCD.

RES, Background


RES, Background

Hughes, G., "FRICCTIONAL RESISTANCE OF SMOOTH PLANE SURFACES IN TURBULENT FLOW", INA, 1952.

RES, Background
Hughes, G., "FRICTION AND FORM RESISTANCE IN TURBULENT FLOW AND A PROPOSED FORMULATION FOR USE IN MODEL AND SHIP CORRELATION," INA, 1954.


"Each Transmittal of this document outside the Department of Defense must have prior approval of the Head, Hydromechanics Laboratory, Naval Ship Research and Development Center."


The form-drag coefficient of parabolic bodies of revolution with fineness ratios greater than 1 operating at zero angle of yaw and zero cavitation number is determined both theoretically and experimentally. Agreement between theory and experiment is very good. The theoretical form-drag coefficient of paraboloids is about half the form-drag coefficient of cones of comparable fineness ratio.
A high-speed investigation was conducted to determine the hydrodynamic characteristics of a planing surface having an angle of dead rise of $20^\circ$ and horizontal chine flare. The data indicated that the planing characteristics at a given trim depend only on lift coefficient. The ratio of center-of-pressure location to the mean wetted length can be considered approximately equal to 0.67 up to $18^\circ$ of trim. This ratio decreases with further increase in trim. Pile-up of water at the keel of the model was substantial at trims above $12^\circ$. Friction drag is negligible at high trims. The resistance for trims of $18^\circ$ and higher, therefore, may be assumed equal to the load times the tangent of the trim angle.

The effect of vertical chine strips on the planing characteristics of two prismatic surfaces having angles of dead rise of $20^\circ$ and $40^\circ$ has been determined as part of a general research investigation on planing surfaces. Wetted lengths, resistance, and center-of-pressure locations were determined at speed coefficients up to 25.0, load coefficients up to approximately 80.0, and trims up to $30^\circ$. In addition, comparisons of the more important planing characteristics are made with those for related surfaces having angles of dead rise of $0^\circ$, $20^\circ$, and $40^\circ$, and for surfaces having angles of dead rise of $20^\circ$ and $40^\circ$ with horizontal chine flare. These comparisons show that vertical chine strips are more effective means of increasing the lift of a given surface than horizontal chine flare is. This increase in lift, however, is accompanied by a substantial increase in drag so that the lifting efficiency of the vertically flared surface is comparable to one having horizontal chine flare.

Kimon, P.M., "MODEL EHP TESTS OF TWO DESIGNS OF A 36 FT HYDROJET LCVP," DTMB Report 1046, August 1956, AD 124-2911L. Distributed only on authorization of BUSHIPS.


This report is one of a series on the experimental investigation of the planing characteristics of a series of related prismatic surfaces.

The principal planing characteristics have been obtained for an inverted V prismatic surface having an angle of dead rise of -10 deg. Wetted lengths, resistance, and center-of-pressure location were determined at speed coefficients ranging up to 19.5, beam-loading coefficients from 0.87 to 71.5, and trims up to 30 deg. Keel-wetted length-beam ratios were extended to approximately 8.0 in all cases where excessive loads or excessive spray conditions were not encountered.

The data indicated that the important planing characteristics are independent of speed and load for a given trim and are dependent primarily upon lift coefficient. The difference between keel wetted length and chine wetted length is constant for a given trim angle. The ratio of the center-of-pressure location forward of the trailing edge to the mean wetted length is dependent on trim angle and on wetted length. The drag data indicate that the friction-drag component is a large percentage of the total drag at the low trims but decreases rapidly with increase in trim. At the high trim angles of 24 and 30 deg, the induced drag exceeds the total drag and indicates an apparent negative friction force.

Koelbel, J., "POWERING OF PLANING BOATS," The Planimeter, March, April, May, 1954, also in "HOW TO DESIGN PLANING HULLS," Vol. 49, Motor Boating Ideal Series under title "BETTER PERFORMANCE FOR STEPLESS PLANING HULLS".


POWER BOAT BIBLIOGRAPHY

Resistance 87

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


Tests of prismatic Vee planing surfaces were made at the Experimental Towing Tank, Stevens Institute of Technology, in order to determine the wetted length under various conditions of trim, deadrise, speed, and loading. The data obtained were used to supplement the previously available test data of Sottorf, Sambraus, and Shoemaker in deriving empirical formulae which express the functional relation between these five variables. All the data needed for a quick and easy estimation of the wetted area and of the location of the center of pressure of Vee planing surfaces are presented on two summary charts.

This report carries a bibliography of related references.

RES, Background

POWER BOAT BIBLIOGRAPHY Resistance 88


Lamb, H. "ON THE EFFECT OF THE WALLS OF AN EXPERIMENTAL TANK ON THE RESISTANCE OF A MODEL", Advisory Committee for Aeronautics, Aeronautical Research Committee Reports and Memoranda No. 1010, January 1926.

Landweber, L., "REANALYSIS OF BOUNDARY-LAYER DATA ON A FLAT PLATE," Iowa Institute of Hydraulic Research, October 1960

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

Lord, L., "MONOHEDRON HULL, AN APPRAISAL," The Planimeter, January 1950, SECU.

RES, Background


Martinof, "DATA FOR THE DESIGN OF HYDROGLIDERS", Two articles published in the Soviet magazine, SAMOVOET, No. 12, 1936, and No. 2, 1937.

Early work on porpoising.


Marwood, and Silverleaf, DISCUSSION IN RELATION TO PAPER ON "DESIGN DATA FOR HIGH SPEED DISPLACEMENT HULLS AND A COMPARISON WITH HYDROFOIL CRAFT", Third Symposium on Naval Hydrodynamics, Wageningen, 1960.

RES, BACKGROUND


Four types of planing surfaces were tested on a rectangular free-water jet 3 inches wide by 3/4 inch deep at speeds varying from 80 to 200 fps. No large effect of speed was obtained on any of the models tested but the lift coefficients for the flat plate and the longitudinally curved surface appeared to increase slightly with speed in the higher portion of the speed range. The lift data for the flat plate and the hydroski obtained on the free-water jet were less than those obtained for similar surfaces in comparatively unrestricted towing tanks. For the trims and length-beam ratios investigated, the ratio of tank lift data to jet lift data for the flat plate appeared to be a function of the ratio of the height of the trailing edge of the model above the lower jet boundary to the wetted length.

RES, Background


RES, Background


A model of a new design for a 40 ft. high speed LCVP was tested to determine effective horsepower requirements as displacement of 18,000, 26,000 and 30,000 lb. Modifications to the hull form and the addition of bow and side spray strips were required to obtain satisfactory performance. The final version of the model, with bow and side spray strips, was tested at the DIMB standard condition for landing craft, and also its performance was compared with that of the World War II LCVP.

RES, Background


RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance 92

RES, Background


RES, Background


RES, Background


RES, Background


Johnson's method for supercavitating hydrofoils at zero cavitation number has been programmed to calculate the lift, drag, and center of pressure of cambered planing surfaces (as well as supercavitating foils) of zero deadrise and rectangular planform.

Very high lift/drag ratios are predicted by this method for cambered planing surfaces operating at practical trim angles.

Test run on planing surface models of the circular-arc and three-term shape gave somewhat higher lift/drag ratios than those predicted by the theory.

RES, Background

Moss, J.J., "RESISTANCE TEST RESULTS FOR 1/12 TH SCALE MODELS OF THREE PLANING CATAMARANS." University of Michigan, Dept of N.A. and M.E., Report 02:44, July 1909 for Grafton Boat Co., Inc.

RES, Background

The effects of convexity were to increase the wetted length-beam ratio (for a given lift), to decrease the lift-drag ratio, to move the center of pressure forward, and to increase the trim for maximum lift-drag ratio as compared with values obtained for a flat surface. The effects were greatest at low trims and large drafts. The maximum negative lift coefficient based on the model beam obtainable with a ratio of the radius of curvature to the beam of 20 was -0.02. The effects of camber were greater in magnitude for convexity than for the same amount of concavity.

RES, Background


An evaluation was made of the resistance of high-speed seaplane in waves of three heights. Various conditions were investigated for a seaplane having a dead-rise of 20°, a length-beam ratio of 15, and a wing loading of 120 pounds per square foot. The resistance was greater in waves than in smooth water and increased wave height. The increase was greatest between hump speed and take-off (in 6-foot waves the maximum increase was 65 percent at a speed equal to 70 percent of getaway speed). The increase in resistance was nearly the same with dead-rise angles of 40° and 60° as with the 20° dead-rise angle.

RES, Background


Wetted length, resistance, and center-of-pressure location were determined for a radius of curvature of 20 beams, beam-load coefficient C_4 from -3 to -3, Froude numbers from 6 to 25, and Reynolds numbers from 5x10^6 to 10^7. Compared with a 0°-dead-rise surface with the same curvature, the 20°-dead-rise surface had (for the same lift) greater wetted-length-beam ratio, lower lift-drag ratio, more forward center-of-pressure location, and had greater trim for maximum lift-drag ratio. Except for very low trims, the variation of the center-of-pressure location with wetted length was nearly the same for an angle of dead rise of 20° as for an angle of dead rise of 0°.

RES, Background


An extension of the Taylor Standard Series to higher displacement length ratios and speed/length ratios typical of free-running tugs.

RES, Background

RES, Background


RES, Background


Resistance, trim, and sinkage were measured for a family of hull shapes derived from a simple box-like parent, similar to present amphibians. The data were analyzed to reach conclusions as to the feasibility of major resistance reductions, the effects of drastic variations in hull proportions, and the presence of scale effects.

RES, Background


RES, Background

RES, Background


RES, Background


RES, Background

Parkinson, J. B., and Olson, R. E., "TANK TESTS OF AN ARMY OA-9 AMPHIBIAN," NACA ARR. Dec. 1941.

RES, Background


RES, Background


RES, Background

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

Model 4525, a round bilge 40 ft. AVR design, was tested to determine the effective horsepower requirements for the full scale craft. The model was tested at displacements corresponding to 20,000, 25,000, and 30,000 lbs, full scale; all tests were zero initial trim. Different spray strip positions were tested in an effort to determine the most satisfactory location.

RES, Background


RES, Background


RES, Background

Richardson, H.C., "AIRPLANE AND SEAPLANE ENGINEERING", Bureau of Aeronautics Tech. Note No. 59, 1923; Aerial Age Weekly, 1918-1919

RES, Background


"Contains a great deal of information which still remains of value (1955) in studying and predicting the behavior of planing craft" - Saunders.

RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance 98
Richardson, H.C., "DESIGN OF A LARGE FLYING BOAT", SNAME, Transactions, 1928

RES, Background

Ridgely-Nevitt, C., "THE RESISTANCE OF TRAWLER HULL FORMS OF 0.05 PRISMATIC COEFFICIENT," SNAME, 1956.

RES, Background


RES, Background


RES, Background


24 References on pp. 25-27.

RES, Background


RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance

RES, Background


The results of an investigation made to obtain the wetted areas, the three components of planing forces, and the three components of moments acting on a 0° and a 20° dead-rise surface in high-speed, unsymmetrical planing conditions are presented. Hydrodynamic data were obtained for trim angles between 60° and 30°, roll angles between -15° and 15°, yaw angles between 0° and 20°, mean wetted-length-beam ratios up to 7.7, load coefficients up to 49.0, and speed coefficients up to 18.0.

RES, Background


RES, Background


RES, Background


RES, Background

RES, Background


RES, Background

Schoenherr, K.E., "RESISTANCE OF FLAT PLATES MOVING THROUGH A FLUID," SNAME, 1932.

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background


Sherman, P., "MODEL TEST RESULTS AND PREDICTED EHP FOR A HARD CHINE 40 FT. LCP (L) FROM TESTS OF MODEL 4618," DTMB Report 1095, November 1956, prepared for the Bureau of Ships. Distributed only upon their specific authorization. AD 145-073L.

A model of a hard chine 40 ft. LCP(L) was tested to determine the EHP requirements at displacements of 17,500, 20,000, 22,500, and 25,000 lb. After these tests the concavity at the stern of the model was reduced and the model retested at the 20,000 lb. displacement. The modified model was also tested at the DTMB standard condition for planing hulls, both with and without the keel.


POWER BOAT BIBLIOGRAPHY

Resistance 102

RES, Background


A model of a planing boat was equipped with two horizontal submerged hydrofoils which were designed to carry part of the weight of the craft. The foils were located forward of the center of gravity. Smooth-water resistance tests were made with foils at various fore-and-aft positions and various angles of attack to determine the optimum arrangement. Tests were also made of the foils alone. It was found that an appreciable scale effect on foil performance existed at Reynolds numbers below about 5x10^6.

The data from the tests of the hull with foils, when corrected for scale effect on foil performance, indicated that the resistance of a planing boat can be decreased when such foils are added by as much as 27 1/2 percent. The best result was attained with the foils located at 28 percent of the hull length aft of the bow, and with the foil chord line at an angle of -3.5 deg with respect to the hull baseline.

RES, Background


RES, Background


Results of Tow Tank Tests of four full-sized eight oared shells are presented. A comparison is made of the four hulls over a range of speeds. Also the effect of other parameters on performance is investigated.

RES, Background


RES, Background


RES, Background

A summary is given of the background and present status of pure-planing theory. Data for models having sharp chines have been obtained for a rectangular flat plate and two V-bottom surfaces having constant angles of deadrise of 20° and 40° and also for rectangular-flat-plate surfaces having very slightly rounded chines. The theory presented in NACA Technical Note 3233 for a rectangular flat plate is revised and extended to include triangular flat plates planing with base forward and V-shaped prismatic surfaces having a constant angle of dead rise, horizontal chine flare, or vertical chine strips. The agreement between the results calculated by the proposed theory and the experimental data is satisfactory for engineering calculations of lift and center-of-pressure location.

RES, Background


RES, Background


RES, Background


An important paper in the history of Planing Hulls.

RES, Background


RES, Background


Historical work on planing.

RES, Background
Sottorf, W., "EXPERIMENTS WITH SKIMMING PLANES, PART I TO IV", May 1933. Translation by Miss S. Skan, Aeronautical Research Committee Seaplane Subcommittee.

**RES, Background**

Sottorf, W., "EXPERIMENTS WITH PLANING SURFACES", NACA TM 661, 1932 and NACA TM 739, 1934.

Experiments with planing surfaces are fundamental hydrodynamic researches for the purpose of obtaining the most favorable forms for planing boats, flying boats, and seaplane floats, with respect to water resistance and seaworthiness.

**RES, Background**

Sottorf, W., "GESTALUNG VON SCHWIMMWERKEN (THE DESIGN OF PLANING FLOATS)", Luftfahrtforschung, 20 April, 1937; English Translation in NACA T.M. 860, April 1938.

Historical work on planing.

**RES, Background**


Historical work on planing.

**RES, Background**

Sottorf, W., "VERSUCHE MIT GLEITFLACHEN, PART IV, (TESTS WITH PLANING SURFACE, PART IV,"

**RES, Background**


Early work on the separate computation of frictional resistance in scaling from models.

**RES, Background**


**RES, Background**
Spooner, C.W., Jr. "SPEED AND POWER OF MOTORBOATS UP TO A SPEED-LENGTH RATIO OF THREE," "Unpublished manuscript dated October 1950; available in the TMB Library"--Saunders.
University of Michigan Report.

RES, Background

Springston, G.B., Jr., "MODEL TEST RESULTS AND PREDICTED EHP FOR EXPERIMENTAL 65 FT. LANDING CRAFT (LCM) FROM TESTS OF MODEL 4416," NSRDC No. 850, July 1956. Distributed only upon specific Bureau of Ships authorization, (DDC AD 124-026L)

RES, Background


RES, Background


This report is one of a series on the experimental investigation of the planing characteristics of a series of related prismatic surfaces.

The principal planing characteristics have been obtained for a V-shaped prismatic surface having an angle of dead rise of 50 deg. Wetted lengths, resistance, and center of-pressure location were determined at speed coefficients up to approximately 20.0, beam-loading coefficients from 0.87 to 71.51, and trims up to 30 deg. Keel-wetted-length-beam ratios were extended to approximately 8.0 in all cases where excessive loads or excessive spray conditions were not encountered.

The data obtained indicate that the important planing characteristics are independent of speed and load for a given trim and are dependent primarily upon lift coefficient. The difference between keel wetted length and chine wetted length is constant for a given trim angle and the variation of this difference with trim has the same general trend as indicated by theory. For practical purposes the ratio of center-of-pressure location forward of the trailing edge to the mean wetted length is a constant equal to 0.58 and is independent of trim angle. The drag data indicate that the friction-drag component is a large percentage of the total drag at the low trims, but decreases rapidly with increase in trim to a small percentage at the higher trim.

RES, Background


RES, Background

POWER BOAT BIBLIOGRAPHY

Resistance

106
The relations between bottom shapes, pressure distribution, and drag of a planing surface in steady motion over an undisturbed free surface are investigated by carrying out a separation of the velocity potential into a part independent of gravity and a part dependent on gravity. The gravity-free velocity potential, which describes planing at infinitely large Froude number and contains all the essential irregularities of the planing problem, furnishes the gravity-free shape of the planing surface as well.


Tarbox, L.H., "REPORT ON RELATIVE RESISTANCES OF SIMILAR ROUND AND V BOTTOM MODELS," The Planimeter, August 1952, SSCD.


A model of a round-bilge boat was tested for resistance, with and without Snadecki-type longitudinal strakes. In general, for the condition tested, the addition of the strakes caused an increase in resistance. However, at very high speeds, and with the CG in an aft position, some reduction in resistance was obtained. Further effects of adding the strakes were to decrease the running trim and to increase the CG rise of the model.

Model tests of a new and somewhat unconventional boat, the 36-foot River Patrol Craft, were made by the Model Basin. The bottom of this craft has a single deep tunnel forward which gradually decreases convexly in depth to a flat bottom of 60 percent of the hull length. There it bisects into two shallow tunnels which are symmetrical about their centerlines. The afterbody tunnels increase in depth to the transom.

During the tests it was discovered that the single tunnel forward collected an appreciable quantity of air which then migrated aft past the propeller positions in the tunnels of the afterbody and from there astern into the wake.

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

Todd, F.H., "FURTHER MODEL EXPERIMENTS ON THE RESISTANCE OF MERCANTILE SHIP FORMS COASTER VESSELS", INA 1931.
Todd, F.H. and Weedon, J., "EXPERIMENTS WITH MODELS OF CARGO-CARRYING TYPE COASTERS", IMF 1940.

RES, Background

Todd, F. H. and Weedon, J., "FURTHER EXPERIMENTS WITH MODELS OF CARGO-CARRYING COASTERS", NECI 1942.

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

(Unknown), "FLYING BOATS, GENERAL DATA ON EFFECT OF DIMENSIONS, DETAILS OF FORM FOR GOOD RESULTS, AND SOME STRENGTH DATA", NECI, February 1920.

RES, Background
"EXPERIMENTS WITH MODELS OF FLYING BOAT HULLS AND SEAPLANE FLOATS, 22ND SERIES" 
Advisory Committee for Aeronautics (England), Aeronautical Research Committee Reports 
and Memoranda No. 785, January 1922.

RES, Background

"D.T.TWIN FLOATS; REPORT OF THE ADDITIONAL EXPERIMENTS WITH MODEL NO. 2394", 

RES, Background

"BESTIMMUNG DES WILDERSTANDES VON MOTORBOOT SANHANGEN", Versuchsanstalt Fur 

Model test of Shaft, Strut, and Rudder.

RES, Background

"THE DEVELOPMENT OF FLYING BOATS", Aeroplane, January 16, 1924.

RES, Background

"FLOAT TYPES, GENERAL REQUIREMENTS", INA Transactions, July 1914.

RES, Background

"TOWING TESTS OF A PROPOSED 5-TON HIGH SPEED AMPHIBIAN," Davidson Laboratory 

Curves of resistance for heavily loaded inverted-Vee hull form at various displacements 
and LCG's in smooth water and waves.

RES, Background

"TOWING TESTS OF A 1/16 SCALE MODEL OF A 40 FOOT V-BOTTOM PLANING AMPHIBIAN 
WITH LOW CHINE FORWARD (SEA HORSE B)," Davidson Laboratory Report LR-745, May 1959.

RES, Background


Van Mater, P.R., and Dornak, H.E.Jr., "HYDRODYNAMIC CHARACTERISTICS OF BASIC PLANING HULL TYPES", Great Lakes Section, SSCD, April 3, 1965.


The planing characteristics as determined by tank tests, are presented for three surfaces representative of hydro-ski forms. One surface was of rectangular plan form with a flat bottom; the second surface had a rectangular plan form with transversely curved bottom; and the third surface had a flat bottom but was triangular in plan form.

The range of trims investigated was 4° to 20°. The data are presented in the form of plots of the total load, resistance, trimming moment, and draft against wetted area. Plots of wetted length, wetted area forward of the observed wetted length at the chine, and aerodynamic tare forces are included.


The planing characteristics are presented for six planing surfaces. The surfaces varied in plan form and transverse bottom curvature. The plan forms included rectangles, triangles, and their combinations. The bottom curvatures included flat, convex, and concave-convex transverse sections. The ranges of trims and speeds investigated were 4° to 20° and 15 to 35 feet per second. The data are presented in the form of plots of wetted length, load, resistance, trimming moment, and draft against wetted area. Plots of wetted area forward of the observed wetted length at the chine are included.

RES, Background


Early work on theory of planing.

RES, Background


RES, Background


RES, Background


RES, Background


RES, Background

The principal high-speed planing characteristics for a prismatic surface having an angle of dead rise of 0° (flat bottom) have been determined over a wide range of planing variables. Wetted length, resistance, center-of-pressure locations, and draft were determined at speed coefficients ranging up to 25.0, beam loadings up to 87.3, and trims up to 30°. Mean wetted lengths up to 7.0 beams were obtained whenever possible.


Wittholz, C.W., "PLANING BOAT DESIGN COMMENTS," The Planimeter 12/59 - 1/60, SSCD.


Anonymous, "GAY CLASS FAST PATROL BOAT. FINAL EHP AND RUNNING RISE AND TRIM CURVES", Admiralty Experiment Works.

RES,


RES,

Clement, E.P., "EHP AND FLOW TESTS OF A TUNNEL-BOTTOM RECONNAISSANCE BOAT, MODELS 4389 AND 4389-1", NSRDC Report No. 1210, February, 1968, AD 205-643L Distributed only upon authorization of BUSHIPS.

RES,


RES,


RES,

A concise presentation of the principles of waterjet propulsion systems.

Van Manen & Oosterveld, "ANALYSIS OF DUCTED PROPELLER DESIGN", SNAME Transactions, 1966

Water jet for a 1 ton payload, 20 knot boat tested in the High Speed Channel at Hydronautics, Inc. at static conditions for both forward and reverse thrust and at various forward speeds.

Prop, Useful


PROP, Useful


PROP, Useful


PROP, Useful


PROP, Useful

Estimates of wake fraction and appendage resistance. PROP, Useful

Gawn, R.W.L., and Burrill, L.C., "EFFECT OF CAVITATION ON THE PERFORMANCE OF A SERIES OF 16 IN. MODEL PROPELLERS", INA, 1957. PROP, Useful


Detailed methods for estimating appendage drag and propeller performance, including effects on operating trim and therefore hull drag. PROP, Useful


Contains bibliography with 37 entries. PROP, Useful


PROF, Useful


PROF, Useful


PROF, Useful


PROF, Useful

Covers the hydrodynamics, mechanical and control problems of CP propellers.

PROP , Useful


PROP, Useful


PROP, Useful


PROP, Useful


PROP, Useful

POWER BOAT BIBLIOGRAPHY
This paper deals with open-water tests with propellers of the L 4-55 series in nozzles of systematically varied form. The results of the open-water tests with the "screw plus nozzle" combination are given for each form of nozzle in a $K_S - K_m - \lambda$-diagram, as is usual with systematically varied series of screws (1, 2).

By means of these diagrams the optimum "screw plus nozzle" combination for the nozzle form under consideration can immediately be determined, while it is also possible to compare the efficiency with that of the screw without nozzle.

A method is discussed for determining the translational velocity in the nozzle in the vicinity of the screw.

The influence of the various parameters, decisive for the open-water "screw plus nozzle" combination, are examined as regards their importance.

Finally, attention is devoted to the framing of a condition of minimum loss of energy for the "screw plus nozzle" combination, and at the same time directions are given for cavitation-free design of the screw in the nozzle according to the vortex theory.

PROP, Useful
Acevedo, M.L., "CAVITATION ON MARINE PROPELLERS AND ITS PREDICTION BASED ON THE RESULTS OF TESTS WITH PROFILES", DTMB Translation 230, January 1951.


Powering characteristics of the LCM-A vehicle were determined by tests conducted at the David Taylor Model Basin with Model 4746. This report describes the special procedures employed and gives the results of the propulsion tests.

Blount, D.L., "SMOOTH WATER POWERING CHARACTERISTICS OF AN EXPERIMENTAL LCVP(T)," DTMB Report 2283, September 1966. AD 800-129L.

Full-scale standardization trials were conducted on an experimental LCVP designated LCVP(T) and the results are reported herein for comparison with those for a partially air supported craft, LCVP(K). Trials were conducted at four displacements with the craft free to trim. Two different propellers were utilized at each displacement. Shaft horsepower, thrust, RPM, trim, and speed are given for each condition along with wake factors.


Excellent review of controllable pitch in the Navy from patrol craft to ships. 30 References.

See Also "Discussion of Controllable Pitch Propellers" in ASNE Journal, December, 1967.

Bryner, A.M., "IS YOUR PROPELLER BIG ENOUGH FOR THE JOB," The Planimeter, October 1964 SSCD.


Clement, E.P. and Kimon, P.M., "PROPULSION CHARACTERISTICS OF A 36-FT LCP (L) FROM TESTS OF MODEL 4555," NSRDC Report No. 1162, July 1957. AD 145-128 L. Distributed only upon authorization of BUSHIPS.


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 propeller 2 inches inboard.

The altered stern lines resulted in a 3 percent increase in enp at 8 knots and a 15 percent increase in shp at 6 knots. The alterations also greatly improved the bollard pull astern capabilities.


PROP, Background

Ficken, N.L., "CONDITIONS FOR THE MAXIMUM EFFICIENCY OPERATION OF CYCLOIDAL PROPELLERS", SNAME, Chesapeake Section, April 1966.

PROP, Background

Gawn, R.W.L., "EFFECT OF PITCH AND BLADE WIDTH ON PROPELLER PERFORMANCE", INA, 1953.

PROP, Background


PROP, Background


18 References.

PROP, Background


Hagara, S.S., "SELF - PROPELLED AND TOWING TESTS IN WAVES OF MODEL 4532 REPRESENTING A 60TON AMPHIBIOUS CARGO CARRIER IN A FULLY FLOODED CONDITION," NSRDC Report No. 1104 October, 1957. AD 144-899. Distributed only upon authorization of BUSHIPS.


Six supercavitating propellers were tested to determine their backing characteristics. The propellers tested were TMB propellers 3671A, 3767, 3769, 3770 and 3820.

The tests were performed in open water and in the TMB 24-inch variable pressure water tunnel at several cavitation indices over a range of speed coefficients.

POWER BOAT BIBLIOGRAPHY

Propulsion

In an effort to achieve supercavitating performance at relatively low speeds, ventilation of an SC propeller was investigated. Tests were run with a two-bladed SC propeller ventilated through holes in the propeller blades.

The results of the tests show that ventilated propellers operate with a fully developed cavity at speeds too low for supercavitating operation. Powering performance was found to be dependent upon the cavitation index based on cavity pressure.


This report presents the open-water test results of four similar propellers varying only in pitch ratio. The propellers are two-bladed, commercially manufactured, and designed for weedless operation.


"Each transmittal of this document outside the Department of Defence must have prior approval of the Head, Hydromechanics Laboratory, Naval Ship Research and Development Center."


Full scale tests of Michigan Dyna-Jet three-bladed propeller in the 36 inch water tunnel.


The performance characteristics of a marine propeller with a jet flap was investigated. It was found that the jet flap effectively reduced propeller blade cavitation and that for a given advance coefficient the thrust was considerably increased by using the jet flap. The propeller efficiency decreased somewhat primarily because of the power required in delivering the jet.


"Each transmittal of this document outside the Department of Defense must have prior approval of the Head, Hydromechanics Laboratory, Naval Ship Research and Development Center."

Kotik, J., "AMPHIBIOUS VEHICLE STUDIES", TRG Division, Control Data Corporation, Melville N.Y., June 1966 for ONR, Contract Nonr-4650 (00).

An attempt to improve the propulsive efficiency of tracked amphibians.


Waterjet versus conventional propeller. Results of full scale testing of 16 foot boat.


The section moduli for the TMB EPH, NACA 16, 65A and 66 TBM modified sections are given in this report along with incipient cavitation curves for the NACA 16,65A,0000-1.10/1.575 section with a = 1.0 and 0.8 mean lines and the NACA 66 TMB modified section with an a = 0.8 mean line.

Wake surveys were conducted in the DTMB Subsonic Wind Tunnel on a model of the AG(EH) main strut-pod-foil configuration with and without a pod fairing, and on three related DTMB strut-pod-foil configurations. This report presents the results of these wake surveys. One of the significant results is that each pod corner causes an additional stress reversal per cycle on the propeller blades, intensifying fatigue and vibration problems.

Mohr, W.L., "WAKE SURVEYS BEHIND HYDROFOIL-STRUT-NACELLE CONFIGURATIONS—FOR APPLICATION TO THE AG(EH)," DTMB Report 1864, June 1964. AD 603-062


This paper presents the results of open-water tests and observation of the cavitation characteristics of systematic series of flow decelerating nozzles (or pumpjets). The tested nozzle shapes have been derived theoretically. The results of these theoretical calculations and of the experiments are presented in a nondimensional form in graphs. A discussion of the results is given.


PROP, Background


PROP, Background


PROP, Background


PROP, Background

Ram inlets applicable to high speed (up to 100 knots) waterjet propelled ships are analyzed and shown to present exacting design requirements. Based on the analytical results, variable geometry appears to be a necessity to achieve the thrust capability for acceleration to design speed. The selection of the design inlet velocity ratio is shown to be very critical, making it necessary to adhere to the optimum value or suffer high power losses. At 100 knot speeds, base vented inlets appear definitely superior, with respect to drag over both subcavitating and supercavitating types. Methods are presented for selecting the optimum waterjet inlet system based on tradeoffs between external and internal performance losses. Cavitation free designs are generated and analyzed with the aid of the Neumann Problem solution. Accounting and calculation procedures for external drag and internal losses are established and applied to the inlet system of a 100 knot surface effect ship.


Experimental studies were conducted on four propellers in the partially submerged condition. Three were existing NSRDC supercavitating propellers, and one was an eight-bladed propeller specifically designed for partially submerged operation. Experimental results show that the thrust and torque are proportional to the submergence, and that efficiency is essentially independent of the submergence. Also, Froude effects are important for certain speed regimes.


"Each transmittal of this document outside the Department of Defense must have prior approval of the Head, Hydromechanics Laboratory, Naval Ship Research and Development Center."


The water ramjet is a low weight contender for propelling the high speed Surface Effect Ships of the future. This propulsor which has no moving parts in contact with the water phase consists of a simple contoured duct. Compressed air is injected at a high pressure region in the duct, generating a two phase flow. The expanding gas phase accelerates the flow through a nozzle, thus producing forward thrust. The flow is described using the Euler and Rayleigh equations, the equation of movement of the bubbles relative to the water phase and the first law of thermodynamics. These equations are used in a computer program for predicting thrust and propulsive efficiency. The effects of scale, forward speed, compression cycle and nozzle length on propulsive efficiency is discussed and tabulated. The basic data and nozzle shape of a water ramjet which generates 40 tons thrust at 80 knots are given and a conceptual design is discussed. Propulsive efficiency is of the order of 50-60%.


Mamontov, Yu. N., "DIAGRAMS FOR EVALUATING THE EFFECT OF NOZZLES ON PROPELLER PERFORMANCE (DIAGRAMY DLA OPIREDENIA EFEKTIVNOSTI USTANOVKI NAPRAVLJATUSHCHEKH NASADOK I RASCHETA GREBNYKH VINTOV)", Sudostroenie, No. 8, August 1959, DTMB Translation No. 301 by B.V. Nakonechny, AD 249-440.

POWER BOAT BIBLIOGRAPHY


Volker, "UNIVERSAL PROPELLER CHARTS FOR SHIP DESIGN", ISP (Date Unknown)


Wagner, W., "HYDRAULIC STEERING GEARS", The Planimeter, February 3, 1957, SSCD.

POWER BOAT BIBLIOGRAPHY

STEER, Background


STEER, Background


STEER, Background

Fischer, K., "CALCULATION OF RUDDER FORCE", Translation No. 52, Nov.1938 USEMB (DTMB) by M.C. Roemer.

STEER, Background

Interesting use of semi-circular shroud to replace rudder in MIT experimental work. Contains theoretical work and test data.


Hoerner, S.F., "THE HYDRODYNAMIC TORQUE OF SHIP RUDDERS", 2nd Ship Control System Symposium Naval Ship Research and Development Laboratory, Annapolis, Md. 21402 Nov. 1959.

Each transmittal of this document outside of agencies of the United States, Canadian, or United Kingdom governments must have the prior approval of the Commanding Officer, Naval Ship Research and Development Laboratory, Annapolis, Maryland.

STEER, Background


STEER, Background


A rapid approximate procedure is given for predicting the static and dynamic loads on a rudder of a surface ship or submarine in a steady horizontal turn as a function of the rudder angle of attack.

STEER, Background


STEER, Background

Sobolev, G.V., "CALCULATIONS OF MANEUVERABILITY OF FAST SURFACE SHIPS", Translated by Michail Aleksandrov and Peter Fitzgerald, University of Michigan, Dept. NA&ME, No. 060, February 1970.

STEER, Background


DuCane, P. and Goodrich, G.J., "THE FOLLOWING SEA, BROACHING AND SURGING", Transaction, INA, 1951.


Thieme, H., "DESIGN OF SHIP RUDDERS", DTMB Translation 321, November 1965.


MOTIONS, Useful


MOTIONS, Useful


MOTIONS, Useful


MOTIONS, Useful

Motions, Background


"Each transmittal of this document outside the Department of Defense must have prior approval of the Head, Hydromechanics Lab, NSRDC."

MOTIONS, Background


MOTIONS, Background


MOTIONS, Background


Tests of TMB Model 4943 were conducted in Langley Tank No. 1 to determine the motions and resistance of a round bilge 41-ft. Personnel Boat in waves. Model pitch, heave, and accelerations at bow and CG were measured on a 1/6-scale model in head seas in regular waves.

The hull responses to regular waves were obtained experimentally, and the method of linear superposition was applied to characterize the craft's behavior in a State 3 sea.

MOTIONS, Background


MOTIONS, Background

POWER BOAT BIBLIOGRAPHY

Seakeeping and Motions
Gersten, A., "EFFECT OF METACENTRIC HEIGHT ON ROLL DAMPING", NSRDC Report 2982, Oct. 1969. Experiments have been conducted by the Naval Ship Research and Development Center on a floating circular cylinder to determine the effect on roll damping of changes in transverse metacentric height GM. The relationship between log decrement $\delta$ and GM is defined, both graphically and by means of an empirical equation which shows that $\delta$ varies inversely as the square root of GM. In addition, the total energy lost per cycle and the energy losses due to wavemaking are discussed.


Hsu, C.C., "ON THE MOTIONS OF HIGH SPEED PLANING CRAFT," Hydronautics, Inc. Technical Report 603-1, AD 658151, DDC.


Locke, F.W.S., Jr., "GENERAL PORPOISING TESTS OF FLYING BOAT HULL MODELS", NACA ARR, September 1943.


Lueders, D., "MODEL TESTS OF TWO PLANING FORMS AND A ROUND BOTTOM FORM IN AN IRREGULAR HEAD SEA," Davidson laboratory Report 746, April 1959.


MOTIONS, Background


MOTIONS, Background


MOTIONS, Background


MOTIONS, Background


MOTIONS, Background


MOTIONS, Background
St. Denis, M. and Pierson W.J., Jr., "ON THE MOTIONS OF SHIPS IN CONFUSED SEAS,
SNAME Transactions, 1955.

Savitsky, D., "HIGH SPEED TESTS IN WAVES AT DAVIDSON LABORATORY, STEVENS INSTITUTE OF TECHNOLOGY", Davidson Laboratory, August 1969.


An investigation was made in Langley tank No. 1 to determine the effects of increasing the angle of dead rise on the hydrodynamic performance of a flying-boat hull having a length-beam ratio of 15. The hydrodynamic qualities determined were longitudinal stability during take-off and landing, spray characteristics, and take-off performance in smooth water and landing behavior in waves. The results of this investigation indicate an over-all improvement in the hydrodynamic characteristics including a large reduction in the accelerations and motions in waves.


The "Bible" for determination of bottom design pressures in planing craft.

LOADS, Useful

Lankford, B.W., "THE STRUCTURAL DESIGN OF THE ASR CATAMARAN CROSS-STRUCTURE", ASNE, JOURNAL August 1967, See Also ASNE Journal, October 1967 "Errata to ASR Catamaran Cross-Structures'.

Statistical techniques applied to ship strength calculations. Good paper on wave loading.

LOADS, Useful

Anonymous, "EXPERIMENTS WITH FULL SIZE MACHINES, 3RD SERIES, P-5 FLYING BOAT N 86 IMPACT TESTS", National Tank Staff, Advisory Council for Aeronautics, Aeronautical Research Committee, Reports and Memoranda No. 926, April 1924.


Archer, S., 'PROPELLER-EXCITED VIBRATION; FIVE BLADES OR FOUR?', ISP Vol 9 No. 91, March 1962.

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads 156

LOADS, Background


LOADS, Background


A theoretical method for estimation of the bow-impact force of high-speed marine craft on regular waves is presented, based on the strip theory and the concept of virtual mass. Numerical results are obtained for two models, one with constant deadrise and the other with varying deadrise. Experimental studies on impact lift, drag, pitch moment, and phase angle are reported, for the same models under various wave conditions. The theoretical results for impact lift are found to be in good agreement with measurements, except in the case of very high and steep waves.

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads


POWER BOAT BIBLIOGRAPHY

Applied Loads 158

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background
Underway vibration trials of LCM(8) landing craft were conducted to evaluate basically similar designs in steel and aluminum. Vibration measurements were made on engine and gear-box foundations, hull girder structure, and local structural areas. Generally, vibration levels of the three-bladed aluminum boat were lower than those of steel boat. The effect of substituting four-bladed propellers and removing a set of skeg struts from the aluminum boat was insufficient to justify these modifications.

LOADS, Background


LOADS, Background


LOADS, Background

Jones, E.T. and Blundell, R.W., "FORCE AND PRESSURE MEASUREMENTS ON V-SHAPES ON IMPACT WITH WATER COMPARED WITH THEORY AND SEAPLANE ALIGHTING RESULTS", R&M No.1932, ARC, 1938.

LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads
Hydrodynamic pressure distributions have been obtained during pure planing for five related prismatic surfaces. The distributions gave integrated lifts that in almost every case were well within 10 percent of the applied load. Comparison of experiment with theory shows that existing theories will adequately predict flat-plate pressures. For the V-shaped surfaces, experiment and theory are in poor agreement. The lift and center-of-pressure data for both the flat and V-shaped surfaces are in good agreement with recent experimental and theoretical NACA research on planing surfaces.


Kreps, R.L., "EXPERIMENTAL INVESTIGATION OF IMPACT IN LANDING ON WATER", NACA TM 1046 (1943).


LOADS, Background


LOADS, Background


LOADS, Background


Summary Experimental Data; Extension Incompressible Theory for Oblique Impact.

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background
Miller, R.W., "HYDRODYNAMIC IMPACT LOADS IN ROUGH WATER FOR A PRISMATIC FLOAT HAVING AN ANGLE OF DEADRISE OF 30 DEGREES," NACA TN 1776, (1948)

This contains an appended bibliography of Hydrodynamic Publications of Langley Impact Basin.


Mixson, J.S., "THE EFFECT OF BEAM LOADING ON WATER IMPACT LOADS AND MOTIONS", NASA Memo 1-5-59L (1959)


LOADS, Background


LOADS, Background

Monaghan, R.J. and Crewe, P.R., "FORMULAE FOR ESTIMATING THE FORCES IN SEAPLANE-WATER IMPACTS WITHOUT ROTATION OR CHINE IMMERSION", R&M No. 2904, ARC (1955).

LOADS, Background


The problems of vibration and noise aboard ship have been given increased attention by the Navy since World War II as a result of many technological developments and tactical requirements. Many problem areas are identified and those which have particular attention in the design of river tugboats are reviewed.

The paper is addressed primarily to the naval architect, shipbuilder, or operator and identifies those areas to which attention should be drawn during design and development. Specific suggestions and specifications are presented, based on current naval practice.

LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads 165

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads 166


Schnitzer, E., and Hataway, M.E., "ESTIMATION OF HYDRODYNAMIC IMPACT LOADS AND PRESSURE DISTRIBUTION ON BODIES APPROXIMATING ELLIPTICAL CYLINDERS WITH SPECIAL REFERENCE TO WATER LANDING OF HELICOPTERS", NACA TN 2889. (1953)

Sedov, L., "ON THE IMPACT OF A SOLID BODY ON THE SURFACE OF AN INCOMPRESSIBLE FLUID," Tr CAHI, Report 187, Moscow (1934), Also available as ACSIL Translation # 538, (1953).


Smiley, R.F., "A STUDY OF WATER PRESSURE DISTRIBUTION DURING LANDINGS WITH SPECIAL REFERENCE TO A PRISMATIC MODEL HAVING A HEAVY BEAK LOADING AND A 30 DEG. ANGLE OF DEADRISE," NACA TN 2111 (1950)
A semiempirical procedure is presented for computing the water-pressure distribution on flat and V-bottom prismatic surfaces during planing or landing. For the rectangular flat plate, a consideration of several previous theoretical derivations and some observations of the experimental data lead to the development of simple equations which are in good agreement with experimental data for trims below $30^\circ$ and for wetted-length-beam ratios at least up to 3.3. This development is based primarily on the assumption that the longitudinal distribution of pressure on a rectangular flat plate is substantially a function only of the normal-load coefficient so that this distribution may be computed from the existing theory for two-dimensional flow. The transverse distribution of pressure is obtained as a compromise between the available theoretical treatments for very small and very large wetted-length-beam ratios. For a V-bottom prismatic surface with appreciable chine immersion, the pressures on chine-immersed sections of a model having an angle of dead rise of $30^\circ$ are found to be very similar to those on the corresponding flat plate so that a simple modification of the flat-plate equations can be used to predict approximately the pressures on V-bottom surfaces.

LOADS, Background


LOADS, Background


LOADS, Background

Smiley, R.F., "WATER-PRESSURE DISTRIBUTIONS DURING LANDINGS OF A PRISMATIC MODEL HAVING AN ANGLE OF DEAD RISE OF 22-1/2\degree AND BEAM-LOADING COEFFICIENTS OF 0.48 AND 0.9/\degree", NACA TN 2816, November 1952.

As part of an over-all program, smooth-water landing tests of a prismatic float having an angle of dead rise of 22-1/2\degree were made. Water-pressure, velocity, draft, and acceleration data are presented. Landings were made for beam-loading coefficients of 0.48 and 0.9/\degree at fixed trims between 0.2/\degree and 30.3/\degree for a range of flight-path angles from 4.6\degree to 25.9\degree and also for 90\degree. The experimental pressure distributions are found to be in fair agreement with the predictions of the available theory; however, better agreement is obtained by modification of the theory.

LOADS, Background

LOADS, Background


The results of a seaworthiness investigation are presented for three designs of a proposed United States Coast Guard 160-ft water patrol craft. The results were obtained from model tests in regular head seas with a wavelength to wave height ratio of 15:1.

A comparison of the three designs with respect to speed reduction in waves, magnitudes of vertical acceleration and amplitudes of motions, indicates that no one design is superior to the other two in all respects. The selection of the most suitable design, therefore, depends on which performance characteristics are considered to be of major importance. The conclusion is reached that the design designated as B is the best with respect to amplitudes of accelerations and motions, and Design C is the best with respect to resistance in waves. The major difference in the two designs is that Design B has a transom stern and Design C a cruiser stern.

LOADS, Background

Steiner, M.F. "ANALYSIS OF PLANING DATA FOR USE IN PREDICTING HYDRODYNAMIC IMPACT LOADS" NACA TN 1694, August, 1948.

LOADS, Background


LOADS, Background


LOADS, Background


LOADS, Background

POWER BOAT BIBLIOGRAPHY

Applied Loads

169


POWER BOAT BIBLIOGRAPHY

LOADS, Background


LOADS, Background

Frankland, J.M., "EFFECT OF IMPACT ON SIMPLE ELASTIC STRUCTURES", DTMB Report No. 481, April 1942. AD 408-33

LOADS,

Mewes, E., "DIE STOSSKRAFTE AN SEEFLUGZEUGEN BEI STARTS UND LANDUNGEN," J. Vereinigung fur Luftfahrtforschung (1935).

LOADS,


LOADS,

POWER BOAT BIBLIOGRAPHY

Applied Loads

Best source for formulas and tables for bending, buckling, diaphragm loading etc.  

STRESS, Essential


Good text for strength of materials.  

STRESS, Essential


A method for determination of minimum scantlings is presented. Several existing craft are included as examples.  

STRESS, Useful

Preceding page blank
Static stresses were measured on a highly skewed marine propeller blade using a specially constructed pressure chamber which allowed the blade to be loaded under air pressure. The measured stress distribution was radically different from those previously measured on unskewed blades. The highest stresses occurred in a relatively narrow band extending from near the trailing edge at the blade root to near the leading edge at 90-percent radius. For a uniform pressure loading of 1.0 psi, the maximum measured principal stress was 2200 psi in compression and 1800 psi in tension. The maximum radial stress calculated by beam theory for the equivalent unskewed propeller was 910 psi both in tension and compression.


An experimental stress analysis of the high stress areas of a fiber glass boat hull was conducted during normal boat operation and while firing a 57-mm gun. The purpose of the test was to obtain data bearing on the integrity of the fiber glass hull from a shock-fatigue standpoint. The measurements indicated a range of shock loadings which could be tolerated before cracking of the outside fiber glass hull occurred.


An interesting account of a loading test on a typical 36 ft. wooden hard chine fishing craft in which deflections are measured and stresses calculated.

STRESS,

Anonymous, A GUIDE FOR THE ANALYSIS OF SHIP STRUCTURES, U.S. Department of Commerce.

STRESS,


STRESS,


STRESS,


Good basic structural design information, basically applicable to metal ships but a useful reference for small craft structures particularly in steel.

Fraser, D.J., "ESTIMATED HULL WORK AND MATERIAL CONTENT FOR 100 FT COMBINATION FISHING VESSEL IN DIFFERENT MATERIALS", Paper Presented at Conference on Fishing Vessel Construction Materials, Montreal, October 1968.

An outstanding paper, a 100 ft. fishing vessel is designed in steel, aluminum, wood, GRP and ferro cement. Midship sections are presented for each design. Weights and costs are included.


Good general description of wood boatbuilding techniques, ship equipment and facilities. Cost estimating and job planning is discussed.

Figures and Scantling tables are given for small fishing vessels not covered by bodies such as Lloyds and A.B.S. They are for wooden boats of from 30 to 90 ft. with bent-frame construction and for those of from 30 to 125 ft. with sawn frames. They also cover V-bottom wooden boats of from 30 to 90 ft. and welded steel vessels of from 30 to 130 ft. in length overall.

Kilgore, U., "GENERATION OF DEVELOPABLE HULL SURFACES" The Planimeter 1/65 SSCD.


Tjossen, W.W., "LINES DEVELOPMENT BY CONIC CONSTRUCTION," The Planimeter, SSCD v.04.

POWER BOAT BIBLIOGRAPHY

General Construction Methods

An outstanding structural study of 30 designs for advanced landing craft. Comparison is made between designs and to existing craft with respect to unit structural wts., design criteria, cost versus payload, etc.


Plywood, solid wood, and GRP, steel and aluminum are compared with respect to their suitability for fishing vessel construction.

Burgess, C.P., "DEVELOPABLE SURFACES FOR PLYWOOD BOATS", The Rudder, February 1940.


A method for mathematically generating lines for developable surface craft. Example is given for a convex bottom hard chine boat.
Giffin, A.H., "COAST GUARD 40' UTILITY BOAT CURRENT CONSTRUCTION METHODS", Presented 13 October 1951 Chesapeake Section SNAME at U.S.Coast Guard Yard, Curtis Bay, Maryland. (B-8743 Treasury CGHQ, Washington, D.C.)


Account of design, construction, and service of a copper-nickel yacht.


See also expansion of this work in Saunders, Vol. II, Section 76.8

CONST, Background


Describes principles and methods of developed surface hull design.

CONST, Background


CONST, Background


CONST, Background


CONST, Background

GRP (simple skin and sandwich) is compared to steel, aluminum, and various woods for strength, weight, durability and cost.


POWER BOAT BIBLIOGRAPHY General Construction Methods

ALUM, Useful


ALUM, Useful

Anonymous, "RECOMMENDED ALUMINUM APPLICATIONS FOR BOATS AND YACHTS. SPECIAL INFORMATION REPORT, S-1," ABYC.

ALUM, Useful


Good general text on marine applications.

ALUM, Useful


Contains some engineering and production data of value.

ALUM, Useful

Colvin, T.E. "ALUMINUM ALLOYS IN SMALL CRAFT DESIGN AND CONSTRUCTION", Chapter 16 of *Problems in Small Boat Design* (1959), Edited by Gerald Taylor White, Sheridan House, New York, also in *The Planimeter*, October, November, December, 1955, SSCD.

ALUM, Useful

Leveau, C.W. "ALUMINUM AND ITS USE IN FISHING BOATS" (with discussion), Pgs. 229-245 of *Fishing Boats of the World: 3* (1965) Edited by Jan-Olof Traung, Food and Agriculture Organization of the United Nations, Published by Fishing News (Books) Ltd., London.

Comprehensive discussion of Aluminum hull construction. Tables of material properties and welding and riveting procedures are presented. Structural details sketches and photos of aluminum craft under construction are included. ALUM, Useful
Leveau, C.W., "ALUMINUM AND ITS USE IN NAVAL CRAFT", Part I, ASNE Journal, Feb., 1965

Excellent data on welded aluminum construction.

ALUM, Useful


ALUM, Useful

Ifoutz, D.R., "ALUMINUM ON WATER-AN ANNOTATED BIBLIOGRAPHY ON USES OF ALUMINUM IN BOATS AND SHIPS," The Aluminum Association, 420 Lexington Avenue, New York, N.Y. 10017.

437 articles listed with notes.

ALUM, Useful

Rukin, J.B., "RECOMMENDED GUIDE FOR ALUMINUM CREWBOATS AND YACHTS," Reynolds Metal Co.

ALUM, Useful


Properties and fabrication procedures for marine aluminum are described.

ALUM, Useful

POWER BOAT BIBLIOGRAPHY

Aluminum 184


ALUM, Background


ALUM, Background


ALUM, Background

Anonymous, "ALUMINUM ALLOY LIFEBOATS", Engineering, December, 1953

ALUM, Background


ALUM, Background


ALUM, Background


ALUM, Background

Detailed discussion of the design, construction and operation of the 117 ft. aluminum cargo vessel "Independence".

ALUM, Background

Colvin, T.E., "CARE AND MAINTENANCE OF ALUMINUM VESSELS", The Planimeter 4-5-6-58 SSDC.

ALUM, Background


ALUM, Background


ALUM, Background


ALUM, Background


ALUM, Background


ALUM, Background

ALUM, Background

Holtyn, C.H., (Reynolds Metal Co.) "ALUMINUM, FROM BOATS TO SHIPS", Pacific N.W. Section SNAME, April 5, 1963.

ALUM, Background


ALUM, Background


History and present applications of aluminum hulls.

ALUM, Background

Leveau, C.W., "MARINE ALUMINUM APPLICATIONS," Kaiser Aluminum, Oakland, Calif.

ALUM, Background

Leveau, C.W. "ALUMINUM IN THE MARINE INDUSTRY", The Planimeter, 9/10/56, SSCD.

ALUM, Background


ALUM, Background

ALUM, Background


ALUM, Background


ALUM, Background


ALUM,

Little, R.S., "INTRODUCTORY NOTES TO ALUMINUM," American Bureau of Shipping.

ALUM,

McMullen, E.B., "ALUMINUM HONEYCOMB STRUCTURES" (Summary only), Paper presented at symposium "Modern Developments in Materials Applicable to Yacht Construction," University of Southampton, England, 11 April 1969.

ALUM,


Pospelov, V.I. "ALLOWANCE FOR FLEXIBILITY IN STRENGTH CALCULATIONS OF MARINE FERROCONCRETE ELEMENTS", Abstract Journal, NAVSHIPS Translation No. 1176 (Abstract only)


Sutherland, W. and Jackson, G., CONCRETE BOAT BUILDING, ITS TECHNIQUE AND ITS FUTURE, International Marine Publishing Co., 21 Elm St., Camden, Maine, 04843.

Anonymous, "TO SEA IN A STONE," The Skipper, December 1967.


Anonymous, "FERRO-CEMENT: DOES IT HAVE A FUTURE IN THE WORK BOAT FIELD?", The Workboat, February 1969, Pg. 22.


CEMENT, Background

Collen, L.D.G., "SOME EXPERIMENTS IN DESIGN AND CONSTRUCTION WITH FERRO-CEMENT", The Institute of Civil Engineering of Ireland, January 1960.

CEMENT, Background


CEMENT, Background


Comments regarding advantages costs, techniques and misconceptions for the ferro-cement hull construction.

CEMENT, Background


CEMENT, Background


CEMENT, Background


CEMENT, Background


History of ferro-cement and a somewhat biased advertisement for "Seacrete".


Yi-Yan, S., "REINFORCED GLASS FIBER CONCRETE BARS, (BOLISI SHUINICHUAN)," Naval Intelligence Command Translation No. 2576, 15 April, 1968.


Canby, C.D., "FERRO CEMENT WITH PARTICULAR REFERENCE TO MARINE APPLICATIONS", Presented to the Pacific Northwest Section of SNAME, March 1969.


Very comprehensive handbook, still the "bible" for GRP small craft construction.

GLASS, Essential


GLASS, Useful


Reprints of articles from Yachting Magazine.

GLASS, Useful


A design study for a GRP trawler; materials selection is discussed at length including comparison to structural designs for the same craft in wood and steel. GRP designs are presented in both single skin and sandwich.

GLASS, Useful

POWER BOAT BIBLIOGRAPHY  

Fiberglass
Gibbs and Cox, MARINE SURVEY MANUAL FOR FIBERGLASS REINFORCED PLASTICS, Available from Sailing Book Service, 34 Oak Ave., Tuckahoe, N.Y. 10707.

Lunn, J.S., and Berg, R., "HULL TO DECK JOINTS IN FIBERGLASS BOATS", Symposium-Structural Design and production of Small Boats and Yachts, SNAME, New York Section, January 1966.


Silvia, P.A., "BOLTING HIGHLY LOADED FOUNDATIONS TO FIBERGLASS STRUCTURES", U.S. Coast Guard, Naval Engineering Division.


An early standard reference, now outdated.


Account of construction of a 50 ft. polyurethane cored catamaran by spray-up of foam on male molds.


Excellent "State of the Art" report for GRP to 1964 with emphasis on European industry.


Interesting account of the construction of a 42 ft. sailboat utilizing wood male forms and mahogany veneer in lieu of a conventional mold.


Marine applications of the Swiss "Aerex" PVC foam.


Describes material properties, testing and application of the Swiss "Aerex" PVC core material. Many small craft applications, to 77 ft. in length, are described and illustrated.


Discussion of fiberglass craft constructed for the British Navy including a midship section for a large minesweeper.


Good description of all mat Halmaic FRP hull construction. Good photos and some structural details.


Interesting paper on long term performance of fiberglass in hull construction.


Good guidance in materials selection, describes the growing pains of GRP as a hull material for fishing craft in the Atlantic Provinces of Canada.


Excellent account of the first large scale production construction of 74 ft. and 83 ft. fishing craft in GRP, in South Africa.

Hargrave, J.B., "DESIGN OF POWER BOATS FOR PRODUCTION IN FIBERGLASS", Symposium-Structural Design and Production of Small Boats and Yachts, SNAME N.Y. Section, January 1966.

Lord, L., "SYNTHETIC REINFORCEMENTS IN PLASTIC HULL CONSTRUCTION," Great Lakes Section, SSCD, April 1965, printed in The Planimeter


Excellent detailed account of construction of a 26 ft. surf boat by the "core-mold" method, many photos.


Detailed discussion of production of 74 ft and 83 ft production GRP Trawlers in South Africa. Designs for 97 ft., 146 ft., 200 ft. GRP crafts are discussed.

Report of a comprehensive survey of 120 FRP Navy craft in service for periods up to 15 years.

GLASS, Background


GLASS, Background


An account of the Navy's feasibility studies and development program toward a 180 ft. FRP minesweeper.

GLASS, Background


GLASS, Background


Good "State of the Art" summary to 1966. Thirteen midship section drawings are presented.

GLASS, Background


GLASS, Background

POWER BOAT BIBLIOGRAPHY


GLASS,


GLASS,


GLASS,

Anonymous, "DESIGN MANUAL FOR JOINING OF GLASS REINFORCED STRUCTURAL PLASTICS", NAVSHIPS 250-346-3 (1959)

GLASS,


GLASS,


GLASS,


GLASS,

Bushey, A.C., et al, "LAMINATED GLASS PLASTIC CONSTRUCTION WITH SPECIAL REFERENCE TO BOATS" SNAME, Cheaspeake Section, February 1952.


Good discussion of the potential of FRP as a trawler hull material. FRP design details are discussed with a particularly comprehensive commentary on secondary bonding. A cost analysis for a 73 ft. Shrimp Trawler is provided.

DuPlessis, H., FIBERGLASS BOATS (FITTING OUT MAINTENANCE AND REPAIRS), Adlard Coles (U.K.) and John DeGraff, Inc. (USA), Tuckahoe, New York.


McInnes, A., and Hobbs, W.L., "GLASS REINFORCED PLASTIC BOATBUILDING", Lloyds Register of Shipping, 10 Church St. London.


Pusey, B.B., and Carey, R.H., "EFFECTS OF TIME, TEMPERATURE, AND ENVIRONMENT ON THE MECHANICAL PROPERTIES OF POLYESTER GLASS LAMINATES", The source is missing.

GLASS,


GLASS,


GLASS,
Colvin T.E., "PAINTING OF NEW STEEL VESSELS," The Planimeter, April 1967, SSCD.


Discusses grades of steel and their application to trawler construction under Lloyd's Rules.


Good description of constructing a small steel trawler using modern construction techniques.

The "bible" for traditional wooden boat construction.

WOOD, Essential


Excellent modern work on wood construction.

WOOD, Essential


WOOD, Useful


WOOD, Useful


WOOD, Useful

Anonymous, "WOOD HANDBOOK," Forest Products Laboratory, Handbook No. 72, 1935 or later.

WOOD, Useful

WOOD, Useful


WOOD, Useful


WOOD, Useful


WOOD, Useful


WOOD, Useful


WOOD, Useful


WOOD, Useful
Excellent discussion by two of the real old timers in the field. Various wood species are discussed and listed both in order of ability to resist rot and in accordance with their strength and ability to hold fastenings. A list of construction do's and don'ts is provided.

Based on investigation of 22 successful fishing vessels from 50 to 150 ft. in length, diagrams and tables are presented from which basic structural scantlings may be obtained. An excellent discussion of fastenings is presented. The discussion provides many enlightening comments on fishing craft scantlings in several countries, along with numerous scantling tables.

WOOD, Background


WOOD, Background

Anonymous, "LAMINATED OAK FRAMES FOR A 50 FT. NAVY MOTOR LAUNCH COMPARED TO STEAM BENT FRAMES," Forest Products Laboratory, FPL Report R1611, October 1946.

WOOD, Background


WOOD, Background


WOOD, Background


WOOD, Background


Discussion of plywood characteristics and applicability to fishing craft construction.

WOOD, Background

POWER BOAT BIBLIOGRAPHY

Discussion of materials, techniques, and quality control in Canadian wood laminating industry.


Fox, U., "SEAMANLIKE SENSE IN POWERCRAFT," (1968), Peter Davies, London pp. 139-145.

Brief but informative discussion of several examples of advanced use of wood for hull structure. Seven structural plans are presented. Interesting data compilation; hull planking thickness vs-L.O.A. for example.


An excellent discussion of material properties and design considerations for wooden fishing craft structure. Design proposals are made for optimum use of the material.


Interesting and useful discussion of construction techniques for wood fishing vessels.


Presents results of computer analysis and full scale testing of sawn and laminated fishing vessel frames of different shapes.


Traditional construction of wooden sailing yachts.

POWER BOAT BIBLIOGRAPHY


WOOD,


COMP, Background


COMP, Background


Marine applications of Plyfoam PVC foam core.

COMP

Mark, R, "BALSA CORES FOR REINFORCED PLASTIC STRUCTURES", Modern Plastics, 1956

COMP,


COMPOS,

POWER BOAT BIBLIOGRAPHY

Composite and Miscellaneous 222

ENGINE, Background


Engine, Background


ENGINE, Background


ENGINE, Background

Paynter, H.M. ANALYSIS AND DESIGN OF ENGINEERING SYSTEMS, MIT Press, 1961

ENGINE, Background

Vibrans, F., "VARIATIONS IN MARINE ENGINE PERFORMANCE WITH DEPARTURE FROM DESIGN," ASME Oil and Gas Power Proceeding, 1956.

ENGINE, Background


ENGINE, Background

POWER BOAT BIBLIOGRAPHY

Engine Selection and Rating 223

Davies, J.H., "GASOLINE VS DIESEL ENGINES", The Planimeter, SSCD, 12/56


Good explanation of basic acoustic principles for the designer.

ENG INST, Useful


ENG. INST, Useful


ENG INST, Useful


ENG INST, Useful


Mufflers and acoustic treatments for boats.

ENG INST, Useful


Sorel, R.T., "NOISE AND VIBRATION: ITS PREVENTION AND CURE," The Planimeter, November 1956, SSCD.


A practical discussion of the mechanics of installing engines in wood boats.

Krogstad, W., "AUTOMATED CONTROLS FOR THE LARGE MARINE DIESEL ENGINE", SNAME, Section Paper, Great Lakes and Great Rivers Section, 1963.


DRIVES, Useful

Budd, W.I.H., "MAIN REDUCTION GEARS FOR CONTRA-ROTATION" SNAME, Marine Technology, October 1969.

DRIVES, Background


DRIVES, Background


DRIVES, Background


DRIVES, Background


DRIVES, Background

POWER BOAT BIBLIOGRAPHY

Shafting, Gears, and Propellers (mechanical) 228


Spaetgens, T.W., "TORSIONAL VIBRATIONS. SOME ACTUAL MARINE PROBLEMS AND SOLUTIONS," Transactions, Institute of Marine Engineers, Canadian Division Supplement, No.11, March 1963.

Bremen, N.C., "HEAVY DUTY CHAIN DRIVES FOR MARINE PROPULSION", Proceedings ASME Oil and Gas Power Division, 1946.


Anonymous, "MARINE ENGINEERING INSTALLATION FACTS," A bulletin of Detroit Diesel Division General Motors Corp.


Excellent paper dealing with many subjects related to powering small craft and the rational selection of power plant and propulsion units. Results of experimental boat programs.


Collection of articles on boat electrical installations.


**PIPING, Useful**

Anonymous, "EDUCTOR DESIGN MANUAL", U.S. Navy Bureau of Ships, Index No. N.S. 662-078 NAVSEC.

**PIPING, Background**

Ammons, W.D., "MARINE AIR CONDITIONING, HEATING AND REFRIGERATION," The Planimeter, SSCD, Fall/66.

**PIPING**


**PIPING**


**PIPING**

Woodward, J.B., (University of Michigan) "HYDRAULICS FOR PIPING SYSTEM DESIGN", Unpublished notes.

**PIPING**