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RESEARCH MEMORANDUM

ADDITIONAL ABSTRACTS PERTAINING TO SEAPLANES

By

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SUMMARY

About 500 additional references pertaining to the hydrodynamic design of seaplanes have been compiled, and the information is presented in the form of abstracts classified under six main headings: GENERAL INFORMATION, HYDROSTATICS, HYDRODYNAMICS, AERODYNAMICS, OPERATION, and RESEARCH. The compilation is an extension of NACA RM No. L6I13, entitled "Abstracts Pertaining to Seaplanes," by Jerold M. Bidwell and Douglas A. King.

An author index and a subject index are included.

INTRODUCTION

A large volume of technical information pertaining to seaplanes has accumulated but exists, through the world, in scattered and fragmentary treatises. Part of the large number of references pertaining directly to the hydrodynamics of seaplanes, as well as indirectly to hydrodynamic design, has been abstracted, compiled, and presented in NACA RM No. L6I13, entitled "Abstracts Pertaining to Seaplanes," by Jerold M. Bidwell and Douglas A. King. These additional abstracts have been prepared or obtained and compiled in the same way so as to be useful to persons engaged in seaplane research and development.

The abstracts are not intended as substitutes for the original papers but serve only as condensations of the important points. It is believed, however, that in many cases the abstracts will contain sufficient information to obviate procurement of the original papers.

References used have been principally books, society journals, periodicals, American, British, and German published and unpublished reports, and reports made available by Boeing Aircraft Company, Consolidated Vultee Aircraft Corporation, The Glenn L. Martin Company, and Stevens Institute of Technology. Miscellaneous American, British, French, German, Russian, Swedish, Italian, Japanese, and Spanish books and papers have also been included.

Many abstracts were taken directly from summaries in the original papers. Abstracts were also taken from "Aero Digest," "Aeronautical Engineering Review," "Aircraft Engineering," "The Engineering Index," "Journal of the Aeronautical Sciences," "Journal of the Royal Aeronautical Society," and "Science Abstracts." Acknowledgment is made to James M. Benson, Calvin M. Class, and Ralph W. Krone for assisting the authors in the preparation of abstracts.

A large number of the abstracts have not been checked with the original papers but have been included because they offer some information which might be of interest. References that have not been checked are marked with an asterisk, and the source of the abstract is included just below the abstract. Some editing of the unchecked abstracts was performed when clarity could be improved without loss of accuracy.

METHOD OF PRESENTATION

Abstracts

The classification system for the abstracts has been made so general as to include any conceivable report that would pertain to the hydrodynamics of seaplanes. The headings have been arranged to permit the use of a number classification system if it is so desired at a later date.

The main headings have been designated as GENERAL INFORMATION, HYDROSTATICS, HYDRODYNAMICS, AERODYNAMICS, OPERATION, and RESEARCH. The GENERAL INFORMATION classification is concerned with bibliographical references and references in which the performance or geometrical characteristics of seaplanes are described or discussed in a very general way. References that deal with a seaplane at rest in the water are classified under HYDROSTATICS. HYDRODYNAMICS, which is the main subject under consideration, contains references that relate to the characteristics of a seaplane from rest to get-away. AERODYNAMICS includes information on the aerodynamic characteristics that directly or indirectly influence the design of the hydrodynamic surfaces. OPERATION contains those references in which the conditions under which seaplanes must operate are described. References that relate to the manner in which research is carried out and to the equipment used are classified under RESEARCH.

The complete classification used is as follows:

GENERAL INFORMATION
- General
- Design
- Descriptions
- Take-off
- Bibliographies

HYDROSTATICS
- General
- Buoyancy
- Stability

HYDRODYNAMICS
- General
- Hydrodynamic sustentation
  - Planing surface
    - Steady condition
    - Unsteady condition
  - Hydrofoil
- Forces and moments on hulls and floats
  - Longitudinal forces and moments
    - Steady condition
      - Resistance
      - Lift
      - Moment
    - Unsteady condition
      - Resistance
      - Lift
      - Moment
  - Lateral forces and moments
    - Steady condition
      - Side force
      - Heeling moment
      - Yawing moment
    - Unsteady condition
      - Side force
      - Heeling moment
      - Yawing moment
  - Pressure distributions
- Spray and wake
- Stability under way
  - Longitudinal stability
    - Low-angle stability
    - High-angle stability
    - Stability characteristics
  - Lateral stability
    - Heel stability
    - Directional stability

AERODYNAMICS
General
Propulsive arrangements
Forces and moments on hulls and floats

OPERATION
General
Piloting
Seaplane bases
Seaways

RESEARCH
General
Equipment
Technique

The abstracts are arranged alphabetically by title under the headings and are numbered consecutively. To facilitate cross referencing, the abstract numbers are a continuation of those in NACA RM No. L6I13, which ran from 1 to 401. Abstracts 402 to 914 are presented in this report. At the end of each group of abstracts, reference is made to other abstracts which contain, in part, information of interest on the same subject. Where two or more reports contain similar analyses of the same data, the abstracts are grouped together under the same abstract number with successive abstracts taking letter suffices. The most complete or the most generally available report is listed first.

Abstractors' notes are enclosed by brackets.

Author Index

In hydrodynamics, as in other fields of research, the names of the authors are very useful in locating information of a type for which an author is well known. The names of the authors of the papers given are therefore indexed alphabetically. After the name of each author, a list of abstract numbers is given indicating the reports of which he was author or coauthor.

Subject Index

The subject index is intended to meet the needs of persons interested in the specific details of the hydrodynamics of seaplanes. Research and design parameters, auxiliary devices, specific functional parameters, and seaplane designations are listed. The subject index is not intended to be complete but includes the factors that appear to be of most interest to seaplane specialists.

LIST OF ABBREVIATIONS

The following abbreviations are used in denoting the type and source of the papers which have been abstracted, or the source of the abstract:

ACA	Advisory Committee for Aeronautics
ACR	Advance Confidential Report
ADR	Aviation Design Research
Aero. Eng. Rev.	Aeronautical Engineering Review
Aero. Res. Inst., Tokyo Imperial Univ.	Aeronautical Research Institute, Tokyo Imperial University
Airc. Eng.	Aircraft Engineering
ARC	Aeronautical Research Committee
ARR	Advance Restricted Report
BAC	Boeing Aircraft Company
Bull. Tech. du Bureau Veritas	Bulletin Technique du Bureau Veritas
Bur. Aero.	Bureau of Aeronautics, Navy Department
Bur. Ships	Bureau of Ships, Navy Department
CAA	Civil Aeronautics Administration
CAC	Consolidated Aircraft Corporation
CAHI	Central Aero-Hydrodynamical Institute (Moscow)
Canadian Jour. Res.	Canadian Journal of Research
Comptes Rendus	Comptes Rendus des Séances de l'Académie des Sciences
CVAC	Consolidated Vultee Aircraft Corporation
Dept. Comm.	Department of Commerce
DTMB	David Taylor Model Basin
DVL	Deutsche Versuchsanstalt für Luftfahrtforschung
Edo	Edo Aircraft Corporation
Eng. Abstr.	Engineering Abstracts
Eng. Ind.	The Engineering Index
Eng. Rep.	Engineering Report

FB	Forschungsbericht
Forsch. auf dem Geb. des Ingenieurw.	Forschung auf dem Gebiete des Ingenieurwesens
GLM	The Glenn L. Martin Company
Illustr. Flugwoche	Illustrierte Flugwoche
Ing.-Archiv	Ingenieur-Archiv
Ing. Vet. Akad. Handl.	Ingeniors Vetenskap Akademien, Handlingar
Inst. Aérotech. de St. Cyr	Institut Aérotechnique de St. Cyr
Inst. für Seeflugw. der DVL	Institut für Seeflugwesen der Deutsche Versuchsanstalt für Luftfahrtforschung
Inst. Nav. Arch.	Institution of Naval Architects
Int. Cong. Appl. Mech.	International Congress for Applied Mechanics
Izv. Akad. Nauk SSSR	Izvestia Akademii Nauk SSSR
Jahrb. der deutschen Luftfahrtforschung	Jahrbuch der deutschen Luftfahrtforschung
Jahrb. der Schiffbautech.	Jahrbuch der Schiffbautechnik
Jour. Aero. Sci.	Journal of the Aeronautical Sciences
Jour. Am. Soc. Nav. Engrs.	American Society of Naval Engineers, Journal
Jour. Inst. Aero. Engineers	Journal of the Institution of Aeronautical Engineers
Jour. Oceanogr.	Journal of Oceanography (Japan)
Jour. R.A.S.	Journal of the Royal Aeronautical Society
Jour. Soc. Nav. Arch. Japan	Journal of the Society of Naval Architects of Japan
KB	Kurzbericht (probable)
Lab. Aero. R. Politec. Torino	Laboratorio di Aeronautica Reale Politechnico di Torino
M.A.E.E.	Marine Aircraft Experimental Establishment
Min. Airc. Prod.	Ministry of Aircraft Production
MR	Memorandum Report
NACA	National Advisory Committee for Aeronautics

PB	Prufungsbericht
Proc. Cambridge Phil. Soc.	Cambridge Philoscophical Society, Proceedings
Proc. Roy. Soc. (London)	Royal Society of London, Proceedings
R. & M.	Reports and Memoranda
R.A.E.	Royal Aircraft Establishment
RB	Restricted Bulletin
Rep.	Report
SAE Jour.	Society of Automotive Engineers, Journal
Sci. Abstr.	Science Abstracts, Section A, Physics
SIT	Stevens Institute of Technology
Soc. Nav. Arch. and Mar. Eng.	Society of Naval Architects and Marine Engineers
Tech. Ber.	Technische Berichte
Tech. Data Digest	Technical Data Digest
Tech. Vosdushnogo Flota	Technika Vosdushnogo Flota
TM	Technical Memorandum
TN	Technical Note
Trans. Inst. Engrs. and Shipbuilders in Scotland	Institution of Engineers and Shipbuilders in Scotland, Transactions
Trans. N. E. Coast Inst. Engrs. and Shipbuilders	North-East Coast Institution of Engineers and Shipbuilders, Transactions
Trans. Sci. Tech. Soc. Shipbldg. and Engrg. (Russia)	Transactions of the Scientific and Technical Society of Shipbuilding and Engineering (Russia)
UM	Untersuchungen und Mitteilungen
USEMB	United States Experimental Model Basin
W.R.H.	Werft-Reederei-Hafen
Z.f.a.M.M.	Zeitschrift für angewandte Mathematik und Mechanik
Z.F.M.	Zeitschrift für Flugtechnik und Motorluftschiffart
Z.V.D.I.	Zeitschirift des Vereines deutscher Ingenieure
Z.W.B.	Zentrale für wissenschaftliches Berichtwesen über Luftfahrtforschung

ABSTRACTS

GENERAL INFORMATION
General

402. Warner, Edward P.: A. S. M. E. Seaplane Meeting at Cleveland. Aviation, vol. 27, no. 11, Sept. 1929, pp. 571-573.

Review of Aeronautical meeting of ASME in Cleveland with abstracts of papers presented: uses of seaplanes and conditions governing their design and construction. T. P. Wright and G. A. Luburg; possibilities in use of hydrovanes or separate planing surfaces below hull of seaplane; problem of design treated by A. Rohrbach with more technical detail; advantages of amphibian gear for commercial use; catapulting aircraft, W. M. Fellers; float design, H. C. Richardson. Eng. Ind., 1929, p. 1645.

403. Anon.: The Case for the Flying Boat. Flight, Nov. 25, 1943, pp. 582-585, 595.

The advantages offered by the use of flying boats for long-range commercial operation are enumerated. The take-off run, hull-size, drag, wing loading, structural weight, and hull pressurizing are discussed to show in what respects the flying boat is or can be made superior to the landplane. A floating dock which would facilitate handling is described. Summer and winter flying-boat operation is mentioned and recommendations for flying-boat development are outlined. A number of sketches, tables, and curves are included.

403a. Pollitt, C. A. H.: 'Where Angels Fear -'. Flight, Dec. 16, 1943, pp. 661-662.

The article described in abstract 403 is challenged and the question of whether there will really be a place for the flying boat in the post-war era is asked. An example is given to show that landplane service would be more convenient and would waste less time than an equivalent flying-boat-landplane-feeder service. Structural weight is reexamined and it is stated that the ton mileage loss of payload due to sacrificing internal space to an arrangement of steps and chines may be sufficient to turn the scales in favor of the landplane. The use of different propulsive arrangements was shown to influence the design of the floating dock (abstract 403). British flying-boat designs, it is declared, are inferior to American designs only in quantity and not in a technical sense.

[redacted]

GENERAL INFORMATION
General

403b. Knowler, Henry: The Case for the Flying Boat. Flight, Jan. 6, 1944, p. 19.

The questions raised in abstract 403a about the use of flying boats in the post-war era (abstract 403) are answered. Because the proposed main routes are planned for stages ranging from 1300 to 3500 miles, point to point, important main bases will be relatively few in number. Location of flying-boat bases need not be any further from large cities than main landplane bases. As the flying boats mentioned in abstract 403 are intended to operate at a height of 20,000 feet, neither the rectangular fuselage nor the conventional hull may be used but a circular section with a hull bottom can be employed. It is agreed that maintenance and handling problems are the most formidable in the use of flying boats.

403c. Kemp, W. P.: The Future of the Flying Boat. Flight, Jan. 27, 1944, pp. 100-102.

The point in abstract 403a concerning flying-boat bases is challenged. Maps of North America, South America, Africa, and India are given to illustrate the vast potentialities for flying-boat bases near the largest trade cities of the world. It is believed that shipping companies will be the likely operators of flying-boat lines in the future.

*403d. Pollitt, C. A. H.: The Flying Boat. Flight, Feb. 24, 1944, pp. 196-198.

Previous observations (abstract 403a) as to superiority of the landplane over the seaplane are enlarged upon and arguments (abstract 403b) offered in favor of seaplanes are answered. The objections are mainly concerned with problems of loading, lateral stability, forced landings, and costs of construction of bases.

Aero. Eng. Rev., May 1944, p. 77.

*403e. Kemp, W. P.: The Flying Boat. Flight, March 30, 1944, pp. 340a, 340b.

The merits of the flying boat are compared with those of the landplane. The flying boat is favored and criticisms made in a preceding article (abstract 403d) are answered. Questions of forced landings, freight loading, lateral stability, and relative efficiency are discussed.

Aero. Eng. Rev., June 1944, p. 77

404. Baker, Donald L., and Driggs, Ivan H.: A Comparative Study of Landplanes and Flying Boats as Long Range Bombers. ADR Rep. No. R-17, Bur. Aero., June 14, 1943.

A statistical and theoretical analysis of weight and aerodynamic performance data of existing and hypothetical long-range bombers is made to evaluate the reasons underlying the apparent disparity in performance between flying boats and landplanes. It is concluded that large flying boats (gross weights greater than 150,000 pounds) will have equal or greater range than corresponding landplanes, but less speed and rate of climb. Reasons for the differences in performance between flying boats and landplanes are: the tendency to design flying boats with greater power loading and less wing loading than landplanes; and a disregard of the correct relationship between beam loading, power loading, and wing loading. The ratios of hull or fuselage wetted area to wing area, and of parasite drag area to hull or fuselage wetted area, are greater for flying boats than for landplanes.

405. Rennie, J. D.: A Comparison of Operating Costs. The Aeroplane, vol. LXIX, no. 1782, July 20, 1945, pp. 70-71.

Costs of operating the Blackburn B-49A, a 310,000-pound flying boat equipped with turbine-driven propellers, are compared with operating costs for the Douglas DC-4, Douglas DC-7, and a proposed Pan American transport airplane designated the "Type 10." For comparison, operating costs are also computed for the B-49A with reciprocating engines, and for a landplane of the same gross weight and design with turbines and reciprocating engines. Total direct flying costs are listed under the groupings of fuel and oil; depreciation of airframe and engines; maintenance of airframe and engines, and servicing costs; crew pay and expenses; public liability and accident insurance; and loss on investment.

It is concluded that there is a reduction in operating costs per ton-mile with increase in gross weight, a slight reduction in favor of a flying boat as compared with a corresponding landplane,

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General

and a considerable reduction in favor of propellers driven by turbines as compared with propellers driven by reciprocating engines. The difference in operating costs between landplanes and flying boats increases with increasing range. The structural weight of the B-49A would be about 11,800 pounds less than that of a landplane of the same gross weight and design.

*406. LePage, W. L.: The Development of the Amphibian Airplane. Aviation, vol. 22, no. 17, April 1927, pp. 828-832.

Earliest designers endeavored to develop amphibious aircraft resulting in poor conversions; Loening production shows pioneer development from first principle.

Eng. Ind., 1927, p. 17

*407. Rennie, J. D.: The Development of the Long-Range Flying Boat. Flight, vol. XXIII, no. 1167, May 8, 1931, pp. 413-416; and no. 1168, May 15, 1931, pp. 434-437.

The broad outlines of the subject of long-range flying boats are discussed from the point of view of airworthiness, seaworthiness, and ton-mile performance. The majority of British flying boats are designed as a compromise between these qualities, and it is considered that air performance might well be sacrificed to give real seaworthiness of an altogether higher standard that would render disaster after a forced landing improbable.

Take-off performance, economical speed, and fuel consumption are discussed qualitatively by means of charts, with gross weights ranging from 40,000 to 90,000 pounds. The curve of fuel disposition ranges from 20,000 to 30,000 pounds total weight.

Jour. R.A.S., Aug. 1931, p. 744

*408. Maycock, R. B.: The Employment of Flying-Boats. The Aeroplane, vol. XXXV, no. 24, Dec. 12, 1928, p. 944.

Employment and development of flying boats are discussed; brief history given; relative performance figures for F 5 of 1916 and Southampton of 1925; seaworthiness of modern flying boat; bases and supplies; working flying-boat units in RAF; important part in future civil aviation; in discussion, military and naval value of flying boat taken up. Abstract of paper presented before Royal United Service Inst. Eng. Ind., 1928, p. 1659

409. de Pinedo, Marchese: A Flight of 33,000 Miles. Jour. R.A.S., vol. XXX, no. 189, Sept. 1926, pp. 507-518.

A qualitative comparison is made between landplanes and seaplanes on the basis of: proximity of landing places to the centers of large towns; initial and operating costs of regular and emergency landing places; disposition of emergency landing places; and ease and safety of making emergency landings. It is considered that the difficulties which beset the landplane in these matters would be absent for seaplanes because large towns are located either on the seacoast or on large rivers or waterways that form natural landing places for seaplanes and interconnect the towns. A forced landing of a seaplane, either on land or on water, is considered to be less dangerous than a forced landing of a landplane.

A description is given of a trip made by the author in a seaplane from Rome to Melbourne via Bagdad, Bombay, Rangoon, the Netherlands Indies, and the west coast of Australia, from Melbourne to Tokyo via New Guinea, the Philippine Islands, and Shanghai, and return from Tokyo to Rome via Hong Kong, Bangkok, Calcutta, Delhi, and Bagdad. The total length of the flight was 33,000 miles, of which 24,000 miles were along the coast or in sight of land, 5000 miles were over open sea, and 4000 miles over dry land. The seaplane had a maximum range of about 800 miles, a useful load of about 1 ton, and was fitted with a set of sails for emergency sailing on the sea.

*410. Fry, H. L.: The Flying-Boat and the Future. Aeronautics, July 1945, pp. 42-47.

The suitability of flying boats for postwar transport is discussed by a flying-boat captain. The advantages of certain types of flying boat for these tasks are pointed out and the continued operation of flying boats on some important routes is urged.

Aero. Eng. Rev., Sept. 1945, p. 63

GENERAL INFORMATION
General

411. Nicolson, David: Flying Boat Construction. The Aëronautical Journal, vol. XXV, no. 128, Aug. 1921, pp. 385-412.

The construction of wooden flying-boat hulls is discussed from the point of view of a naval architect. Details of the F.3, F.5, P.5, N.4 Atalanta, N.4 Titania, and Supermarine four-seater are discussed as examples. The laying out of full-size lines in a mold loft is important. The discussion following the paper dealt mainly with bulkheads.

412. Schildhauer, C. H.: Flying Boats. Aero. Eng. Rev., vol. 5, no. 3, March 1946, pp. 5-9, 109.

The advantages of the flying boat over the landplane have become controversial. The establishment of a firm program for the development of long-range patrol planes and long-range, high-altitude bombers for military operations is advocated, based upon the usefulness of flying boats in the past war. Increased efficiency in this respect can be obtained by higher wing loadings, reserving the present low wing loading for aircraft in rescue operations on the high seas, a necessary type of military operation with flying boats. New power plants embodying the gas-turbine principle can be equally efficient used on flying boats or landplanes.

The development of the commercial transport flying boat will take advantage of higher wing loadings, new power plants, and increased handling efficiency with increased size. This development will produce a low cost form of transportation due to the increase in useful load of the large flying boats, particularly those in the vicinity of 400,000 to 500,000 pounds gross weight. The international air-transport industry must realize that it is not speed that is essential - it is low cost transportation. The potentialities of the flying boat conclusively tend toward satisfactory rapid air transportation on long flights at a cost under that of the landplane. To meet foreign competition, use of both landplanes and flying ships is essential, and the military and commercial future of our country must not neglect their parallel further development.

413. Gouge, A.: Flying-Boats and Their Possible Developments. Trans. N. E. Coast Inst. Eng. and Shipbuilders, vol. LI, 1934-35, pp. 277-302. Reprinted in Jour. R.A.S. vol. XXXIX, no. 296, Aug. 1935, pp. 691-713.

The growth of flying boats and seaplanes from their inception in 1910 to the present day is discussed briefly. The resistance characteristics and means for lateral stabilization of flying boats are discussed, and typical curves of trim and resistance plotted against speed and of trimming moment and resistance plotted against trim are given. The progress which has been made with regard to engines is described and the relative advantages of compression-ignition and of spark-ignition engines are compared. It is considered that a flying boat having a gross weight of 300,000 pounds would have weight empty of 182,000 pounds, a total power of 24,000 brake horsepower, and, with a payload of 50,000 pounds, would have a range of 1600 miles at a cruising speed of about 165 knots.

414. Gaudillere: Hydravions coloniaux. (Colonial Seaplanes.) Revue de l'Armee de l'Air, June 1937, pp. 629-646.

Advantages of using seaplanes in defense of colonies are discussed, covering: numerous lakes and rivers available for alighting; missions of exploration, observation, cooperation with ground troops, heavy and light defense, and transportation; design requirements for such seaplanes; and types of bases needed.

*415. Martin, Glenn L.: I Prefer Flying Boats. Skyways, April 1943, pp. 12-15, 40.

The advantages of flying boats compared with land-base planes are analyzed. Flying boats are found to be more efficient and safe and to possess a larger average disposable-load proportion than large landplanes. The use of flying boats eliminates the necessity for vulnerable airports and presents greater flexibility in landing and refueling possibilities. Common objections to flying boats are answered with respect to operations under icy conditions, comparable speeds, costs and weights, size limitation, passenger rates and operation costs, safety, and comfort. The Martin Mars is given as an example of a successful flying boat.

Great value is seen in the towplane-glider combination.

Aero. Eng. Rev., May 1943, p. 51

[redacted]

GENERAL INFORMATION
General

*416. Ley, Willy: Landing Puddles or Airports. Air News, June 1944, pp. 18-19.

After a brief comparison of the flying-boat and land-based airplane on points of serviceability, efficiency, production, and safety, it is indicated that the flying boat is more suitable under certain conditions and has an added advantage in the type of landing site it requires. Construction and maintenance costs of marine sites are claimed to be cheaper than those of airports and the number of marine sites available in the United States is shown to be large. The water bases are indicated to be as desirable for private airplanes as for large transports, the pontoon-equipped Fairchild is cited as an example. The opinion is offered that flying boats, even at a size still inferior to comparable landplanes on a weight basis, are more versatile than the landplanes because of the availability and cheapness of water bases.

Aero. Eng. Rev., July 1944, p. 43

*417. Raymond, A. E.: Landplanes or Flying Boats. Skyways, Dec. 1943, pp. 27 and 76.

The advantages of landplanes over flying boats for overseas transportation are cited. After considerable study and experience in building both types of planes, it is the opinion of the Douglas Company that, except in certain special operations, landplanes provide by far the better answer to the transoceanic problem. Some reasons for advocating the landplane are: Landplanes do not necessitate auxiliary transportation services for cargo destined for inland cities; with the multiengined aircraft of today, there is little need for landing during overseas flight and in the case of emergency landings, the seaplane is claimed to have no better chance than the landplane (particularly if the latter is low-winged and properly designed for flotation); the cleaner aerodynamic shape of the landplane fuselage yields increased speed and range for a given fuel load; the development of pressure-cabin airplanes for flight at high altitudes results in less increase in structural weight for the landplane with its round fuselage than for the flying boat with its flat sides and bottom elements; the sealing of the landplane fuselage to make it airtight also makes it watertight; the constant presence of salt water in the case of the flying boat tends to promote corrosion and increase the amount of maintenance required; maintenance work for the flying boat, whether done ashore or afloat is usually more difficult or more costly, flying-boat schedules are liable to be disrupted because of river and harbor ice, and adverse conditions are apt to be less of a menace on ground fields than on seaplane bases.

Aero. Eng. Rev., Jan. 1944, p. 65

418. Hall, Theodore P.: Landplanes or Flying Boats for Cargo? Flying, March 1943, pp. 20, 21, 124.

The practical advantages of landplanes and flying boats for cargo purposes are compared, with the conclusion offered that each is expedient for different tasks and that operational circumstances should govern the choice. In a situation where great speed is essential and where suitable airports are available, the landplane is recommended. Where high speed is not essential and where there are no suitable airports, the flying boat is favored. Among the factors to be considered in making a choice are economical construction, running expenses, terrain, and weather.

419. Rohrbach: Large All-Metal Seaplanes. Jour. R. A. S., vol. XXVIII, no. 168, Dec. 1924, pp. 655-672. Discussion pp. 672-675.

Metal seaplanes are less affected by seawater and climatic conditions, and have less structural weight than wooden seaplanes. Furthermore, the weight of wooden seaplanes is often increased by water soaking into the wood. The most outstanding advantage of a large seaplane over a small one is its increased seaworthiness. Increasing the wing loading as the gross weight is increased is shown to result in increased payload, cruising speed, landing and take-off speed, maneuverability, and in decreased cost. A description and several photographs of the Rohrbach Ro II flying boat are given. The hull is very narrow and lateral stability is obtained by two large auxiliary floats near the hull. (See also abstract 39.)

420. Rennie, J. D.: The Merchant Flying Ship. Flight, vol. XLVIII, no. 1906, July 5, 1945, pp. 7-9.

The effects of size and gross weight of landplanes and flying boats on aerodynamic efficiency and landing-gear problems, landing facilities, costs, and insurance are discussed. It is deduced that, for large aircraft (gross weight more than 100 tons):

GENERAL INFORMATION
General

(1) The operational efficiency, expressed in ton-miles per gallon of fuel, is higher for the flying boat than for the corresponding landplane.

(2) Landing-gear problems alone may conceivably set a lower limit to the size of the landplane as compared with the flying boat.

(3) The prototype design and development period is less for the flying boat than for the landplane.

*421. Lufft, H.: The Military and Political Considerations which Led to the Choice of the Flying Boat for British Empire Communications. Luftwehr, vol. 5, no. 8, Aug. 1938, p. 313.

The choice of the flying boat instead of the landplane appears to be mainly due to the following factors:

(1) Land aerodromes are difficult to defend against attack, especially sabotage by natives. A harbor is easily patrolled by ships.

(2) The landing surface on the ground may be effected by weather or enemy action. This does not apply to landing on a water surface.

(3) Overland routes require a considerable ground organization which is not only expensive but also vulnerable to enemy action. For this reason the Cape-Cairo route has now been shifted from the direct central African position to the east coast.

It appears that the object throughout has been to link the command of the sea by surface ships to the problem of Empire communication by air.

Jour. R.A.S., April 1939, p. 310

422. Richardson, Holden C.: Naval Development of Floats for Aircraft. Engineering, vol. CXXII, no. 3177, Dec. 3, 1926, pp. 705-708. Abridged from paper for meeting of Soc. Nav. Arch. and Mar. Eng., Nov. 11 and 12, 1926.

Progress in the design of flying-boat hulls and seaplane floats in the United States is discussed and it is stated that interest of the Navy and the use of tank tests of models have contributed largely to the success which has been attained. The limitations of model tests and results of typical tests are discussed.

*423. Travers, C. T.: Neglected Weapons? Canadian Aviation, Oct. 1942, pp. 39-40.

A proposal is made that the skiplane and seaplane be more fully developed for military purposes. These planes are not inherently slow and heavy and it is asserted that both types can be produced to give performance suitable for air-force requirements. The advantages of lakes and rivers as natural airports, particularly in the case of Canada, are pointed out. It is also demonstrated that the uses of skiplanes and seaplanes are not localized but can be applied in many areas.

Aero. Eng. Rev., Dec. 1942, p. 49

424. Loening, Grover: 1943 Report on Cargo Aircraft to Donald M. Nelson, Chairman, War Production Board. July 30, 1943.

A comparison is made of a number of cargo airplanes used for commercial and military purposes. Comparisons are made on the bases of fuel efficiency, cargo efficiency, manpower efficiency, production efficiency, range, speed, and maintenance and operational costs. The use of these cargo airplanes by the Air Transport Command, Troop Carrier Command, the Naval Air Transport Service, and the Commercial Airlines is discussed and general statistics are given.

It is found that the two large flying boats, the Mars and the HK-1, are much superior to any of the landplanes as cargo carriers and because of the numerous inaccessible places in Europe and in the South Pacific, flying boats could be used without the elaborate landing fields required for landplanes.

A decrease in the production of C-76's and C-47's and a large increase in the production of C-54-A's and Mars is recommended. As military needs become satisfied, it is also recommended that more cargo airplanes be put into commercial use.

*425. Hunsaker, J. C.: Notes on Seaplane Design. Jour. Inst. Aero. Eng., vol. 1, no. 9, Sept. 1927, pp. 29-31.

As results of author's experiences, original single-float type with improved wing-tip floats has been found more rugged than twin-float

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type for use in flying school, gives better protection to propeller from spray, is cheaper in first cost and maintenance, and is more suitable for catapulting; it is not suitable for high-powered seaplanes of short span; twin-float typo has been found suitable for high-powered machines, for torpedo carrying, and for rough sea work; small flying boat has been found dangerous for school work as compared with tractor type on floats; flying-boat type is necessary for very large machines when twin-float design becomes structurally weak and heavy.

Eng. Ind., 1927, p. 727

*426. McCarty, L. C., Jr.: Ocean Air Transportation. SAE Jour., vol. 40, no. 5, May 1937, pp. 13-17.

Cruising speeds will increase greatly, with 300 to 325 miles per hour as a perfectly feasible limit in the not too distant future, and with 200 to 250 miles per hour as an economic operating speed in the more immediate future. The trend in establishing the limitation of landing speed for the larger transoceanic flying boats with reference to seaworthiness, general safety, and the burden upon piloting technique is indicated.

Important requirements for aircraft in regular transoceanic service, as determined by experience, characteristics, and performance of flying boats in the transoceanic service of various countries at the present time and near future, passenger comfort and accommodations, superiority of large flying boats over large landplanes, the safe limit for landing speeds, and the probability of forced landing due to mechanical failure of the power units are considered.

Progress to date in ocean flying, outstanding advantages of Baltimore as the American terminus for mail, passenger, and express air service to Europe, either direct or by way of Bermuda, and the North Atlantic routes are also discussed.

Jour. Aero. Sci., April 1937, p. 265

*427. Anon.: Seaplane? Landplane? Flying Boat? Which Will the Germans Use on Their Trans-Atlantic Service? Western Flying, Sept. 1938, pp. 9-11.

Survey flights that were made by Deutsche Lufthansa across the North Atlantic, in which seaplanes, landplanes, and flying boats were used, are discussed, and the German technique of catapulting large seaplanes and flying boats is described.

Jour. Aero. Sci., Nov. 1938, p. 38

428. Glubareff, Michael E.: Seaplane or Landplane for Transoceanic Service. Aviation, vol. 40, no. 3, March 1941, pp. 38, 39, 124, 126.

Large flying boats are compared with large land air transports for long distance overwater air service. It is believed that in sizes from 50 to 100 tons the flying boat would have equal cruising speed combined with greater pay load or longer range than a landplane of similar size and power. Design factors are offered to show that the pay load or range differential should be approximately 20 percent.

429. Van Dusen, C. A.: Seaplanes and National Defense. Consolidator, vol. 5, no. 12, Dec. 1940, pp. 12-13, 67.

The case for large flying boats as military bombers is presented. While there will always be landcraft for the Air Corps, landing fields for large bombers together with their maintenance and defense cost millions to provide. A map showing locations of water suitable for use by flying boats and seaplanes within the areas covered by aeronautical charts of the United States is presented. Water take-off and landing runways cannot be blown up and usually offer more area and fewer obstructions surrounding them. It is suggested that large troop-carrying flying boats would combine advantages of load, range, and wider choice of landing facilities.

*430. Post, George B.: Seaplanes on Land. Aviation, vol. 38, no. 1, Jan. 1939, pp. 28, 29, 84.

Some notes on landing of seaplanes on field surface with pontoons; properly executed landing results in no damage to seaplanes or pilot.

Eng. Ind., 1939, p. 1053

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*431. von Gronau, W. J.: Seeflugzeug und Schiff (Seaplane and Ship). Z.F.M., Jahrg. 22, Nr. 17, Sept. 14, 1931, pp. 519-524.

A discursive article on the role of the seaplane and marine transport, with a descriptive account of the qualities desired and the conditions to be met.

Jour. R.A.S., April 1932, p. 341

432. Watter, Michael: Some Aspects and Possibilities of Flying Boat Design. Aero. Digest, vol. 38, no. 2, Feb. 1941, pp. 125, 126, 129, 130, 133.

A discussion of the future of long-range flying-boat design indicates that the aerodynamic disparity in present-day flying boats and landplanes is an outcome of trends and not necessarily basic differences between the two types. Problems of beam loading, transverse stability, seaworthiness, handling facilities, and corrosion are discussed. The special considerations required by military seaplanes are also discussed. It is concluded that, although the present-day landplane is aerodynamically superior to existing flying boats, flying boats afford greater pay load with equal range or the same pay load with a greater range. It is stated that the present aerodynamic inferiority of flying boats is not due inherently to design limitations but to the fact that greater mechanical complications are accepted in a landplane design for the sake of aerodynamic refinement.

(See also abstracts 457 and 814.)

Design

*433. Bennett, D. C. T.: The Air Mariner: A Flying Boat Guide. Sir Isaac Pitman & Sons, Ltd. (London), 1943.

Information about the general design of flying boats, marine equipment and moorings, water handling and towing, the characteristics and operation of flying boats, and anchors and anchoring is offered. Definitions of the various parts of the flying boat and of terms comparable to those which describe parts of surface vessels are included. The technique of handling a flying boat on the water is similar to that of handling surface vessels of comparable size, and the ordinary rules of small-boat seamanship are applicable in many ways. Instructions for piloting flying boats are also offered.

Aero. Eng. Rev., Sept. 1944, p. 136

*434. Bellanca, Giuseppe M.: Amphibian Design and Transportation. SAE Jour., vol. XXVII, no. 4, Oct. 1930, pp. 462-464, discussion pp. 464-465.

Difficulties of combining landplane and seaplane; landing gear weighs from 5 to 7 percent of gross weight or 30 percent of pay load, and, if exposed, reduces speed 6 percent; retractable-wheel problem.

Eng. Ind., 1930, p. 68

435. De Cenzo, Herbert A.: Analysis of the Possibilities Presented by Hydrofoil-Equipped Aircraft. Aero Digest, vol. 45, no. 5, June 1, 1944, pp. 70-72, 128, 130.

Comparisons on the bases of weight and aerodynamic performance are made of a fighter airplane of the landplane, hydrofoil-equipped, and float seaplane types, and of large two- and four-engined airplanes of the all-wing landplane, all-wing hydrofoil-equipped, and conventional flying-boat types. It is shown that a hydrofoil-equipped airplane has better performance (maximum speed and rate of climb) than a float seaplane or a flying boat and has slightly poorer performance than a landplane. Factors requiring consideration in the design of a fighter airplane equipped with hydrofoils for taking off from and landing on water are discussed. A design is given for an airplane which is similar to a racing airplane described in abstract 33. Jet propulsion is proposed for hydrofoil-equipped aircraft.

*436. Pabst: Bericht über einen neuen Entwurf von Lastannahmen von Schwimmwerken (New Set of Load Assumptions for Floats). FB No. 63, Z.W.B.

The new set of load assumptions is based on the research of recent years. In contrast to the older assumptions, it takes into

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account the width, the speed, the keel arrangement, the dimensions, reduction of weight, and other factors corresponding to the actual conditions. The new assumptions made possible a better utilization of the material than did the old assumptions. As a check, stress measurements on actual aircraft are compared with the analytical study.

Author

*437. Parkinson, H.: Changing Over to "Boots." The Aircraft Engineer, no. 153 (vol. XVI, no. 10), supp. to Flight, vol. XXXV, no. 1556, Oct. 20, 1938, pp. 65-68.

Conversion of landplane to seaplane is discussed with formulas calculating float shape, position of water line and center of buoyancy, setting of floats relative to the aircraft, propeller-water clearance, metacentric heights, track of floats, float weights and center-of-gravity position, center of gravity of the complete airplane, aerodynamic resistance of floats, hydrodynamic data, and design of rudder. Data are applied to an analysis of a 4000-pound seaplane.

Jour. Aero. Sci., Dec. 1938, p. 77

*438. Anon.: Les coques d'hydravions (The Hulls of Flying Boats). Bull. Tech. du Bureau Veritas, vol. 6, no. 5, May 1924, pp. 81-86.

Discusses stresses in hulls and floats and experimental results; types of hulls; review of developments during past 12 years.

Eng. Ind., 1924, p. 298

*439. Gouge, A.: Design and Construction of Flying Boats. Instn. Engrs. and Shipbldrs. in Scotland - Trans. vol. 74, 1930-1931, pp. 526-566 and (discussion) 566-574.

Progress with design and operation of big flying boats; model test methods and interpretation of results; resistance curves, performance curves and other characteristics illustrated by graphs. (See also Flight, vol. 23, nos. 3 and 4, Jan. 16, 1931, pp. 59-64 and Jan. 23, pp. 83 and (discussion) 83-86 and the Aeroplane, vol. 40, nos. 2 and 3, Jan. 14, 1931, pp. 71-72, 74, 76, and Jan. 21, pp. 113-114.)

Eng. Ind., 1931, p. 1265

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440. Burke, Walter F.: Design Information on Seawings. Eng. Rep. No. 1429, GLM, Mar. 31, 1941.

Factors to be considered in the design of seawings [stub-wing lateral stabilizers] are listed. Notes based on available information are given on the choice of section profile, plan form, and location. Seawings and wing-tip floats are compared with respect to their relative effects on the water and air performances of a flying boat. Some information is given on the structural loads on seawings.

*441. Richardson, H. C.: Design of a Large Flying Boat. Soc. Nav. Arch. and Mar. Eng., advance paper for meeting Nov. 15-16, 1928.

Determining form and loading conditions in large flying boat being constructed for Navy Department by Consolidated Aircraft Corporation; all-metal twin-engined triple-float patrol monoplane; first instance of aircraft contractor to Navy Department going deeply into stress analysis using methods of naval architect; important effects on hull design of take-off, landing and flying conditions, beaching and hoisting, not met with in surface type hulls.

Eng. Ind., 1928, p. 1658

442. Lucking, D. F.: The Design of Marine Aircraft in Relation to Seaworthiness. Jour. R.A.S., vol. XXVII, no. 155, Nov. 1923, pp. 535-551.

Some general characteristics of marine aircraft, such as position of the thrust line, center of gravity, wings, and tail, wing-tip floats, hull form, and the like, are discussed from the point of view of their effects on seaworthiness. Specific characteristics and problems of several twin-float seaplanes, single-float seaplanes, and single-engined, twin-engined, and multiengined flying boats are discussed. Hydrofoils and some points to be considered in detail design are discussed briefly.

*443. Anon.: Elements of Flying Boat Design. The Aeroplane, vol. LXV, no. 1697, Dec. 3, 1943, pp. 642-645.

The fundamental principles of flying-boat design are briefly surveyed. Features of types manufactured by the British, Americans,

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Germans, Russians, and Japanese are examined. A table of particulars on flying boats of various nations is included, listing the type, span, length, wing area, total power, empty weight, loaded weight, wing loading, power loading, and maximum and cruising speeds.

Aero. Eng. Rev., March 1944, p. 81

*444. Carter, W. G.: Flying Boat Development for Speed Research. The Aircraft Engineer, supp. to Flight, vol. 22, no. 39, Sept. 26, 1930, pp. 1068-1079.

Comparison of tentative design and performance of racing seaplanes equipped with floats, hull with stub wings, and hull with wing floats; wing area, 240 square feet; power-weight ratio, 2.05 pounds per brake horsepower; thrust horsepower, 3300; drag, 75.5 pounds; with two Rolls Royce engines of 4000 horsepower maximum speed is estimated at 425 miles per hour.

Eng. Ind., 1930, p. 1575

*445. Lanchester, F. W.: Flying-Boat Entrance Lines. Engineering, Sept. 15, 1939, pp. 298-299.

The punt-like entrance line is taken merely as a basis for the discussion of the design of the entrance lines of a flying-boat hull. It is shown that there is no objection to the horizontal lines being drawn as easy as the designer wishes, as in the lines of an ordinary boat or sea-going vessel, but all vertical section lines must comply with the conditions laid down. A hull is represented diagrammatically in side elevation and it is shown that when the hull encounters a steep wave front, the reaction is at right angles to the entrance line. If the entrance line has too great an inclination, the wave tends unduly to throw up the nose of the boat and to cause it to porpoise, and in its subsequent descent the boat may strike the water at a dangerous angle. The surface of another boat shown is more nearly vertical so that all forces acting on the surface pass near the center of gravity.

Jour. Aero. Sci., Nov. 1939, p. 33

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*446. Sizer, John A.: Flying Boat Project. Flight, vol. XLI, no. 1746, June 11, 1942, pp. 594-597.

With given specifications, the procedure to be adopted in roughing out a required flying-boat design is outlined. The specifications followed are: (1) gross weight not more than 10,000 pounds; (2) no slots or flaps to be fitted; (3) landing speed not be exceed 60 miles per hour; (4) crew to consist of pilot, observer, radio operator, engineer; (5) top speed not less than 150 miles per hour at sea level; (6) rate of climb at sea level not less than 800 feet per minute; (7) endurance not less than 6 hours at full load and at 75 percent of full throttle; (8) any engine or engines may be used. The procedure is separated into details on the wing, aspect ratio, taper ratio, wing section, the hull, steps, main step and center-of-gravity relationship, the profile and forebody length, distance between steps, and general outline. The hull cross section, control surface areas, tail unit, engines, lateral stability, float attachment, weight estimate, the center of gravity, and load waterline are also considered.

Aero. Eng. Rev., Aug. 1942, p. 47

*447. Munro, W.: Hull Design of Flying Boats. The Aircraft Engineer, vol. XXIII, no. 22, supp. to Flight, May 29, 1931, pp. 33-36.

Type of hull most generally used in England and main reasons for v-shaped planing bottom and two transverse steps built of either duralumin or Alclad; master curve for planing bottom.

Eng. Ind., 1931, p. 1266

448. Cox, H. Roxbee, and Coombes, L. P.: The Hull-Less Flying Boat The Aeroplane, vol. LIII, no. 1384, Dec. 1, 1937, pp. 677-680.

Several hull-less designs of flying boats are proposed, including a flying wing, in which the hydrodynamic and flotation requirements would be incorporated as primary components of the wing. Preliminary results of tank tests and of structural studies are cited to support the belief that large seaplanes can be built in one of the proposed forms with considerable reduction in weight and in parasite drag compared with conventional flying boats and landplanes.

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449. Munro, William: Marine Aircraft Design. Sir Isaac Pitman & Sons, Ltd. (London), 1933.

An endeavor has been made to present simply and concisely the fundamental matter required for the practical design and construction of marine aircraft having gross weights up to about 25,000 pounds without overlapping existing textbooks on aeronautical engineering and airplane design.

Chapters are included on design of flying boats, hull design, strength of hulls, hull construction, lateral stability of flying boats and construction of wing-tip floats, wing design, take-off performance of flying boats, twin-float seaplanes, design of seaplane floats, construction of seaplane floats, stress analysis of seaplane float struts, and notes on general problems. Data sheets on weight and strength of structural members are included.

*450. Moffett, R. J.: Metal Hulls, Design and Construction. Engineering Journal, supp. to Jour. R.A.S., No. 2, Dec. 1931, pp. 24-30.

The design and methods of construction of metal hulls are described and are illustrated by photographs. In an appendix the Froude law of similarity is discussed and the calculation of the metacentric height is formulated.

Jour. R.A.S., Oct. 1932, p. 886

451. Hope, Linton: Notes on Flying-Boat Hulls. The Aeronautical Journal, vol. XXIV, no. 116, Aug. 1920, pp. 440-471, and vol. XXIV, no. 117, Sept. 1920, pp. 495-497.

The estimation of the dimensions and weight of a flying-boat hull is discussed, and data on the dimensions, weight, and construction of a number of hulls are given. An equation for the beam at the step as a function of gross weight, power, and angle of dead rise is given. The information on weight estimation is applicable to wooden hulls of the flexible or "Linton Hope" type of construction. The importance of making tank tests of a model to determine the resistance, stability, and spray characteristics of a hull design is pointed out. Data on the air drag of several hulls is given, and there is a short discussion of static strength tests of a hull. A hull with a hollow transverse section has lower spray and is more efficient than a hull with a straight transverse section, especially when the hollow is near the chine.

452. Hyatt, J. A., Baker, D. L., and Locke, F. W. S., Jr.: Patrol Boat Design Study. ADR Rep. No. R-41, Bur. Aero., 1944.

A study is made of the relative performance of two and four engine patrol seaplanes. Detailed studies of the wing and hull designs were made on the twin engine, 75,000-pound seaplane. The hull dimensions of the four-engine design, 105,000-pound seaplane, were raised by the cube root of the ratio of gross weights and the wing area by the ratio of gross weights. The effects of the hull-shape parameters on main spray, bow spray, skipping, porpoising, landing impact, directional stability, and resistance were evaluated.

453. Shonts, James G.: Production Float Design. Aero Digest, vol. 35, no. 3, Sept. 1939, pp. 42-43.

A design of aircraft float that could make use of modern production methods (utilization of the hydraulic press and drop hammer for 90 percent of major structural parts) is given. Basically, the float structure described consisted of two main watertight fore-and-aft strut attachment bulkheads, intermediate floor frames, side frames and crown arches, bow and stern frames, and the side and crown longerons. A typical transverse frame assembly incorporated a floor frame, side frame, and crown arch, these parts being formed as a single-stage stamping in the hydraulic press.

454. Berman, Sydney D.: Proposed Method for the Design of Bottom Plating for Flying Boat Hulls and Seaplane Floats. Jour. Aero. Sci., vol. 6, no. 2, Dec. 1938, pp. 64-67.

A lack of complete data for designing the bottom plating of flying-boat hulls and floats prompted an investigation of the subject of stresses in the plating due to the normal pressures incurred while taking off or landing. In this undertaking, use was made of an approximate method of determining the stresses in thin plates given by Timoshenko. Since the dimensional requirements for adequate strength obtained by the application of Timoshenko's method are in close agreement with successful practice, the resulting design information should be useful. [A case intermediate between simply-supported edges and clamped edges is offered.]

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455. Flight Research Loads Section: Proposed Specification for the Structural Loading of Floats and Hulls. NACA MR, Bur. Aero. and CAA, Feb. 12, 1943.

Requirements for the structural loading of floats and hulls are proposed to improve the present design requirements, certain aspects of which are shown to be erroneous. Parts of the theory that had been found to be meritorious are utilized; special cognizance is given to the past experience of two flying boats (see abstracts 711 and 733). Design applied water-load factors, inertia-load factors, and design applied local water-load factors are offered both for forebody and afterbody impact. The requirements are discussed in detail.

*456. Langheinrich, M.: Rückschlüsse von Lufthansa-Betriebserfahrungen mit Schwimmorken auf die Lastannahmen (Load Specifications as Affected by Experience Obtained by the Lufthansa with Float Seaplanes). Jahrb. 1938 der deutschen Luftfahrtforschung, vol. 1, pp. 339-341.

Conclusions with respect to permissible load based on experiences of Lufthansa with seaplane hulls; examples given show that planes designed on basis of existing code, fulfilled all requirements with regard to strength of hulls; new high-speed large seaplanes are different in many ways; it is suggested that detailed stress measurements should be made before existing code is revised. (See also RTP trans. no. 816.)

Eng. Ind., 1939, p. 1052

457. Penny, R. E.: Seaplane Development. Jour. R.A.S., vol. XXI, no. 201, Sept. 1927, pp. 844-874, Discussion pp. 874-885.

After a survey of early attempts to fly off water and of the early development of float seaplanes and flying boats, the aerodynamic and propulsive designs of marine aircraft are discussed. The design of hulls and floats is briefly discussed in relation to seaworthiness, resistance, stability at rest, porpoising, impact, and air drag. Wood, steel, and duralumimum are compared as materials for hull construction. Hulls of metal construction are lighter than those of wooden construction. For the same gross weight, the weight of the hull and tip floats of twin-engined flying boats is shown to be less than the weight of fuselage and landing gear of twin-engined landplanes. The determination of the longitudinal and lateral metacentric heights of seaplanes and flying boats is described in appendices.

458. Gouge, A.: Some Aspects of the Design of Sea-Going Aircraft. Jour. R.A.S., vol. XXXV, no. 245, May 1931, pp. 341-365, Discussion pp. 366-371.

Consideration is given mainly to hull and float shapes and characteristics, and the results of numerous tank tests are given graphically showing resistance and moment as functions of speed and trim. The observed distribution of pressure on a flat planing surface at 10° trim is plotted as a family of curves of constant pressure. Twin-float seaplanes and flying boats are compared and the manner in which tip floats increase in size as the airplane is made larger is described. The effect of nonstandard atmospheric conditions on the take-off of a flying boat or seaplane is discussed with the aid of charts. A number of aircraft designs are discussed and photographs are included.

*459. Anon.: Stodflottorer Nagra Synpunkter pa Sidostabiliseringsanordningar hos Flygbatar (Wing Tip Floats as Lateral Stability Devices for Flying Boats). Flygning, April 1941, pp. 11-12.

A study is made of the history and use of sponsons and wing tip floats on modern seaplanes. The sponsons or sea wings used on the Boeing 314 were first fitted to the Dornier Wal type flying boats built 15 years ago. In order to overcome the air resistance caused by fixed tip floats, several types of retractable floats have been designed. The structure, application and use of these floats are discussed.

Jour. Aero. Sci., June 1941, p. 14

*460. Gabrielli, G.: Sul calcolo del fondo degli scafi metallici degli idrovolanti e sulla sua forma (Calculation of Bottom of Metal Floats of Seaplanes and their Shape). Notiziario Tecnico di Aeronautica, vol. 6, no. 12, Dec. 1930, pp. 205-211.

Methods of calculating dimensions of float, and effect of bottom shape on weight of whole structure.

Eng. Ind., 1931, p. 1266

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*461. Nelson, Wm.: Watertight Subdivision of Seaplane Hulls and Floats. Aviation, vol. 27, no. 1, July 1929, pp. 34-36.

Design of hulls and floats for watertight subdivision is discussed; advantages of double bottom in flying boats for stowage of fuel merit attention; watertight construction taken up; subdivision of wing-tip floats; hulls should be designed having at least 6 and perhaps as many as 12 compartments to meet properly requirements of safety.

Eng. Ind., 1929, p. 1646

(See also abstracts 402, 407, 411, 414, 432, 465, 476, 478, 481, 497, 504, 518, 522, 707, 717, and 819.)

Descriptions

462. Manning, W. O.: The Ayr Flying-Boat. The Aeroplane, vol. XLVIII, no. 1248, April 24, 1935, pp. 474-475.

Wing-tip floats and stub wings are briefly compared and a picture and short description of the Ayr flying boat are given. The Ayr flying boat was a biplane with the lower wing attached near the chines to give lateral stability on the water.

463. Anon.: Blackburn Retractable Hull Flying-Boat. The Aeroplane, vol. LXVIII, no. 1778, June 22, 1945, pp. 714-715. Also Engineering, vol. CLX, no. 4155, Aug. 31, 1945, pp. 165-166, and 170.

Details of the design, engineering, construction, and performance of the Blackburn B.20 are given. The B.20, which was completed and flown in 1940, incorporates the patented feature of a planing bottom that is retractable. This planing-bottom portion of the hull is separated from the main section, on which it is mounted, by means of a set of links. The links are so proportioned that in the extended position of the planing bottom, the hull and wing assume the best attitude for take-off, while in the retracted position the planing bottom or pontoon fits snugly to the hull in streamline contours.

The aircraft itself is a medium-sized, general purpose, high-wing, cantilever monoplane flying boat of all-metal construction, with twin engines carried in nacelles mounted on the leading edges. Details of its hull, pontoon, wing, and internal arrangement are shown. Specifications are tabulated and pictures of the seaplane are presented. (See also abstract 479.)

*464. Anon.: Collapsible Seaplane for Submarine (Mureaux). Revue de l'Armee de I'Air, Jan. 1936, p. 106.

A description is given of a French Mureaux patent for a folding seaplane which can be rapidly folded up into a tubular hangar for accommodation on a submarine, and rapidly reassembled for flight. The French "Surcouf" will be the first submarine known to be equipped for seaplanes. The seaplane has a central float with side floats said to be similar to those of the catapult planes of the U. S. Navy.

Jour. Aero. Sci., April 1936, p. 224

*465. Nicolson, David: Design and Construction of Flying Boats. Engineering, vol. 107, no. 2786, May 23, 1919, pp. 681-686.

Deals particularly with types known officially as F.2a, F.3, F.5, P.5, and N.4. Paper presented before Instn. Engrs. and Shipbuilders in Scotland. (See also Aeronautics, vol. 16, no. 293 (New Series), May 29, 1919, pp. 562-565; Flight, July 3, 1919, pp. 874-876, and July 10, 1919, pp. 915-919.)

Eng. Ind., 1919, p. 201

*466. Anon.: A Design for a High-Speed Boat. Aircraft Engineering, vol. IV, no. 35, Jan. 1932, p. 6.

Three-view drawing and characteristics of high-speed (400 miles per hour estimated) single seat flying boat designed by Dornier. Two engines in hull driving high propeller through shafting. Lateral stabilizing floats retract into sides of hull.

*467. Dornier, C.: Dornier Discusses Large Flying Boats. Aviation, vol. 27, no. 23, Dec. 1929, p. 1124.

Large flying boats practical for sea work; outline of some of the work done in evaluation of design of Do X flying boats; several

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planes have withstood sea; Do.X sturdiness; declutching of propeller from its engine.

Eng. Ind., 1929, p. 1645

468. Anon.: Dornier DO-26 Long Range Flying Boat. Aero Digest, vol. 35, no. 2, Aug. 1939, pp. 138, 141.

A description, with photographs and a drawing, is given of the Dornier DO-26 flying boat, proposed for transatlantic mail service and designed for catapulted take-off. It is powered by four diesel engines mounted in two nacelles driving two tractor and two pusher propellers. To protect the rear propellers from spray the rear engine and propeller units are tilted up 10° about a transverse axis during take-off, raising the rear propellers by 15.6 inches. The inboard floats are retracted into the wings in flight. Fuel is stored in the hull instead of in separate fuel tanks. (See also abstract 472.)

469. Dornier, Claudius: The Dornier Do.X Seaplane. Aircraft Engineering, vol. 1, no. 10, Dec. 1929, pp. 339-341.

The design, construction, and operation of the Dornier Do.X flying boat, weighing 48,000 kilograms (106,000 pounds), are discussed. A comparison of the Do.X with other smaller Dornier flying boats shows that the ratio of beam over stub wings to beam of hull decreases with increasing gross weight and should become about unity for gross weights of more than 100 tons.

470. Dornier, C.: The Do.X Flying Boat. L'Aéronautique, no. 162, Nov. 1932, pp. 336-350.

Information scattered over several publications and years is assembled and new data on wing loading and hull distortion is given. Comparison shows the superiority of water-cooled engines under full power demands at low speeds even for short periods.

The 500 horsepower Jupiter is rated at 310 horsepower (62 percent) for taxying at low airspeeds, while the 630 horsepower Curtiss Conqueror is rated at 520 horsepower ($82\frac{1}{2}$ percent).

Excellent photographs are reproduced.

Jour. R.A.S., May 1933, p. 446

471. Anon.: Final Report on Service Acceptance Trials of Model PBY-2 Airplane No. 0454 Consolidated Patrol and Bomber Flying Boat. Rep. No. NASSD-178, Navy Dept., Sept. 13, 1937.

Service acceptance trials of a Consolidated PBY-2 flying boat were made at the U. S. Naval Air Station, San Diego, to determine the suitability of the PBY-2 for service as a patrol bomber and to determine whether the contract guarantees had been fulfilled. The trials included tests of the aerodynamic performance and stability, water landing, take-off and landing in smooth and rough water, engine cooling, and operation of various pieces of equipment.

The PBY-2 exhibited excellent characteristics as a patrol-bomber flying boat and was generally superior to the PBY-1, although failing to meet the contract guarantees as to maximum and minimum speed. A description and photographs of the flying boat and the results of the various tests are given.

472. Anon.: A German Long-Range Flying-Boat. Aircraft Engineering, vol. XI, no. 127, Sept. 1939, pp. 357-361.

A description is given of the Dornier Do. 26, a gull wing flying boat with retractable wing-tip floats and tandem engines; the rear engines pivot upward to give clearance from spray. The flying boat is built specially for catapult take-off. The flaps are of the split type and the ailerons are of the Frise type. Numerous photographs of the structure are included. (See also abstract 468.)

*473. Anon.: New Fokker Seaplane. Les Ailes, Aug. 12, 1926, no. 269.

It is reported that Fokker is designing a very strange seaplane. It consists of a wing having a very pronounced sweep back and a considerable dihedral. The machine has neither body nor tail, but will rest on the center underpart of the wing, which is considerably bulged out at this point. It is to be fitted with an engine developing 150 to 200 horsepower.

Jour. R.A.S., Dec. 1926, p. 772

GENERAL INFORMATION
Descriptions

*474. Anon.: A Novel Seaplane Installation. Aircraft Engineering, vol. 3, no. 31, Sept. 1931, pp. 225-226.

All metal monocoque floats with longitudinal flutes and airfoil section spreader bar made by Edo Aircraft Corporation of Long Island, N. Y.

Eng. Ind., 1931, p. 1265

475. Anon.: On Various Sorts of Flying-Boats - I and - II. The Aeroplane, vol. XLVIII, no. 1245, April 3, 1935, pp. 382-383 and vol. XLVIII, no. 1248, April 24, 1935, pp. 471-474.

Descriptions and pictures of some early and contemporary flying boats are given, and some possible future types, such as the Mayo composite aircraft and the flying-wing type, are mentioned. Included in the flying boats mentioned are the Sopwith Bat-boat, Ayr flying boat, Curtiss NC, Savoia S-55, Caproni triplane (see also abstract 114), Dornier Wal and Do. X, a Sikorsky flying boat, and the Porte Baby (Felixstowe Fury).

*476. Dornier, Claudius: Derzeitiger Stand der Entwicklung von Langstrecken-Seeflugzeugen (Present State of the Development of Long-Distance Seaplanes). Zeitschr. V.D.I., Bd. 83, Jan. 7, 1939, pp. 2-12.

Design and performance of flying boats of the United States, Germany, France, England, and Italy that have been used in long distance flights are surveyed and from comparison the direction of future development is indicated. Design, type of construction, power plant, wing loading, useful load, speed, and range of European flying boats are described and compared with those standard American long-distance flying boats. Design in regard to wings and hull and the power plants used (conventional methods of installation, remote control, surface cooling, and fuel tanks) are considered. Flying boats of over 40 tons under construction and contemplated are described. Tables give characteristics and performance for 14 European and 6 American long-distance flying boats, and for 3 French and 7 American boats under construction or projected.

Jour. Aero. Sci., March 1939, p. 217

GENERAL INFORMATION
Descriptions

*477. Anon.: Range of Transatlantic Flying Boats. Les Ailes, March 4, 1937, pp. 7-8.

Range, effect of headwinds, points of merit, series of drawings, and table of characteristics are given for the Dornier Do-18, Blohm and Voss Ha-139, Short Empire, Bleriot Santos-Dumont, CAMS-110, Latécoère Croix-du-Sud and Lt.-de-Vaisseau-Paris, Liore et Olivier H-27 and H-47, Loire 102, Martin 130, and Sikorsky S-42A. Graphs for determining the range for all possible proportions of pay load are included. (French translation from Flugsport.)

Jour. Aero. Sci., May 1937, p. 305

478. Gouge, A.: Recent Progress in the Design of Civil Flying Boats. Jour. R.A.S., vol. XLI, no. 316, April 1937, pp. 257-273, Discussion pp. 273-283.

Problems overcome in designing three classes of British flying boats, the Calcutta, Kent, and Empire which have come directly under the supervision of Mr. Gouge in the last eight years are discussed. It is predicted that the service and civil designs of flying boats will diverge completely in the future and that the service type is nearing its limit in size although no limit is yet in sight for the civil boat. Materials used in construction and characteristics of the three boats are compared, the limiting take-off weight of the Empire is analyzed and improvements in performance are explained. At present there are considered to be no problems to be solved in producing a boat double the weight of the Empire boats, which would have in many respects improved characteristics.

479. Anon.: A Retractable Planing Bottom. The Aeroplane, vol. L, no. 1307, June 10, 1936, p. 744.

Details are given concerning British Patent No. 433925 (Major Rennie). The planing bottom is separated from the rest of the hull and mounted on links so that it can project below the main portion of the hull as long as the craft is on the water. In the air the pontoon is withdrawn into the hull. Two advantages are claimed:

1. Adequate propeller clearance in the case of wing engines is provided for a smaller height of boat structure.

2. The conflicting requirements of take-off and level flight are more easily dealt with. (See also abstract 463.)

*480. Marvin, Thomas: Seaplane Fighters. Air Trails, May 1944, pp. 35, 84, and 85.

Information is given about the seaplane version of the Japanese Zero fighter, which is essentially the regular Zero fighter equipped with pontoons. It is reputed to have a top speed of 330 miles per hour, to have a ceiling substantially equal to that of the land-type Zero, and to maneuver and climb well. It is indicated that the seaplane type of fighter has not been favored by any nation other than Japan, but that it has proved successful as a carrier-based seaplane. Speculation is made as to the possible uses for such a plane, including employment as a battleship or cruiser scout, as a convoy protector similar to the British Cata fighter, and as a defender of water-bounded territory pending the building or repair of shore airfields. Comments are made about the failure of the Allied forces to develop the seaplane type of fighter. Some of the seaplanes in current use are reviewed. Among these are the Vought Kingfisher, Curtiss Seagull, the German Arado Ar 95, the Caproni 310, and the Northrop N3-PB. Characteristics of the seaplane, both favorable and unfavorable to the craft as a fighter, are discussed.

Aero. Eng. Rev., June 1944, p. 99

*481. Fairey, C. R.: Seaplanes. The Aeroplane, vol. XXIV, no. 7, Feb. 14, 1923, pp. 113-114, 116, 118, 120.

Modern types; flying boat; float types; seaworthiness; handling; problems in design; comparison with airplane. (See also Rep. of Int. Air Congress, London 1923.)

Eng. Ind., 1923, p. 586.

482. Lower, J. H.: Some Notes on Flying Boats and Seaplanes. Jour. R.A.S., vol. XXXV, no. 246, June 1931, pp. 515-528.

Brief descriptions of the Short Cockle, Singapore, Calcutta, Mussel, and Valetta are given to illustrate the historical development of marine aircraft. The Messrs. Short Bros.' tank is described and techniques involved in testing seaplanes models are discussed.

The incorporation of information gleaned from tank tests into the final aircraft design and construction is mentioned.

(See also abstracts 406, 411, 419, 438, 443, 448, 819, and 820.)

Take-Off

*483. Verdurand, A.: Les coques d'hydravions de gros tonnage (Large-Tonnage Seaplane Hulls). L'Aéronautique, vol. 10, no. 115, Dec. 1928, pp. 414-416.

Description of starting mechanism of seaplanes; comparison of landings; seaworthiness.

Eng. Ind., 1929, p. 1645

484. Hutchinson, J. L.: Effect of Float Setting on Take-Off and Top Speed of the III F. R. & M. No. 1487, British ARC, 1932.

The effect of angle of float setting on the take-off time and top speed of the Fairey III F float seaplane was investigated. The angle of float setting was varied from 3° to 8° referred to the lower wing root chord. The quickest take-off was obtained with a float setting of 6°, which was approximately the design angle of the Fairey III F. The seaworthiness was satisfactory for this angle. There was a negligible effect of the angle of float setting on top speed.

485. Coombes, L. P., and Read, R. H.: The Effect of Various Types of Lateral Stabilizers on the Take-Off of a Flying Boat. R. & M. No. 1411, British ARC, 1932.

Seaplanes with a single hull are usually laterally unstable on the water. Stability is insured by means of auxiliary wing-tip floats, inboard floats, or stub wings. The relative efficiency of the three arrangements for lateral stabilization is calculated by using data partly from model tests and partly from full-scale tests.

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Calculations were made of the time to take-off over a range of gross weights. The suitability of throttled take-off tests for predicting the limiting weight at which a seaplane can take off was investigated.

The loss of hull efficiency due to fitting either inboard floats or stub-wing stabilizers in place of wing-tip floats is very great, and in this investigation amounted to a reduction in pay load of 9 percent and 17 percent, respectively, for a take-off of 60 seconds in calm conditions. Errors of the order of 2 percent may result if throttled take-offs at normal load are used for predicting the maximum weight at which a seaplane can be taken off in a reasonable time.

486. Jones, E. T.: The Effect of Wind on the Take-Off of Seaplanes. R. & M. No. 1593, British ARC, 1934.

Take-off times were observed of three seaplanes in winds varying from 0 to 30 percent of the take-off speed, and of one seaplane in winds varying from 0 to 40 percent of the take-off speed and in tail-winds. The results of the tests showed that the take-off time and distance of a seaplane in zero wind are given by the equations

$$t_o = \frac{t}{\left(1 - \frac{v}{V_o}\right)}$$

$$S_o = \frac{S}{\left(1 - \frac{v}{V_o}\right)^2}$$

where

t_o take-off time in zero wind

S_o take-off distance in zero wind

t take-off time in wind of velocity v

S take-off distance in wind of velocity v

v wind velocity

V_o take-off speed of seaplane

Results of tests of the longitudinal acceleration and trim of six seaplanes during take-off showed that the maximum weight at which a seaplane can take off with fixed-pitch propellers is almost independent of the wind speed. The effects of gusts and the rippling of the water surface by the wind were not taken into account in the calculations.

487. Perring, W. G. A.: The Effect of Wing Setting on the Water Performance of Seaplanes. R. & M. No. 1656, British ARC, 1935.

The effect of wing incidence on the take-off performance of seaplanes is determined analytically by considering the combined air drag and water resistance of a seaplane. Expressions are given from which the optimum wing incidence (that which gives minimum take-off time and distance) can be determined. It is shown that the optimum incidence depends on trim and the aspect ratio of the wing, and is greater for a monoplane than for a biplane of the same aspect ratio. The theoretical results were checked by take-off calculations for a typical flying boat, based on tank and wind-tunnel tests. The theoretical and experimental results were in good agreement.

488. Richardson, Holden C.: Interpretation of Data of Model Basin Tests on Aircraft Floats. Aero Digest, vol. 23, no. 2, Aug. 1933, pp. 46-47.

Curves of load-resistance ratio as a function of percent of get-away speed are usually accepted as being the best criterion for comparing the merits of different designs of floats. Curves of $\frac{\text{Resistance}}{\text{Gross weight}}$ and $\frac{\text{Resistance} \times \text{speed}}{\text{Gross weight} \times \text{get-away speed}}$ as functions of percent of get-away speed give a clearer conception of conditions. The use of these curves to compare the take-off performance of two models is shown.

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*489. Gouge, A.: An Investigation into the "Take Off" of Flying Boats. The Aircraft Engineer, supp. to Flight, vol. XIX, no. 47, Nov. 24, 1927, pp. 69-72.

Determines relative importance of various factors which enter into any calculations made on take-off; main factors are: effective thrust; water resistance of hull; air drag; wing area.

Eng. Ind., 1927, p. 359

490. Bird, J. H.: Note on Take-Off Corrections for a Flying Boat in Tropical Conditions. Rep. No. H/Res/192, British M.A.E.E., June 9, 1945.

The results of take-off tests on a Sunderland V flying boat under atmospheric conditions varying from temperate to semitropical are presented.

The experimental results have been used to investigate the validity of a recent theoretical Marine Aircraft Experimental Establishment report (abstract 54) in which a method was suggested for estimating take-off performance of seaplanes under tropical conditions from measurements in temperate conditions. The agreement between theory and experiment is fair.

491. Mattocks, A. O.: Seaplane Take-Off Characteristics. The Aircraft Engineer, no. 116 (vol. XI, no. 3), supp. to Flight, vol. XXVIII, no. 1396, Sept. 26, 1935, pp. 20-21.

The take-off time of a seaplane is given by the expression

$$\frac{M}{g}\int_0^{V_0}\frac{dv}{T}$$

where

M gross weight

g acceleration due to gravity

v speed

v_o take-off speed

T excess thrust (thrust minus resistance)

A graphical method is given of obtaining the value of $\int_0^{v_o} \frac{dv}{T}$ from curves of thrust and resistance plotted against speed. The take-off distance can also be determined by this method.

*492. Munk, Max M.: Seaplane Takeoff Computations. Aero Digest, vol. 44, no. 2, Jan. 15, 1944, pp. 82 and 236.

A study is made of the take-off run of a seaplane. By noting that seaplane take-off occurs in two phases - the craft being converted from a predominantly buoyancy sustained vessel to a predominantly hydrodynamically sustained vessel - the equations that refer to the run subsequent to the transition from the first to the second phase are developed. The computations are based on data from the limited amount of available technical literature and on the analysis of actual take-off tests. The take-off time and the maximum take-off weight are estimated from the computations. A formula is established for computing the acceleration, and a diagram shows how rapidly the acceleration of a seaplane falls off. Substitution of the acceleration into the integral for the take-off run results in the solution of the problem, giving the length of the take-off run in feet.

Aero. Eng. Rev., March 1944, pp. 67 and 68

493. Jones, E. T.: Seaplane Take-Off Weights. Part I.- The Factors on Which the Maximum Take-Off Performance Depends. Airc. Eng., vol. VI, no. 70, Dec. 1934, pp. 330-332.

A general discussion is given of the parameters which affect the take-off performance of seaplanes. The take-off performance can be influenced greatly by design parameters which do not affect the air performance. Various factors to be considered in an estimate of take-off performance are enumerated and typical curves of effective thrust, water resistance, and air drag plotted against speed are given for a gross weight less than the limiting gross weight at which take-off is possible. The resistance at high speeds may be reduced slightly by the use of longitudinal steps or scallops in the forebody.

Jones, E. T.: Seaplane Take-Off Weights. Part II.- Methods of Increasing the Present Limiting Take-Off Weight. Airc. Eng., vol. VII, no. 71, Jan. 1935, pp. 8-10.

Requirements necessary for maximum take-off performance are listed. Typical curves of effective thrust, water resistance, and air drag plotted against speed are given for a gross weight near the limiting gross weight at which take-off is possible. For this condition the total resistance at speeds near the take-off speed (this is referred to as a second hump) is almost as great as the effective thrust. The high resistance near take-off speed may be reduced by means of flaps, the deflection of which increases the aerodynamic lift without a change of trim. Lowering the hump trim decreases hump resistance. The effect of variable-pitch propellers on take-off performance is discussed.

Jones, E. T.: Seaplane Take-Off Weights. Part III.- The Effect of Wind on the Performance in Take-Off. Airc. Eng., vol. VII, no. 72, Feb. 1935, pp. 37-38, 40.

The effect of wind on take-off performance is discussed in a manner similar to that of abstract 486.

*494. Green, J. J.: Special Problems Connected with the Take-Off and Landing of Aircraft. Jour. Aero. Sci., vol. 5, no. 8, June 1938, pp. 313-320.

A theoretical analysis has been made of the effect of gradient, wind, and combinations thereof, on the take-off and landing of airplanes. Formulas and charts are given which permit the determination of the length of the ground run for any given conditions providing that the performance on a level surface in still air is known.

From American experience it appears that

$$\frac{\text{Take-off run against wind}}{\text{Take-off run in still air}} = \left(1 - \frac{v}{V}\right)^{1.8}$$

where v is velocity of wind and V is take-off speed of the airplane.

A similar relation holds for the take-off of seaplanes in the absence of current, except that the exponent is 2 instead of 1.8. The effect of wind alone is to alter the length of run rather than the time of take-off. The effect of current alone is to alter the time of take-off without having much effect on the length of run. The take-off of a seaplane is thus always shortest if it takes place against the wind, irrespective of the direction of the current. (See also Canadian Jour. Res., vol. 16, 1938, Sect. A., pp. 1-16.)

Jour. R.A.S., Sept. 1938, p. 846

*495. Proll, A.: Startverkürzung durch Raketenhilfe (Shortening of Take-Off Runs by Use of Rockets). Tech. Ber., vol. 10, no. 5, p. 149, May 1943.

The take-off run of seaplanes is represented according to simple and well-known formulas, and it is shown that the take-off distance can be materially shortened by a relatively light rocket arrangement. Algebraic functions were substituted for water resistance curves. Author

496. Holland, E. P.: Takeoff Performance. BAC Rep. No. D-4745, Mar. 1943.

Full-scale take-off tests of the XPBB-1 at high gross weights were made with a head wind varying from 11 to 18 miles per hour. By use of tank results, take-off calculations were made with and without a head wind to establish the take-off performance of the XPBB-1 for calm conditions. The results were compared with the full-scale results. An investigation was also made of the effect on take-off performance of 8000 pounds jet thrust in addition to the normal propeller thrust.

In order to determine the trim and displacement at each water speed, two sets of curves were used. One curve was an inverted plot of lift against trim for different constant airspeeds, with take-off power, ground effect, and 30° flaps. The second was a plot of displacement against trim for zero hydrodynamic moment at various constant water speeds. When the lift curves were superimposed on the trim curves so that zero lift coincided with the gross weight on the displacement scale, the trim and displacement for zero moment at a given water speed were determined by the intersection of the trim curve for that water speed with the lift curve for the corresponding airspeed (water speed plus head-wind velocity). The resistance and air drag were found directly from tank and wind-tunnel data.

The calculated take-off performance of the XPBB-1 on fresh water was in good agreement with actual take-off tests. The addition of 8000 pounds jet thrust acting for 60 seconds was found to permit take-off at gross weights up to the maximum desirable from the standpoint of performance after take-off.

497. Gassner, Alfred A.: Take-Off Performance of Flying Boats. Aero Digest, vol. 27, no. 5, Nov. 1935, pp. 24, 25, 38.

Relations between the take-off performance and various basic design features of flying boats are summarized. A method is described for quick estimation of hull size and take-off time in preliminary design, and for estimation of the effect on take-off time of changes in the weight or power plant of existing seaplanes. A chart is presented showing the excess thrust required to obtain a given take-off time for various get-away speeds.

498. Garrison, Charlie C.: Take-Off Tests of a Navy PB2Y-3 Flying Boat with and without Jet Assistance. NACA MR No. L6D23, Bur. Aero., 1946.

Three jet motors that produced a total thrust of about 6000 pounds for approximately 40 seconds, were installed in the sternpost of a Navy PB2Y-3 flying boat, and take-offs were made with and without jet assistance in order to learn its effects on take-offs in clam water. The NACA events recorder was installed in the flying boat, and records were obtained during take-offs made at nominal gross loads of 60,000 and 66,000 pounds with the center of gravity at 25 percent mean aerodynamic chord. From these records and visual observations, it was concluded that jet assistance reduced the take-off time and distance by at least one-half when the gross load was 60,000 pounds and by more than one-half when it was 66,000 pounds; that jet assistance shortened the period of time before the hump during which bow spray entered the propellers, and thereby lessened the amount of spray striking the propellers; that the jets caused the hump trim to be lower than that occurring during the unassisted take-offs even though the thrust line of the jets was below the center of gravity; and that the additional power supplied by the jets shortened the period of instability past the hump and lessened the amplitude of porpoising during this period. (See also abstract 216.)

499. Perring, W. G. A.: "Theoretical Investigation of the Take-Off Time of "Singapore II." R. & M. No. 1412, British ARC, 1932.

Computations of the take-off time of the Short Singapore II flying boat were made to determine the effect of wing incidence for a gross weight of 26,900 pounds and no wind, and the effect of wind on the maximum gross weight at which the flying boat could take off. The computations were based on tank tests of a model of the hull and wind-tunnel tests of a model of the flying boat.

The calculated take-off times agreed well with the times observed for several normal take-offs of the full-size flying boat. The addition of a virtual mass of 22 percent of the load on the water in the calculations gave very good agreement between the calculated and observed take-off times. The results of the computations showed that the take-off times would be reduced by $1\frac{1}{2}$ seconds by maintaining best trim, and that the time would be further reduced by 2 seconds by maintaining best trim and by increasing the wing incidence. Increasing the wind speed from 0 to 20 miles per hour increased the maximum weight at which the flying boat could take off from 32,600 to 34,600 pounds.

*500. Crocco, G. A.: Time and Distance for Take-Off and Landing of Aircraft. L'Aerotecnica, vol. 17, nos. 8-9, Aug.-Sept. 1937, pp. 681-720.

Criterions for calculating the take-off and landing time and distance of airplanes and seaplanes are brought up to date by recent data on the variable pitch propeller, flaps, aerodynamic braking, and models of floats.

Jour. Aero. Sci., Jan. 1938, p. 118

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*501. Schiemann, H.: Die Umrechnung gemessener Abflugzieten und wege von Seeflugzeugen auf beliebige Winde und Luftvichten (The Reduction of Measured Take-Off Time and Distance of Seaplanes for any Wind and Density of Air). Tech. Ber., vol. 10, no. 3, March 1943. Reprint from Jahrb. 1942 der deutschen Luftfahrtforschung, Lfg. 9.

The time and distance required for the take-off of seaplanes are important quantities in the performance of each type. After a short discussion of the procedures and the usual method used in take-off calculations, a simple approximating method is given by which the measurements taken during take-off under various weather conditions can be reduced to other conditions of operation, such as no wind and sea-level conditions. Author

(See also abstracts 441, 449, 458, 471, 518, 607, 627, 672, 708, 746, 747, 788, 814, 820, 850, 858, and 913.)

Bibliographies

(See abstracts 518, 530, and 555.)

HYDROSTATICS
Buoyancy

502. Posner, E. C.: One-Tenth Scale Buoyancy Tests. BAC Rep. No. D-1794, Sept. 1937.

Tests of a $\frac{1}{10}$-size model of the hull of the Boeing 314 flying boat were made at the Boeing Aircraft Company to determine: trim and draft for various gross weights, center-of-gravity positions, and conditions of flooded compartments; and curves of net righting moment against angle of heel for various gross weights and center-of-gravity positions.

The gross weight and the longitudinal position of the center of gravity of the model were varied by means of a weight placed on the deck. Flooding of compartments was simulated by adding weights on the deck. The weight of the additional weights was equal to the loss of buoyancy of the flooded compartments and the resultant center of gravity of the weights was directly above the center of buoyancy of the flooded portions of the flooded compartments. The rolling moment was applied by means of off-center weights or by forces directed upwards. The vertical position of the center of gravity was not to scale, but its effect was corrected for in the rolling tests.

*503. Anon.: Studio sistematica alla vasca dei galleggiante a scafo per idrovolanti (Systematic Study of Buoyancy of Flying Boats). Rendiconti Tecnici della Genio Aeronautico, vol. 14, no. 3, Sept. 1926, pp. 1-14.

Details of hydraulic tests of keels numbers 16 to 45 (second series of experiments) as to stability and buoyancy with characteristic curves for each group.

Eng. Ind., 1926, p. 332

(See also abstracts 437, 518, 582, 607, 623, 646, 648, 650, 651, and 819.)

HYDROSTATICS
Stability

*504. Croseck, H.: Beitrag zur Frage der Schwimmstabilitaet der Wasserflugzeuge. Schiffbau, vol. 34, nos. 17, 19, 21, and 23, Sept. 1933 (supp.), pp. 1-6, Oct. 1, pp. 1-6, Nov. 1, pp. 1-10, and Dec. 1, pp. 1-10.

Contribution to problem of floating stability of seaplanes; static stability of floating seaplanes; stability with finite pitch; influence of hydrodynamic forces on stability; rules for arrangement and design of floats; behavior of seaplanes in high sea. (See also Jahrb. 1933 der deutschen Luftfahrtforschung, p. 65.)

Eng. Ind., 1933, p. 1009

505. Bromhead, E. de G. H.: Lateral Stability of Flying-Boats on Water. The Aeroplane, vol. LV, no. 1423, Aug. 31, 1938, p. 265.

In the proposed design, a universal joint gives the tip float freedom of movement in a vertical and horizontal plane. The tail fin keeps the float automatically head on to the flow of the water, and in the air, head to the wind. Small stub wings give the float the necessary longitudinal stability in the water, otherwise, as the float is free on the universal joint, it would be inclined to hunt in the water. Retraction of the float into the wing is recommended.

506. Anon.: A New Idea for Flying-Boats. The Aeroplane, vol. LVII, no. 1478, Sept. 21, 1939, p. 370.

A high monoplane wing curved down at a sharp dihedral angle on each side of the hull to meet the water level from which it rises again with a sharp dihedral to keep the wing tips well clear of the water is proposed for use on flying boats to provide transverse stability. It is stated that the drag is reduced and that all tendency to heel is eliminated.

507. Anon.: Report on Static Stability Study. BAC Rep. No. D-2230, May 1939.

The results of all investigations of the hydrostatic rolling stability characteristics of the Boeing 314 flying boat are correlated in the form of curves of net righting moment plotted against angle of heel. Curves of upsetting moment due to cross winds of various velocities are given.

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Stability

508. Ferguson, E. A., and Posner, E. C.: Rolling Tests. Model and Airplane. BAC Rep. No. D-1994, July 1938, Revised Sept. 1938.

The static rolling stability of the Boeing 314 flying boat was investigated at several gross loads by tests of the full-size flying boat and of a $\frac{1}{10}$-size model of the hull for the following configurations: original stub wings at 7.5° dead rise; and stub wings at 4.5° dead rise with 6-inch extension at the root. Tests of the model were also made for the latter configuration with V-bottom floats under the tips of the stub wings.

*509. Wolff, G.: Schwimmstabilität des Zentralschwimmerflugzeugs Vought V-85-C bei Längs- und Querneigung (Water Stability of the Single Float Vought V-85-C Seaplane during Longitudinal and Lateral Inclination). UM No. 452, Z.W.B.

The hydrostatic stability is determined for a Vought V-85-C seaplane. The tests included lateral and longitudinal inclination on a model for 2100 and 2300 kilograms (4630 and 5070 pounds) gross weight. The effect of the vertical location of the wing floats on lateral stability is also examined. It is found that any raising of the wing floats has a bad effect on the stability about the longitudinal axis. Author

*510. Laute, W.: Schwimmstabilität eines kleinen Seeflugzeuges (Floating Stability of a Small Seaplane). Tech. Ber. vol. 10, no. 4, April 1943. Reprint from Jahrb. 1942 der deutschen Luftfahrtforschung, Lfg. 11.

Data on hydrostatic stability tests made in the model towing tank and on aerodynamic force tests in the wind tunnel are evaluated. The purpose of the paper is to determine the windspeeds which can be practically withstood. By representation in a dimensionless form, an extrapolation becomes possible for similar aircraft of different gross weight. Author

*511. Anon.: Stability of Seaplanes Afloat. The Aircraft Engineer, supp. to Flight, vol. 21, no. 22, May 30, 1929, pp. 40-41.

Notes are given which may be of use to aeronautical engineers when planning disposition of floats in seaplanes or flying boats; accurate estimate can be made by methods given, in order to find righting couple that will be available to counteract any upsetting

HYDROSTATICS
Stability

force likely to be met in service when machine is at rest or traveling on surface.

Eng. Ind., 1929, p. 1650

*512. Budig, F.: Stabilisation of Seaplanes on the Water by Means of Budig Stabilising Planes. L'Aerophile, no. 7, July 15, 1931, p. 209.

Watertight compartments near the wing tips can be rotated about the wing chord. When not operating, the stabilizers conform to the profile of the wing surfaces and do not affect its aerodynamic quality. To prevent dangerous immersion of the wing tips in a cross wind or a swell, the stabilizer is rotated until its immersion produces the necessary buoyancy.

Jour. R.A.S., Jan. 1932, p. 65

*513. Lower, J. H.: Static Longitudinal Stability of Seaplane Floats. Flight, vol. 21, no. 5, Jan. 31, 1929 (supp.), pp. 1-3.

Description of suitable apparatus and methods of testing static stability of seaplane floats; how tests can be made with model floats in water tanks; actual results which have been obtained.

Eng. Ind., 1929, p. 1646

514. Cushing, R. K., Crouch, A. S., and Angell, R. W.: Static Stability Tests of Six Full Scale Twin Float Seaplanes. R. & M. No. 1653, British ARC, 1935.

The lateral and longitudinal hydrostatic stability of six full-scale twin-float seaplanes were determined by tests and were calculated from the dimensions of the floats. It was noted in the tests that a change in the angle of heel resulted in a change in trim that was negligible up to an angle of heel of 3°. The lateral and longitudinal metacentric heights as determined by the tests were in good agreement with those calculated. In calculating the metacentric heights it was found that an error of 5 percent in displacement would result in errors of 1 percent and $2\frac{1}{2}$ percent in the lateral and longitudinal metacentric heights, respectively, and that an error of $\frac{1}{2}^{\circ}$ in trim would result in errors of approximately 3 percent and 9 percent in the lateral and longitudinal metacentric heights, respectively. The results of the tests were compared with the British Air Ministry specifications for static stability of twin-float seaplanes, and it was considered that compliance with the specifications would give adequate stability.

515. Study of Various Types of Wing Floats. BAC Rep. No. D-2508., Jan. 1940.

Several modifications of the Boeing 314 flying boat have been investigated in order to improve the hydrostatic heel stability. The modifications included wing-tip floats in conjunction with stub-wing stabilizers, wing-tip floats without stub wings, and inboard wing floats without stub wings. The heel stability characteristics of each modification are discussed and the change in performance expected with each modification is described.

(See also abstracts 413, 432, 437, 449, 450, 458, 502, 503, 518, 570, 573, 574, 577, 579, 580, 582, 607, 610 to 613, 615 to 618, 623, 645, 647, 650, 653, 746, 747, 819, and 913.)

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*516. Browne, A. D., Moullin, E. B., and Perkins, A. J.: Added Mass of Prisms Floating in Water. Proc. Cambridge Phil. Soc., vol. 26, April 1930, pp. 258-272.

A floating body performing free simple harmonic vibrations in a vertical plane creates a field of pulsating current flow in the liquid, and the total kinetic energy of the whole moving system corresponds to that of the floating body with an enhanced mass. The added mass of rectangular and triangular prisms floating in water is found in connection with an investigation of the natural frequency of lateral vibration of a ship's hull. The experimental values are compared with those yielded by calculation.

Sci. Abstr. 1930, abstr. 3006

517. Brahmig, Rolf: Experimental Determination of the Hydrodynamic Increase in Mass in Oscillating Bodies. Trans. No. 118, D.T.M.B., Navy Dept., Nov. 1943.

The methods for determining virtual mass under conditions of linear and vibratory motion known up to the present are briefly described. For the study and numerical representation of purely hydrodynamic inertia effects on oscillating bodies, a simple test method for forced vibrations is reported and illustrated by tests on vibrating disks. In converting the results of model tests to full scale, principles of similitude must be considered. These are given for the simplified case of a ship propeller vibrating harmonically parallel to the free surface of an undisturbed fluid.

[The possibility of cavitation is not mentioned.]

518. Barrillon, E. G.: Hydrodynamics of Boats and Floats. Vol. VI, Div. S. of Aerodynamic Theory, W. F. Durand, ed., Julius Springer (Berlin), 1936.

A résumé of the hydrodynamic phases of marine aircraft performance is given.

Chapter I gives a general view of the conditions imposed on seaplanes at rest and during take-off and landing. Note is made of the significance of the step and the part it plays in facilitating take-off.

Chapter II describes take-offs and landings under various wind and water conditions. Graphical representation of take-off by means of curves of thrust, resistance, and trimming moment plotted against speed is shown, and the determination of take-off time and distance from these curves is described.

Chapter III contains a more detailed account of take-off and resistance. The wave formation produced by a seaplane or planing surface in motion along the surface of the water is discussed. A discussion is given of the take off of a ladderlike series of vanes at constant trim, and of a combination of wing and planing surface. Results of experiments on planing surfaces by Froude and Sottorf, and on prismatic floats are discussed. The effects on resistance of beam with constant length and of center-of-gravity position are mentioned.

The differences between landplanes and seaplanes with reference to the aerial portions are discussed in chapter IV, and differences and analogies between forms for seaplanes and planing water craft are discussed in chapter V. Chapter VI contains a description of calculations of buoyancy and static stability. The directional stability of a seaplane when drifting, moving forward under power, and being towed are discussed briefly in chapter VII. Results of Rumpler's method of determining the principal characteristics - wing area, structural weight, and payload - of a series of flying boats of varying gross weight are compared with a series built by Dornier in chapter VIII. Procedures and equipment used in tests of reduced-scale models, and water pressure distribution on a hull are discussed in chapters IX and X, respectively. The desirability of more complete theoretical solutions of the two-dimensional and three-dimensional planing processes and Sottorf's analysis of the frictional, induced, and wave-making components of the total resistance form the contents of chapter XI. A bibliography is given of some reports published between 1924 and 1935.

519. Lower, J. H.: The Hydrodynamics of Marine Aircraft. Jour. R.A.S. vol. XXXVII, no. 269, May 1933, pp. 423-434.

The hydrodynamics of marine aircraft is presented in a general form and the development and description of seaplanes, model testing apparatus and results, dynamic stability, and the pressure distribution on planing surfaces are discussed.

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Items of special interest are:

1. The Messrs. Vickers tank at St. Albans is equipped to produce waves.

2. Porpoising is thought to depend upon the distance between the steps on a hull, the ratio between forebody length and afterbody length, and so forth.

3. Bottom pressures are shown in the form of contour lines at a given speed and trim.

*520. Weinig, F.: Kavitation als primaere Ursache Korrosionscheinungen an Flugzeug-Schwimmkoerpern (Cavitation as Primary Cause of Corrosion of Airplane Floats). Z.F.M., vol. 11, no. 21, June 14, 1930, pp. 279-280.

Brief discussion of various factors affecting phenomenon; formulas for calculation of pressure.

Eng. Ind., 1930, p. 1573

*521. Wolff, G.: Der Masstabseinfluss bei Schwingungsmessungen an Schwimmwerksmodellen (The Influence of the Scale for Vibration Measurements on Float Gear Models). FB No. 1056, Z.W.B., July 5, 1939.

Die-out tests are performed in calm water on three geometrically and dynamically similar floating bodies of the scale 1, 1/2, and 1/4. It is determined whether period of vibration and damping obey Froude's law. The test results show that this rule can be applied with good approximation. Author

522. Simmonds, O. E.: Recent Progress in Flying Boat Design. Jour. R.A.S., vol. XXIX, no. 180, Dec. 1925, pp. 634-644, Discussion pp. 645-647.

General brief discussion of static trim, hump resistance, porpoising (obviated by suitable location of two steps in hull), spray, materials (wood, steel, dural), airfoil characteristics, parasite drag, and structure.

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*523. Wolff, G.: Schwingungsversuche mit einen Zweischwimmer-flugzeug vom Muster He 59 auf dem Wasser einschliesslich Modelluntersuchungen (Vibration Tests on a Twin-Float Seaplane of the Type He 59 on the Water, Including Investigations of the Model). FB No. 846, Z.W.B., July 19, 1937.

The values of period and damping of the natural oscillation that are decisive for judging the behavior of a twin-float seaplane on the water are determined for steady conditions. The natural oscillation in moving forward was investigated on a model; a faster fading of the vibration amplitudes with increasing velocity was ascertained. Similarity considerations permitted the conclusion that a numerical application of the model results obtained thus far to the full-scale model is not permissible. Further scale tests are necessary for elucidation of the rule of application. (See abstract 521.) Author

*524. Holzapfel, A.: Seaworthiness Tests of the Rohrbach "Romar." Flight, vol. 21, no. 4, Jan. 24, 1929, pp. 59-61.

During tests, wind was northeast, strength 6-7, and seaway in open sea was 6; in Neustädter Bay seaways of 3, 4, and 5 could be found by choosing suitable distance from coast; collapse of starboard strut; plane rolled into Neustadt in cross-sea under her own power.

Eng. Ind., 1929, p. 1650

*525. Johns, A. W.: Ship Resistance and the Ramus Principle. Engineering, vol. CX, no. 2856, Sept. 24, 1920, pp. 395-397.

Critical study of suggestion of Charles Meade Ramus to British Admiralty to adopt stepped inclined planes as shape of bottoms of ships with a view to increasing speed. Suggestion was made to Admiralty in 1872 and has been since examined theoretically and experimentally.

Eng. Ind., 1920, p. 498

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*526. Dimpker, A.: Über schwingende Körper an der Oberfläche des Wassers (Oscillating Bodies at the Surface of Water). W.R.H., vol. 15, no. 2, Jan. 15, 1934, pp. 15-19.

Four cylinders of different cross-sectional forms, and a few millimeters shorter than the tank width, were constrained to oscillate in a vertical plane under spring control. The mounting of the apparatus is shown in a diagrammatic sketch. The four cross sections were a circle, a rectangle with a semicircle on the lower face, an equilateral triangle with the vertex downwards, and a flattened rectangle with rounded corners. Free and forced oscillations and wave formations were observed.

Approximate methods of calculation are developed and discrepancies were expressed in terms of apparent mass. The period, coefficient of damping (observed), and apparent mass (calculated) are shown graphically as functions of the maximum depth of immersion. For small frequencies and amplitudes the waves formed were parallel to the cylinder, but for larger amplitudes, "against all expectation," transverse waves were formed of which examples are shown in three photographs.

Jour. R.A.S., Feb. 1935, p. 178

527. Havelock, T. H.: Wave Resistance: the Mutual Action of Two Bodies. Proc. Roy. Soc. (London), vol. 155, no. 886, July 1, 1936, pp. 460-471.

A new method is given for calculating wave resistance directly from the source distribution equivalent to the body producing the waves. The method can be applied to two source systems representing two distinct bodies in any relative positions, giving the resistance of each separately. It can also be used to obtain the resultant force in any direction or the resultant couples.

Results are obtained for a simple case representing two small spheres in various relative positions. With the two spheres in the line of motion, the resistances differ by certain forces of action and reaction and also by the wave-interference effects, which are assigned entirely to the following sphere.

Taking the two spheres abreast, the results are interpreted as showing the effect of a vertical wall upon the resistance of a sphere; the expressions given in terms of Bessel functions and curves show the magnitude of the influence of the wall for various distances and velocities. An expression is also given for the force toward the wall.

Finally, with the spheres in any relative position, it is shown that effects of wave interference occur when the following sphere lies within the wave pattern produced by the leading sphere, and arise from both the transverse waves and the diverging waves.

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*528. Foottit, H. R.: Float Design. Flying and Popular Aviation, May 1942, pp. 47, 48, and 92.

A description and analysis are given of the development of the single-step pontoon to break suction and hasten seaplane take-off. Diagrams aid in the explanation of how this is effected.

Aero. Eng. Rev., May 1942, p. 17

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*529. Weinig, F.: Der Auftrieb der ebenen Gleitfläche (The Lift of a Plane Gliding Surface). W.R.H., 18 Jahrg., Heft 9, April 23, 1937.

After discussion of some of the principal solution possibilities of the planing plate problem, the most important for the flat planing surface was carried out with the help of the hodograph method. A method for the calculation of optionally curved planing surfaces was described. The experimental results were compared with the simple theory.

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It was shown that for ideal fluids the pressure on the planing plate agreed very well with that on the pressure side of the identically formed thin airfoil so that the use of the airfoil theory for all flow processes for the planing surface appears in order as long as it is not treated under the influence of the earth's field. An attempt was made to understand this influence through an empirical interpolation formula developed out of experimental results.
Author

*530. Sedov, L. I.: Established Gliding. Sudostroyeniye, no. 2, Feb. 1937, pp. 87-96.

Review of theoretical and experimental studies of gliding with special reference to gliding on water. Bibliography.

Eng. Ind., 1937, p. 1029

*531. Barrillon, C.: Gegenwaertiger Stand der theoretischen Arbeiten ueber Gleitflaechen. W.R.H., vol. 13, no. 15, Aug. 1, 1932, pp. 225-226.

Theory of skimmers; author produces simple expression for resistance; using theory of Lamb and Hogner, he compares actual wave system with theoretical; good agreement found for deep water but not so good for shallow; comparison with Pavlenko theory.

Eng. Ind., 1932, p. 1192

*532. Green, A. E.: The Gliding of a Plate on a Stream of Finite Depth. Proc. Cambridge Phil. Soc., vol. XXXI, Oct. 1935, pp. 589-603.

The two-dimensional gliding of a semi-infinite plate on the surface of a stream of finite depth is examined. The lift L in terms of the ratio D/H, where H is the depth of the stream at infinity upstream, and D is the height of the trailing edge of the plate above the surface of the stream, is calculated. In particular it is found that the trailing edge cannot be at a height of more than 0.07 H approximately, above the upstream fluid surface.

Author

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532a. Green, A. E.: The Gliding of a Plate on a Stream of Finite Depth. Part II. Proc. Cambridge Phil. Soc., vol. XXXII, Jan. 1936, pp. 67-85.

The gliding of a plate of finite length on a stream of finite depth is discussed. Numerical calculations are made for the case when the angle of incidence of the plate to the stream is 30°, the results for any other angle being similar. It is found that, for a given depth of stream and a given height of the trailing edge above the bed of the stream, the value of the lift increases with the length of the plate, until finally, when the plate is infinitely long, the lift assumes a maximum value. Further, for a given depth of stream, the total normal lift on the plate is independent of its height above the bed of the stream, when the length of the plate is small, except when the trailing edge of the plate is above the surface of the stream. Finally, when the depth of the stream is very large and the plate is near the middle of the stream, the solution approximates to the classical Rayleigh flow past a plate in an infinite fluid.

533. Sokolow, N. A.: Hydrodynamic Properties of Planing Surfaces and Flying Boats. Rep. No. 149, CAHI, 1932.

A solution of the steady planing of a flat plate is offered and the results are used together with experimental results to illustrate the planing forces on a theoretical seaplane float.

A solid body is considered in steady motion on a surface of separation between two fluids of different density. The equations for the lift and drag forces due to hydrostatic pressure, circulation, and the shape of the body are derived. The equations are shown to decay to the airfoil theorem of Joukowsky when both fluids are of the same density. The experimental results of Sottorf are reviewed in the light of the derived equations and the characteristics of the experimental results are explained physically.

A flat plate of infinite width, planing without the influence of aerodynamic forces is discussed. The mean relative retardation factor ϵ is derived and explained. Friction is then introduced and equations are obtained for a flat plate of finite width. The effect of aspect ratio is not handled separately as it is automatically accounted for in the experimental coefficients.

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In order to determine the values of lift, drag, and moment of a submerged flat plate, it is necessary to determine the mean relative retardation factor and the ratio of the actual wetted length to the length from the step to the intersection of the undisturbed water surface as a function of the velocity, angle of attack, and aspect ratio. Rather than to attempt a difficult theoretical solution, the test results of Sottorf (abstract 82) are employed and the curves are presented. The effect of Reynolds number on the lift-drag ratio and best trim is discussed and illustrated graphically. The computed resistance curve of a seaplane is given to show the contributions due to hydrostatic forces, friction, and form. The computed results are compared with experiment and the correlation is considered good.

*534. Haekkae, E.: Liukuveneen Laskeminen. Teknillinen Aikakauslehti, vol. 22, no. 7-8, July-Aug. 1932, pp. 336-339.

Method of designing hydroplane of minimum resistance; total sum of resistance can be figured in simple way, also length of gliding surface and point of influence of forces; example proving validity of calculation.

Eng. Ind., 1932, p. 849

*535. Green, A. E.: Note on the Gliding of a Plate on the Surface of a Stream. Proc. Cambridge Phil. Soc., vol. XXXII, pt. 2, May 1936, pp. 248-252.

The two-dimensional gliding of a plane plate on a stream of infinite depth is discussed mathematically. A complete solution for any angle of incidence of the plate on the stream is given, the results being expressed in terms of the length of the plate. The motion is supposed to be steady and gravity is neglected. The plate is taken as at rest, and the stream impinges on it so that it leaves the trailing edge smoothly and forms a spray at the leading edge. The solution is obtained by means of the Schwarz-Christoffel transformation. In Wagner's solution, the lift increases linearly with the spray thickness, δ; in the present solution as δ increases from 0 to ∞, the lift increases to a maximum and then decreases to the finite limiting value of the classical Rayleigh flow.

Sci. Abstr., 1936, abstr. 2539

*536. Sretensky, L.: On Motion of Seaplane on Deep Water. Izv. Akad. Nauk SSSR, no. 6, series 7, 1933, pp. 817-835.

Theoretical mathematical discussion of motion of lamina over surface of heavy fluid; equation of motion up and down waves.

Eng. Ind., 1933, p. 1009

537. Perelmuter, A.: On the Determination of the Take-Off Characteristics of a Seaplane. NACA TM No. 863, 1938.

Contributions to the solution of the problem of planing made by Gurevitch and Yanpolski, Sretenski and Pavlenko, Wagner, and Sokolov are stated briefly. An attempt is made to correlate the available theoretical and experimental data on planing surfaces and, further, to develop an approximate analytical method for determining the water resistance of a seaplane without preliminary towing tests in the tank.

The three fundamental stages in the take-off of a seaplane - plowing, transition, and planing - are described in detail and the limits of each stage are defined. The planing characteristics of a flat plate are described and the expressions for resistance, lift, moment, and draft are written down. The formulas given by Wagner for correcting the equations of lift for dead rise are presented and experimental correction factors for the formulas of Wagner are included.

Assumptions are made and the take-off resistances of three seaplanes are calculated and compared with tank results scaled to full size by using the cube of the scale as a conversion factor. The agreement is fair and in all cases the experimental results give higher resistance than the computed results. The resistance of one of the seaplanes was also computed and compared with the results of a $\frac{1}{5.97}$-size model. The agreement, in this case, was much better and the computed resistance was higher than the experimental resistance.

*538. Wagner, H.: On the Gliding of Bodies Over the Surface of Water. Proc. 4th Int. Cong. Appl. Mech., Cambridge, 1934.

At low speeds the weight of a planing boat is supported mainly by the static lift. The faster the boat moves, the greater the

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dynamic forces become until at very high speeds they predominate entirely.

Lord Rayleigh's method for the two-dimensional problem (a planing surface of infinite breadth) showed clearly the connection between the pressure distribution on the bottom of the boat and the wave formation. For a given loading the wave resistance, as determined by the wave energy, decreases rapidly with increasing speed. As the result of the work of Havelock and Hogner, it was found possible to calculate the wave resistance for a given pressure distribution for the three-dimensional problem also.

For the high-speed condition the effect of gravity can be neglected. This mathematically simple limiting case demonstrates more clearly the connection between the shape and inclination of the bottom of the boat and the lifting force. The method also shows that the energy contained in the spray cast off by the leading edge of the planing surface represents a part of the planing resistance (spray resistance). In the limiting case of a fast glide the flow near the planing surface can be compared with that near an airfoil. The wave resistance is equivalent to the induced drag of an airfoil and, apart from the loading and the planing speed, depends only on the width in the limiting case considered.

Experiments with planing surfaces support the theoretical results over a wide range. The experiments also throw light on the behavior of a boat with a deep keel or in a slow glide, cases which cannot be treated theoretically.

Some unsteady conditions can also be handled theoretically. An example is given in the calculation of Havelock and Hogner on the waves produced by an imposed pressure distribution (two-dimensional problem). The case of a keeled boat alighting on the water surface has also been examined in connection with the landing of seaplanes. In conjunction with experiments some explanation could be found for the rise observed in planing experiments and on seaplanes when taking off.

Airc. Eng., Aug. 1934, p. 218

539. Pavlenko, George: On the Theory of Gliding - The Motion of a Plank at a Small Angle of Inclination to the Water Surface. Proc. Third Int. Cong. Appl. Mech. (Stockholm, Aug. 24-29, 1930), Kungl. Boktryckeriet, P.A. Narstedt & Söner, 1931, vol. I, pp. 179-183.

Expressions are derived analytically for the resistance of a planing body due to wave-making in a perfect fluid. The analysis is limited to two-dimensional flow and small angles of attack. From the expressions developed, conclusions are drawn as to the influence of the cross-sectional form, speed, and length of the planing body on the wave resistance.

540. Sedov, L. I.: Planing on a Water Surface. R.T.P. Trans. No. 2506, British Min. Airc. Prod. (from Tech. Vosdushnogo Flota, No. 4-5, 1940).

The hydrodynamic properties of planing surfaces and the characteristics necessary for a good planing hull are discussed. The fundamental parameters of steady planing are summarized and evaluated. The parameters are arranged in four groups according to usage for particular problems.

A general solution of the planing motion is obtained theoretically and some special solutions by contemporary investigators are presented. Methods of defining the hydrodynamic characteristics of planing by considering alternative groups of parameters are discussed and remarks concerning the magnitude of scale effect are made.

The longitudinal stability characteristics of planing surfaces and seaplanes are summarized.

*541. Miki, T., Tadokoro, T., and Noguchi, M.: Suggested Form for Bottom of Body Gliding on Surface of Water. Jour. Soc. Nav. Arch. Japan, vol. 60, June 1937, pp. 119-141.

Form (with broken line in profile) is suggested; broad conclusion for case of such bottom form is derived from results of pressure distribution on lower surface of airfoil with trailing-edge flap, existence of theoretical analogy being assumed; its calculation as two-dimensional flow of half plane along broken-line form.

Eng. Ind., 1937, p. 1050

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542. Wagner, Herbert: Über das Gleiten von Wasserfahrzeugen. Jahrb. der Schiffbautech., vol. 34, 1933, pp. 205-227.

A theoretical investigation is made of planing processes. The analogy of the flow on the lower surface of an airfoil to that on a planing surface is indicated and the conditions for which it is valid are stated. Because of the complexity of the planing problem, in general, all aspects cannot be adequately treated. However, simple limiting cases are considered which in their entirety give a picture of the planing processes and enable the interpretation of experimental results.

A two-dimensional planing surface (infinite width) is first considered at infinitely small angles of attack with the influence of gravity neglected. The results are extended to a plate of finite width by application of the airfoil comparison. The two-dimensional problem with the effect of gravity included is examined next, and finally, a plate of finite width is treated with consideration of gravity.

A comparison is made of theoretical results, and data obtained from Sottorf's tests on planing surfaces. A good check is found for short plates at both large and small angles of attack for a broad range of Froude numbers.

The results of Wagner's investigation are summarized in an appendix. Planing is discussed in relation to Wagner's paper by Weinig and Weinblum.

*543. Sedov, L. E., and Vladimirov, A. N.: Vliyanie Mekhanicheskikh Parametrov Na Yavlenii Glissirovaniya Kilevatoy Plastinki. Izv. Akad. Nauk SSSR, no. 1-2, 1943, pp. 44-66.

Study of influence of mechanical parameters in gliding of tilted surfaces.

Eng. Ind., 1943, p. 533

(See also abstracts 544, 568, 569, 604, 630, and 679.)

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544. Mayo, Wilbur L.: Analysis and Modification of Theory for Impact of Seaplanes on Water. NACA TN No. 1008, 1945.

An analysis of available theory on seaplane impact and a proposed modification thereto are presented. In previous methods the over-all momentum of the float and virtual mass has been assumed to remain constant during the impact but the present analysis shows that this assumption is rigorously correct only when the resultant velocity of the float is normal to the keel. The proposed modification chiefly involves consideration of the fact that forward velocity of the seaplane float causes momentum to be passed into the hydrodynamic downwash (an action that is the entire consideration in the case of the planing float) and consideration of the fact that, for an impact with trim, the rate of penetration is determined not only by the velocity component normal to the keel but also by the velocity component parallel to the keel, which tends to reduce the penetration.

The analysis of previous treatments includes a discussion of each of the important contributions to the solution to the impact problem. The development of the concept of flow in transverse planes, the momentum equations, the aspect-ratio corrections, the effect of the generated wave on the virtual mass, the distribution of surface pressure, and the conditions for maximum impact force are discussed in detail. Impact treatments based on flow in longitudinal planes, as for bodies of very high aspect ratio, have been omitted since they seemed to be of no interest for the problem of the typical float.

The momentum passed to the downwash is evaluated as the product of the momentum of the flow in the transverse plane at the step by the rate at which such planes slide off the step. Simple equations are given that permit the use of planing data to evaluate empirically the momentum of the flow in the transverse plane at the step. On the basis of such study, modifications of the general equations of the previous theory is supplemented by substantial improvement in the formula for the momentum of the flow in the plane element. This improvement can be made because the flow in the plane is independent of the flight-path angle.

Experimental data for planing, oblique impact, and vertical drop are used to show that the accuracy of the proposed theory is good. Wagner's theory, which has been the most popular theory up

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to the present, is compared with the new theory and with recent data for oblique impacts. The data show that the loads calculated by Wagner's equation are excessive, particularly for high trims. Use in this equation of the proposed formula for the momentum of the flow in the planes reduces the calculated force but the values are still excessive.

*545. Sydow, J.: Berechnung der Stosskräfte für längsgestufte Gleitböden (Computation of Impact Forces for Longitudinally Stepped Gliding Surfaces). FB No. 433, Z.W.B., July 31, 1935.

The impact forces on the bottom of floats may be computed by a special procedure employing Wagner's theory. In several examples, the step impact forces are determined as a function of the wetted width of the boat bottom. The linearly keeled, longitudinally stepped bottoms are compared with the linearly keeled bottoms of uniform depth. In most cases, greater impact forces are obtained with the stepped bottoms. The computations also indicate no superiority over bottoms without longitudinal steps. Flared bottoms develop greater impact forces at the beginning of contact, and smaller forces at the end. Author

*546. Lorenzelli, E.: Campo di Velocita ed Onde Superficiali Prodotte dall' Urto e dall' Affondamento di un Corpo in un Fluido Pesante con Superficie Libera a Pressione Constante. Rep. No. 129, Lab. Aero. R. Politec. Torino.

Study of the impact and penetration of a solid in a liquid with a free surface of constant pressure is of interest in aeronautics in connection with the landing and take-off of seaplanes and flying boats. Past investigations have been based on the principle of conservation of momentum. The problem is here treated by the introduction of two sources. For the study of impact, a stationary source above the free surface is assumed, the distance chosen being a function of the radius of curvature of the body. To obtain the velocity field a second source is used. Having obtained the velocity potential, it is possible to determine the amount of the mass of liquid accelerated by the impact and thus obtain a more rigorous solution of the problem by using proper quantities in the momentum equations.

Aero Digest May 1940, p. 168

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*547. Lavrentieff, M., Keldish, M., Markushevich, A., Sedoff, L., and Lotoff, A.: Collected Reports on The Problem of Impact on the Surface of Water. Rep. No. 152, Trans. CAHI.

The first article is confined to the discussion of the general problem of impact of plates against a water surface, to the deduction of basic equations, and to the general mathematical analysis of the solution of similar problems. The problem is confined to the solution of a two-dimensional mixed boundary problem for Laplace's equation, which represents a particular case of a problem discussed by Hilbert in 1905. The solution of this problem is reduced to the conformal transformation of the region occupied by the fluid into a semiplane. In addition a second method is given which allows in some cases the obtaining of more rapid solution in a closed form.

The second article discusses the problem of impact of a plate against the surface of water of a finite depth. The characteristic function of the flow is obtained by means of fixing its special points and is expressed in the form of elliptic integrals. The solution obtained shows the negligible effect of the depth of the water on the impact phenomenon when the depth exceeds the width of the plate.

The third article is confined to the analysis of the impact of a plate having a rotational movement after the impact. The solution is expressed in the form of elementary functions. Besides this in the same article the problem of impact of two plates falling on a water surface is discussed. The solution is obtained by means of a formula developed by Chaplygin in his article, "Theory of a Slotted Aeroplane Wing."

The fourth article discusses the impact of a solid wedge floating on the surface of an incompressible fluid. The effect of a V-shaped bottom is analyzed and the virtual mass is computed.

The fifth article gives the solution of a limit problem of the impact of an elastic plate against a water surface, when the natural elasticity of the plate may be neglected in comparison with the inertia of its elements.

Airc. Eng., Aug. 1936, p. 233

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*548. Sedoff, L.: Impact of a Rigid Body Floating on the Surface of an Incompressible Fluid. Rep. No. 187, Trans. CAHI.

Modern hydrodynamics offers no means for the exact solution of the problem of immersion of a body in a fluid. The impact of a rigid body on the surface of an incompressible fluid suggests itself as the obvious approximate solution of the problem of sudden immersion. The problem of the impact of a rigid body in addition to its interest as an approximate solution has also an interest in its own account. An exact solution of the boundary problems can be used as material for the building up of methods of practical value.

The problem of the initial motion of a floating body to which a sudden finite motion is imparted is investigated. The impact in the course of which there is no separation of any kind between the body and the fluid is called "impact without separation." The opposite case is called "impact with separation."

Let Σ denote the under-water surface of the body, and Σ_1 be the image of Σ relative to the free surface of the water, which must be planar. The motion of the fluid under the impact is similar to that of an infinite fluid bounded by the surface of $\Sigma + \Sigma_1$. The method of von Mises and the concepts of motor and motor dyad are used.

As an example two uniplanar problems are treated. The first deals with the impact without separation of a floating body in which Σ is an arc of a semiellipse defined by one major diameter. The second deals with the horizontal impact on a vertically immersed plate with separation from the rear wall. Motion without separation is physically impossible in this case.

Airc. Eng., Aug. 1936, p. 234

549. Wagner, Herbert: Landing of Seaplanes. NACA TM No. 622, 1931.

An analytical investigation of the impact of a long prismatic body which has a keeled bottom (that is, a bottom with dead rise) landing on water is givon by considering the pressure distribution across a section of the bottom. The basic equations are extended to take into account the effect of the acceleration of gravity, the variation of bottom shape and depth of immersion over the wetted length, finite length of the hull, dead rise, and the elasticity of the hull bottom. The application of the results to practical problems is discussed and examples are given.

550. Fraser, D.: Landing Stresses. The Aircraft Engineer, no. 152 (vol. XVI, no. 9), supp. to Flight, vol. XXXIV, no. 1553, Sept. 29, 1938, pp. 62–64.

A qualitative estimation of the impact forces on a flying-boat hull is attempted by proceeding in a manner similar to that used by von Kármán (abstract 93). A simplified case of a wedge-shaped body dropping vertically into a wedge-shaped wave and then in still water has been considered. The results of a computation are compared with experimental results. [Poor agreement is obtained.]

551. Sedov, L.: On the Theory of Unsteady Planing and the Motion of a Wing with Vortex Separation. NACA TM No. 942, 1940.

A theory of unsteady two-dimensional planing has been developed which extends and generalizes previous investigations by Wagner and Glauert. The problem of a planing surface with arbitrary thin profile and wetted length variable with time is solved. Formulas have been derived for the hydrodynamic forces on such a planing surface and special attention is given to the physical character of the fluid flow during unsteady planing. For reasons of simplicity the investigation has been restricted to the case of large Froude numbers.

The method employed consists of an application to planing of the methods and results of the theory of unsteady flow about a wing. The necessary assumptions underlying the present theory are formulated, therefore, in such a manner that the planing problem reduces to that of the motion of a thin wing. The general results obtained are in agreement with those of Wagner and Glauert when they are applied to their particular problems, that is, steady planing, the landing of a step in an infinite fluid, and the steady oscillations of a planing plate. [This check is noteworthy because the method of reasoning does not follow along conventional lines.]

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*552. Anon.: Seaplane Floats. Z.V.D.I., vol. LXXIV, no. 45, Nov. 8, 1930, pp. 1548-1549.

The impact of a long prism on the surface of water displaces an effective mass of fluid and sets up a pressure distribution which has a mathematical solution in the two-dimensional problem. A sharp wedge keel does not set up impulsive reactions such as are produced by a flat bottomed float. Measurements of the pressure on the hulls and stress measurements on the supporting members of floats show that the forces on striking the water may be six times the weight of the machine, in agreement with calculated results.

Jour. R.A.S., April 1931, p. 300

553. Fagg, S. V.: A Theoretical Analysis of the Impact of an Elastic Body on Water. R. & M. No. 1925, British ARC, 1941.

Of the factors which affect the forces arising during the alighting of a flying boat, one of the most important is the elasticity of the hull and wings. A theoretical analysis is made for the case of the sprung keeled float, taking into account the mass of the float. As a first step towards investigating the effects of hull and wing flexibility on the loads arising on flying boats when alighting, some preliminary calculations on the impact of an idealized elastic hull on water are made. This idealized body consists of a rigid mass simply connected by a massless spring to a rigid V bottom. The body is considered as dropping into water and the accelerations of the main mass and of the V bottom are calculated.

*554. Schmieden, C.: Über den Landestoss von Flugzeugschwimmern. Ing.-Archiv., Bd, X, Heft 1, Feb. 1939, pp. 1-13.

Previous investigation on landing impact of floats assumed two-dimensional flow, that is, the float is infinitely long. The effect of having a finite float length is investigated, and in order to reduce the mathematical difficulties a float shape is assumed such that the pressure surface is in the form of an ellipse, which remains of constant shape (but increasing size) during the impact process.

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The results are given in the form of nondimensional coefficients; the two-dimensional impact case is given also for comparison.

It appears that the maximum value of the impact force occurs appreciably earlier in the case of the finite float.

Jour. R.A.S., May 1939, p. 377

*555. Wagner, Herbert: Über Stoss- und Gleitvorgänge an der Oberfläche von Flüssigkeiten. Z.f.a.M.M. Bd.112, Heft 4, Aug. 1932, pp. 193-215.

Problems scattered through a number of previous papers are dealt with systematically. The methods of mathematical hydrodynamics are applied with assumption as to boundary conditions set up by the displacement of the water surface. Applications of the methods are made to typical float surfaces under various landing conditions and analytical expressions are obtained. No numerical examples are worked out.

Forty-two references are given.

Jour. R.A.S., Jan. 1933, p. 81

(See also abstracts 538 and 722.)

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*556. Wladimirow, A.: Approximate Method for Determining the Hydrodynamic Forces of an Under Water Wing of Finite Span. R.T.P. Trans. No. 995, British Min. Airc. Prod. (from Rep. No. 311, CAHI, 1937).

The theory of the motion of a body below the free surface of an ideal heavy fluid is reviewed, with special application to a body of airfoil shape. Theoretical expressions are next developed for the lift and wave resistance of a wing of infinite span.

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The effect of viscosity and finite span are then expressed in an approximate form and the final prediction compared with experiments in the CAHI tank. It is concluded that the method gives satisfactory results for small angles of attack, provided the depth of the wing below the free surface is at least equal to 1 chord.

Jour. R.A.S., Apr. 1939, p. 315

*557. Brand, M.: Das Druckfeld einer Tragflügelschiff-Kombination in weiter Entfernung vom Schiff (The Pressure of a Wing-Ship Combination at Large Distance from the Ship). UM No. 3180, Z.W.B., Nov. 14, 1944.

The velocity fields on the sea bottom induced by a ship in motion and by the circulation and displacement of a wing fixed on or under the ship are calculated. The pressure field on the bottom of the ship alone or on the wing-ship combination at 30 meters (98.5 feet) depth of water and a speed of 12 miles per hour with various positions of the wing and at various angle of attack, is represented in charts. Author

*558. Sottorf, W.: Experimentelle Untersuchungen zur Frage des Wassertragflügels (Experimental Investigation on the Problem of Hydrofoils). FB No. 1319, Z.W.B.

With circular section wings, the influence of thickness, curvature and reverse curvature with flat and concave pressure side, and nose shape upon drag, lift, spray, and cavitation is investigated. A section with increasing curvature on the suction side near the nose and with a sharp-edge thin circular arc has been found to be the most favorable all around hydrofoil section. The influence of span, depth of submersion, and dihedral is taken into account. Author

559. Nutting, William Washburn: The "HD-4." A 70-Miler with Remarkable Possibilities Developed at Dr. Graham Bell's Laboratories on the Bras d'Or Lakes. Reprinted from Smithsonian Report for 1919, pp. 205-210. Publication 2595. G.P.O. (Washington), 1921.

A description is given of the HD-4, a hydrofoil boat developed at Dr. Graham Bell's laboratories on the Bras d'Or Lakes. The HD-4 [approximate weight 11,000 pounds] has a torpedo-shaped body with two outrigger pontoons, is 60 feet long, and is powered by two 350-horsepower Liberty engines which drive air propellers. When underway, the hull is supported above the water by three ladder-like sets of hydrofoils. The hydrofoils are set at a dihedral angle so that "reefing" or the variation of immersed area with depth of immersion is smooth and continuous. A fourth set of hydrofoils is mounted at the bow to prevent the bow from diving and to help lift the hull at low speeds. The craft rides smoothly even at high speed in waves about $1\frac{1}{2}$ feet high. The top speed is about 70 miles per hour.

*560. Anon.: Hydrodynamic Support of Seaplanes. Les Ailes, May 2, 1940, p. 5.

Immersed vanes located on seaplanes and lying on or in the water do not present improvements for take-off, and, in particular, they increase drag in water and in air. It would be possible to make them retractable during flight, but these vanes are also said to be sensitive to the phenomena of cavitation and to run the risk of deterioration upon encountering bodies floating between the two wakes. B. Worley, however, is an advocate of this arrangement which, he guarantees, would constitute great progress in marine aviation.

Question of whether hydrodynamic support by immersed wings on or in the water can improve take-off of seaplanes is briefly discussed with quotations from a paper by B. Worley and brief references to and illustrations of early inventions by Forlanini, Guidoni, Stern, and Pegna. During hydroplaning the floats of seaplanes first rising higher out of the water, have further contact with the water only on the edge of the step. To eliminate this contact, B. Worley proposes to install immersed vanes under the floats. These wings or vanes would guarantee a higher lift than that furnished by the floats, because on the floats, lift is due to pressure exerted on the bottom of the float while the immersed vane will be stressed by a positive pressure on the bottom part and by a negative pressure on the upper part. It would also facilitate landing.

Jour. Aero. Sci., July 1940, p. 411

*561. Meacham, William M.: Hydroplane Boats: Latest Type of High-Speed Craft. Scientific American, March 3, 1906.

An illustrated article describing writer's experiments with submerged planes which lifted the hull of the boat out of the water, thus lessening the resistance.

Eng. Ind., 1906, p. 153

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*562. Vladimirov, A. N.: Russian Experiments with Under-Water Wings for Ship Propulsion. Soudostroienie, no. 7, 1938.

The stability of the horizontal motion of submerged wings and the effect of these on the propellers are discussed. The conclusions indicate the complexity and difficulties of the problem of motion on the surface of the water by means of submerged wings. The greatest obstacle to a satisfactory solution of this problem is presented by cavitation and it is considered that this will limit the possibility of utilizing submerged wings for gliding boats to speeds of from 55 to 60 miles per hour. Above these speeds it is probable that the usual type of hydroplane will prove more efficient. The article contains a number of formulas and equations and gives graphs and tables of values in connection with the various points discussed in it, and there are also a number of diagrams and illustrations of various types and sections of submerged wings. (See also Eng. Abstr., vol. 2, no. 3, sect. 3, Apr. 1939, pp. 59-60.)

Jour. R.A.S., July 1939, p. 548

563. Benson, James M., Land, Norman S., and Havens, Robert F.: Tank Tests of Ship-Propeller Strut Sections. NACA MR, Bur. Ships, April 16, 1942.

Twelve models representing various shapes of struts for use in supporting ship propellers and having a chord length of 8 inches were towed in Langley tank no. 1 at speeds up to 40 knots. The range of angles of yaw extended from 0° to 10°. Resistance and side force were measured with a dynamometer and the speeds at which cavitation first appeared were recorded. The resistance at zero angle was also measured by means of wake surveys to obtain results unaffected by the interference between model and supports.

Results of the test are presented to show the effect of thickness ratio, shape of the leading edge, and position of the maximum thickness. The data provide a basis for predicting the resistance added by a strut and the bending loads imposed upon the strut at various angles of yaw. The results of the tests emphasize the importance of alining the strut as near to zero yaw as is possible and of providing fillets where the strut intersects other parts of the ship. Methods are suggested for experimentally determining the angle of flow in the region of the strut and for determining a suitable form of fillet.

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564. Bell, Joe W.: Tank Tests of Three Niblick-Vane Arresting Hooks. NACA MR, Bur. Aero., Feb. 21, 1935.

Three different arresting hooks of the "niblick" type were tested in Langley tank no. 1 at speeds up to about 50 feet per second. Tests at higher speeds were considered inadvisable because of the heavy spray and large loads. [The hooks were furnished by the Naval Aircraft Factory and were intended for use on seaplanes to shorten the landing run.] The hooks had the form of a tubular shaft with a hydrofoil mounted at the lower end in such a position as to develop a downward and rearward force. The shaft was inclined 24° rearward from the vertical for all tests.

Each hook was towed at several different speeds and was allowed to enter the water while the carriage was moving. In every case the hook buried itself immediately without any observable tendency to "skitter." The drag of the hooks at a speed of 50 feet per second ranged from 320 to 405 pounds and the downward lift-drag ratio varied from 0.43 to 1.0.

*565. Tietjens, O.: Das Tragflächenboot. W.R.H., Jahrg. 18, Heft 7 and 8, April 1, 1937, pp. 87-90, and April 10, 1937, pp. 106-109.

Hydrofoil boats; attention called to high performance required of high-speed boats; it is shown how, by use of hydrofoils, required engine performance can be greatly diminished; boat developed by author and other types described; significance of cavitation for hydrofoils; influence of Reynolds number on gliding coefficients; possible uses of hydrofoil boats.

Eng. Ind., 1937, p. 127

*566. Holl, H.: Untersuchungen über Propellerprofile mit herobgesetzter Kavitations – Empfind lichkeit (Investigation on Propeller Profiles, with Reduced Sensitivity to Cavitation). Technische Mechanik und Thermodynamik, Forsch. auf dem Geb. des Ingenieurw., vol. 3, no. 3, May-June 1932, pp. 109-116. (Trans. No. 18, USEMB, Feb. 1936.)

The experiments were carried out in a wind tunnel on a series of wing profiles with flat pressure side, and suction side composed of one or more circular arcs. The symmetrical profiles with the greater thickness at midchord gave the smallest pressure range and

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were least subject to cavitation. The results are stated to be in satisfactory agreement with theory.

Jour. R.A.S., Mar. 1934, p. 238

567. Graff, W.: Verringerung des Schiffswiderstandes durch Tragflächenauftrieb (The Reduction of Ship Resistance Through Hydrofoil Lift). W.R.H. no. 22, 1935, pp. 334-338.

In the case of a wing, the ratio of drag to lift is equal to the tangent of the gliding angle and is designated by ϵ.

In the case of a ship, a similar expression can be obtained for the ratio of resistance to displacement $\frac{W}{D} = \epsilon'$.

It is obvious that a combination of ship and hydrofoil can only reduce the over-all resistance to propulsion if ϵ' for the normal ship is greater than ϵ for the hydrofoil.

Values of ϵ' for various types of surface craft under various operative conditions are known to vary approximately as V^2/l where V is the speed and l is the cube root of displacement. Generally speaking ϵ' is less than 0.08 (ocean liner, cruiser, torpedo boat, cargo boat).

Values of ϵ, on the other hand, do not vary much with speed and dimension of wing so long as the incidence is constant and favorable. The values are, however, affected considerably by interference with the hull and drag of supports.

A lower limit for ϵ appears to be 0.08, which happens to be the upper limit for the usual ship construction.

From this it follows that the fitting of hydrofoils is only profitable for high-speed surface craft of relatively small dimensions. Torpedo boats are too large to benefit.

The author works out the case of a 30-ton speed boat running at 50 knots. Without hydrofoils this boat requires over 1000 horsepower. If the hull is lifted out of the water by means of the hydrofoils, only 600 horsepower is required for the same speed;

In order to get the boat to unstick, however, at least 700 horsepower is required, the horsepower diminishing rapidly to 600 as the boat hull lifts clear.

This power reserve could be reduced if the angle of incidence of the hydrofoils could be altered so as to lift the boat at a lower speed. Apart from mechanical difficulties, this introduces the danger of cavitation.

From the shape of the power curves it appears that hydrofoil boats can only be justified if operated at maximum speeds. At intermediate speeds the boat may take considerably more power than a normal boat. If, therefore, a large speed range is required, it is essential to provide some method of folding up the hydrofoil surfaces.

Jour. R.A.S., June 1936, p. 476

(See also abstracts 402, 435, 442, 518, 632, 658, and 681.)

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568. Wolfe, C. M.: Analysis of Test Data of XPBB-1 Model Hull. BAC Rep. No. D-4098, June 1942.

An analysis of the results of general resistance tests of a $\frac{1}{10}$-size model of the Boeing XPBB-1 flying boat made at Langley tank no. 1 shows that the expression of the relationships between lift, resistance, and trimming moment in the planing condition is simplified by the use of coefficients similar to those used in aerodynamics. This simplification for the trimming moment does not occur when the afterbody is wetted. The following expression for the lift of the forebody in the planing condition with the chines wetted is derived:

$$L = \frac{\rho}{2} V^2 b^2 \left(\frac{d}{b}\right) \beta^{0.65}$$

where

L	lift, pounds
ρ	mass density of water, slugs per cubic foot
V	velocity, feet per second
b	beam, feet
d	draft of keel at the center of gravity, feet
β	trim, degrees

569. Gott, J. P.: The Analysis of the Forces on Seaplane Tank Models into Hydrostatic Pressure, Hydrodynamic Pressure and Skin Friction. Rep. No. B. A. 1441, British R.A.E. Nov. 1937.

An attempt has been made to find a method of plotting the water forces on seaplane models so that the measurements for all loads and speeds at one trim would be represented on a single "basic curve." The physical processes associated with planing are discussed in an elementary way and the resulting method of analysis is applied to tank tests made previously on the Singapore IIC (abstract 391). Additional tests were made on simple flat- and V-bottomed planing surfaces.

In the case of a geometrically simple planing form, the forces can be separated into components due to hydrostatic pressure, hydrodynamic pressure, and skin friction. The method of analysis involves consideration of the forces at constant draft. The hydrodynamic forces are reduced to coefficients based on the dynamic pressure $\frac{1}{2}\rho V^2$ and the square of the beam, and the hydrostatic forces are reduced to coefficients based on the weight of a cubic beam of water wb^3. The method appeared to be valid throughout the speed range in general, but did not apply to results obtained at very low speeds.

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570. Anon.: Bureau of Aeronautics Design No. 71 – 2nd Alternative Lines. Model Experiments. Rep. No. 223, USEMB, May 1929.

Specific free-to-trim and fixed-trim resistance tests and tests of the longitudinal and lateral hydrostatic stability were made in the U. S. Experimental Model Basin of a $\frac{1}{16}$-size model of the second alternative hull and original auxiliary floats of the Bureau of Aeronautics design no. 71 flying boat. The results of the tests are given in graphical form. The hydrodynamic characteristics of the model are compared with those of the original and first alternative hulls (abstract 579). The greater resistance of the second alternative hull is caused by the increased angles of dead rise and afterbody keel.

571. Anon.: Bureau of Aeronautics Design No. 71, Mk. III & Mk. IV Hulls. Experiments with Models of. Rep. No. 240, USEMB, Nov. 1929.

Specific free-to-trim and fixed-trim resistance tests and tests of the longitudinal and lateral hydrostatic stability were made in the U. S. Experimental Model Basin of $\frac{1}{16}$-size models of the Mk. III and Mk. IV hulls and auxiliary floats of the Bureau of Aeronautics design no. 71 flying boat. The results of the tests are given in graphical form. The hydrodynamic characteristics of the models are compared with those of the original (abstract 579) and second alternative (abstract 570) models.

572. Anon.: Bureau of Aeronautics Mark X Float – O2U Series. Experiments with a Model of. Rep. No. 394, USEMB, Jan. 1935.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. X float for the Vought O2U seaplane. The results of the tests are given in graphical form. The hydrodynamic characteristics of the Mk. X float are compared with those of the Mk. V (abstract 613) and Mk. VI (abstract 612) floats.

573. Anon.: Bureau of Aeronautics Design No. 71 Hulls, Mark VIII to Mark XI Inclusive. Experiments with Models of. Rep. No. 335, USEMB, Sept. 1932.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal and lateral stability were made in

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the U. S. Experimental Model Basin of $\frac{1}{16}$-size models of the Mk. VIII, IX, X, and XI hulls and the Mk. VII side floats of the Bureau of Aeronautics design no. 71 flying boat. The results of the tests are given in graphical form. Photographs of the spray around the models at several speeds are given.

574. Anon.: Bureau of Aeronautics Design No. 71, Mk. VI and Mk. VII Hulls. Experiments with Models of. Rep. No. 330, USEMB, July 1932.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal and lateral stability were made in the U. S. Experimental Model Basin of $\frac{1}{16}$-size models of the Mk. VI and Mk. VII hulls and various side floats of the Bureau of Aeronautics design no. 71 flying boat. The hulls differed only in the afterbody. The results of the tests are given in graphical form with pictures of the spray at several speeds.

575. Locke, F. W. S., Jr.: A Collection of the Collapsed Results of General Tank Tests of Miscellaneous Flying Boat Hull Models. NACA TN No. 1182, 1947.

Summary charts of the results of spray, resistance, and longitudinal stability tests of nearly 100 flying-boat hull models are presented. The charts are intended to be used as an engineering tool to enable a flying-boat designer to grasp more quickly the significance of various hull-form parameters as they influence a particular design. No attempt is made to produce conclusions but various methods by which the charts may be used are pointed out.

576. Anon.: Comparison of Atalanta and Model Seaworthiness and Fore and Aft Angle. R. & M. No. 1076, British ARC, 1925.

Experiments were made to compare the spray and general hydrodynamic characteristics of the Atalanta N.4 flying boat and a $\frac{1}{16}$-size model. Moving pictures were taken of the full-size flying boat and qualitative measurements were made of the trim and angle of heel. The model was tested free to trim at 0°, 2°, and 4° angle of heel. Although the model and the full-size flying boat were not exactly similar geometrically the general results were in fair agreement.

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577. Anon.: Design No. 71 – Hull and Side Floats – Additional Model Tests – Overload. Rep. No. 302, USEMB, June 1931.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic lateral stability were made in the U. S. Experimental Model Basin of a $\frac{1}{16}$-size model of the Bureau of Aeronautics design no. 71 flying boat. The model used was the same as that used in the tests reported in abstract 610, with a greater gross load. It was found that the original position of the side floats was too low for the gross load tested. Tests were made with the floats raised, and with the floats raised and trimmed up. The position of the floats had little effect on the resistance at speeds less than planing speed. At planing speeds the floats in the low position increased the resistance and created a bow-down moment.

578. Anon.: Design No. 71 Hull, Class VF Flying Boat. Additional Test with Alternate Step. Rep. No. 182, USEMB, Dec. 1927.

Specific free-to-trim and fixed-trim resistance tests were made in the U. S. Experimental Model Basin of a $\frac{1}{16}$-size model of the hull and auxiliary floats of the Bureau of Aeronautics design no. 71 flying boat with the step modified. The results of the tests are given in graphical form. The model with the modified step had greater resistance than the model with the original step, and tended to jump out of the water before get-away speed was reached.

579. Anon.: Design No. 71 Hull Lines. Class VP Flying Boat Hull. Rep. No. 177, USEMB, Oct. 1927.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal and lateral stability were made in the U. S. Experimental Model Basin of $\frac{1}{16}$-size models of the original and altered Bureau of Aeronautics design no. 71 flying boat with auxiliary floats. Additional resistance tests were made with the auxiliary floats removed and also with hooks located at the main step to keep the stern free of spray at high speeds. The results of the tests are presented graphically.

580. Anon.: Design No. 71 – Mark VIII, Modification I, Mark VII Outriggers. Experiments with a Model of. Rep. No. 352, USEMB, March 1933.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the

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U. S. Experimental Model Basin of a $\frac{1}{16}$-size model of a modification of the Mk. VIII hull with the Mk. VII side floats of the Bureau of Aeronautics design no. 71 flying boat. The modification increased the resistance of the model.

581. Truscott, Starr: Douglas Amphibian YO-44 - Tests of Modol of Hull. NACA MR, Air Corps, Mar. 3, 1933.

Specific fixed-trim and free-to-trim resistance tests were made of a $\frac{1}{12}$-size model of a hull for a large amphibian. The results are tabulated and plotted.

582. Dawson, John R., and Drumwright, Arthur L.: Draft and Trimming-Moment Curves from a General Tank Test of a Model of the Hull of the XPBM-1 Flying Boat - N.A.C.A. Model 95. NACA MR, Bur. Aero., March 2, 1939.

General fixed-trim resistance tests were made in Langley tank no. 1 of a $\frac{1}{6.8}$-size model of the hull of the Martin XPBM-1 flying boat. The data were requested for use in the computation of longitudinal stability derivatives. The results of the tests are given in the form of curves of trimming moment, draft, and resistance plotted against speed. The results of hydrostatic trimming-moment and draft tests are also given. The accuracy of the draft measurements is discussed.

583. Sottorf, W.: Der DVL-Einheitsschwimmer; Versuchergebnisse der Familie B, Modells 17, 18, und 19 (The DVL Single Float; Experimental Results with the B Family, Models 17, 18, and 19). FB No. 650, Z.W.B. (Available as Rep. No. ZH-016, CVAC.)

General fixed-trim resistance tests were made of a family of float models with angles of dead rise excluding chine flare of 25° and length-beam ratios of 6.04, 7.50, and 9.19. The models were derived from DVL 1a (abstract 586), and DVL 8 (abstract 587), thereby setting up two related families of floats. The results are presented graphically.

The results showed a decrease in spray with increase in length of model. The spray condition of the family of models with a greater dead rise was as satisfactory as the family of models with lower dead rise.

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*584. Sottorf, W.: DVL-Flugboot, Schleppversuche (DVL Flying Boat, Towing Experiments). FB No. 1099, Z.W.B.

The DVL flying boat has the tail boom attached at the stern of the single float which has been enlarged at the keel to fair into the boom for aerodynamic reasons. The experiments were made to clarify admissibility of this shape of construction by comparing its results with the results of the single float. It was shown that the resistance of the flying boat can be decreased by proper curvature of the rear bottom, by flaring, and by addition of spray strips at the rear chine. The spray strips also eliminate the tendency to porpoise. Separate investigation of the front half and of the rear half with and without struts determined the resistance of the rear part of the float and the tail boom. Finally the effect of a severe sea roughness is recorded. Author

*585. Sottorf, W.: Der einseitig gekielte Schwimmer (The Asymmetrically Keeled Float). FB No. 673, Z.W.B., Aug. 6, 1936.

The longitudinal center section is the plane of symmetry for floats of usual design and for the forces and float conditions that are encountered. With the twin-float seaplane, as with the twin-hull flying boat, this has the disadvantage that the space between the floats is filled with water spray which endangers the propeller and increases the resistance by impinging on the float structure struts. On the asymmetrically keeled float the keel line is moved to the inside of the float whereby the water is prevented from passing over the keel line and the water spray is directed exclusively to the outside. The design was tested in comparative tests with a float of normal design. In maximum resistance and in ordinary gliding it is equal to the compared float, but is is inferior in take-off. Author

586. Sottorf, W.: Entwurf und Untersuchung des Modells DVL 7 (Design and Test of Model DVL 7). FB No. 351, Z.W.B. (Available as Rep. No. ZH-016, CVAC.)

DVL 1a (abstract 661) was satisfactory as a flying-boat hull but was too broad and inefficient to be used in a twin-float arrangement. A small float with a length-beam ratio of 9.19 (DVL-7) was, therefore, derived from DVL 1a by increasing the spacing of the stations along the keel. General fixed-trim resistance tests were made of the model and the results are presented graphically.

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587. Sottorf, W.: Entwurf und Untersuchung des Modells DVL 8 (Design and Test of Model DVL 8). FB No. 444, Z.W.B. (Available as Rep. No. ZH-016, CVAC.)

DVL 8 is another model of a series of floats with an angle of dead rise excluding chine flare of 20° (see abstract 586 and 661). DVL 8 represents a model of average beam and has a length-beam ratio of 7.5 derived from DVL 1a by increasing the spacing of the stations along the keel. General fixed-trim resistance tests were made and the results are presented graphically.

*588. Sottorf, W.: Erweiterte Untersuchung des Modelles DVL 1a (Mod. DVL 6). (Extension of the Study of the Model DVL 1a (Model DVL 6).) PB No. 325, Z.W.B.

Dimensions and hull shape of the flying-boat model DVL 1a are used as a basis for the float model DVL 6 and this model is studied as a supplement to the measurement of the model DVL 1a (abstract 661), in the higher load range required for floats. The always present tendency of increasing maximum drag with increasing loading and simultaneous rise of the corresponding critical speed is especially noticeable. For the evaluation of the water-spray formation, stereographic photographs are included. Author

*589. Sottorf, W. and Pott, W.: Erweiterung der Versuche mit DVL-Einheitschwimmern der Familie B (Extension of the Experiments with the DVL Single Float of the B Group). UM No. 1002, Z.W.B., June 1943.

The results are given for a DVL single float test made according to the general fixed-trim-resistance-test method. The float had a length-beam ratio of 11 and an angle of dead rise of 25°. The results are given of tests of combinations of bows and sterns of the floats with length-beam ratios of 11 and 7.5, that were made to determine the effect of the stern on the resistance characteristics. Author

*590. Cremona, Cesare: Esperienze Sistematiche sul Modello di Idrovolante Biscafo "G. I. S. 6" in Varie Condizioni di Assetto e di Dislocamento in Relazione alla Distanza fra le Mezzerie Degli Scafi (Systematic Tank Tests on a Model of a Twin-Float Seaplane "G. I. S. 6" for Different Conditions of Trim, Loading, and Distance between Floats). Atti di Guidonia, No. 20, Dec. 20, 1939.

The modern nondimensional method of experimentation is applied to the problem of seaplane floats, both single and in pairs. In the first part of the report, the new method is described and the results of a complete series of experiments carried out in the Guidonia tank are given (load, speed, drag, trim, track). From these a general picture is presented, both of the experimental difficulties and of the wide choice of data open to the designer and the mathematician.

Jour. R.A.S., 1941, p. 387

*591. Sottorf, W.: Experimentelle Untersuchungen über das Gleiten von Wasserfahrzeugen (Experimental Investigations on the Planing of Seaplanes). FB No. 234, Z.W.B.

For comparison with the previously investigated hydroplane forms, three more forms that were provided with longitudinal steps were investigatod as well as three forms with different angles of dead rise. According to the test, the longitudinal step has no advantage as far as resistance is concerned. The experiments with various keel forms demonstrated that the characteristics of the lift and drag forces are determined by the forward part of the bottom, which has the greatest curvature. Author

592. Anon.: Experiments to Note the Effect of Varying the Depth of the Step on a Seaplane Float. Rep. No. 170, USEMB, July 1927.

Specific resistance and hydrostatic stability tests were made at the U. S. Experimental Model Basin of a model of a seaplane float with varying depth of step. Two series of configurations were used; one in which the dead rise was held constant; the other, in which the dead rise was varied while the depth of step at the keel was held constant. The height of the sternpost, afterbody keel angle, and dead rise at the sternpost were held constant while the afterbody bottom near the step was warped to form the different depths of step. It was found that a shallow step was best at low speeds, and a deep step was best at speeds where the tail was clearing and the model was beginning to plane. At high planing speeds, too deep or too shallow a step was undesirable. The optimum depth of step was about 7 or 8 percent of the beam. Previous experience has shown that an increase in afterbody keel angle or a decrease in length-beam ratio allows the use of a shallower step.

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593. Anon.: Experiments with a Model of Mark VII Airplane Float. Rep. No. 369, USEMB, Oct. 1933.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. VII float [for the Vought O2U seaplane]. The results of the tests are given in graphical form and photographs of the spray at several speeds are given. Spray at hump speed was very bad, and damping was necessary to control porpoising at planing speeds.

594. Baker, G. S., and Keary, E. M.: Experiments with Model Flying Boat Hulls (24th Series Report). Comparison of Longitudinal with Transverse Steps. R. & M. No. 893, British ARC, 1923.

Specific free-to-trim resistance tests were made at the William Froude National Tank of models having several configurations of longitudinal steps without a transverse step, and of a model of normal form having the same general lines and two transverse steps. The variation of trimming moment and resistance with trim at a high speed was also determined. The results of the tests showed that the resistance of the models with the longitudinal steps was greater than that of the model with the transverse steps. The models with the longitudinal steps required a large trimming moment to change trim and their resistance decreased continuously with increasing trim. Similar results have been obtained with other models in which the main transverse step was eliminated or moved far aft, thus the effects noted in these tests may be regarded as due more to the elimination of the main transverse step than to the longitudinal steps themselves.

595. Keary, E. M.: Experiments with Model Flying Boat Hulls and Seaplane Floats. Twenty-Second Series Report. Comparison of the Vigilant Straight Frame Type and Curved Section Flying Boats. R. & M. No. 785, British ARC, 1922.

Specific free-to-trim resistance tests were made at the William Froude National Tank of a model of the Vickers Vigilant, which had straight sections above the chines, and of several models having curved sections (see figure). The tests were conducted at various gross loads to determine the effect of the different types of construction on resistance. The straight-section type had less resistance at all speeds and ran more cleanly at low speeds than the curved-section type. The variation of resistance and trimming moment with trim at high speeds is discussed and was determined for the models. The speed at which porpoising commenced and the resistance of the Vigilant are compared with those of other straight-section flying boats. The factor $\frac{P^{2/3}}{LB}$, where P is gross load, L is forebody length, and B is beam at step, may be used to compare flying boats with respect to the load which can be carried for the same degree of cleanliness, or amount of spray at low speeds.

Straight section Vigilant   Curved section

596. Anon.: F-5-L Flying Boat Hull (E.M.B. Model No. 2171). Report of Experiments to Determine Effect of Changing Position of the Rear Step. Rep. No. 70, USEMB, March 1923.

Specific resistance tests were made at the U. S. Experimental Model Basin on a $\frac{1}{13.5}$-size model of the hull of the F-5-L flying boat with four different lengths of afterbody. Increasing the length of the afterbody decreased the resistance at planing speeds.

597. Friend, A. B.: Force Vectors of Water Forces on Flying Boats. BAC Rep. No. D-2625, April 1940.

Figures are presented showing the location and direction of the resultant hydrodynamic force vector at various loads, trims, and speeds for the Boeing 314 flying boat (abstract 647) and a planing surface with an angle of dead rise of 20° (abstract 87).

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598. Jarvis, George A.: Free-to-Trim Resistance Test of Models of the Float of the NB-1 Seaplane with and without Winding Surfaces on the Bottom of the Forebody (NACA Models 153C and 153D). NACA MR, Bur. Aero., June 23, 1943.

Specific free-to-trim resistance tests were made in Langley tank no. 2 of a $\frac{1}{4}$-size model of the float of the NB-1 seaplane to determine the effects of changing from a forebody with constant dead rise to one with a warped bottom obtained by increasing the angle of dead rise towards the bow. The model was in two parts: the bow section, which comprised about two-thirds of the forebody; and the main section, which included the afterbody and the aft end of the forebody. Two bow sections were used, one with constant angle of dead rise and the other with a warped bottom. The effect on resistance of the forebody warping was negligible. At low speeds the spray of the model with the warped forebody was higher than that of the model with constant dead rise. (See also abstract 629.)

599. Hanson, J.: Further Measurements of the Full Scale Water Resistance of a IIIF Seaplane in Steady Motion. R. & M. No. 1806, British ARC, 1936.

The resistance of a Fairey III F seaplane in steady motion was determined by measuring the resistance of the floats with respect to the fuselage. Three flap settings were used in the tests; full up, normal, and full down. The dynamometer described in abstract 608 was modified to permit the accurate measurement of resistance at low speeds. The resistance measured with the modified dynamometer agreed very closely with that obtained previously (abstract 608). Deflecting the flaps decreased the load on the water and the resistance.

600. Parkinson, John B., and Ebert, John W., Jr.: Further Tank Tests of a Model of the XPB2Y-1 Flying-Boat Hull - N.A.C.A. Models 76-B, 76-C, 76-D, 76-E, and 76-F. NACA MR, Bur. Aero., July 12, 1938.

Specific free-to-trim resistance tests were made in Langley tank no. 1 of several modifications of a [$\frac{1}{8}$-size] model of the hull of the Consolidated XPB2Y-1 flying boat (abstract 648). The first model for these tests had the chine flare removed from the afterbody and the step moved forward from the position in abstract 648. Modifications were made by successively adding a sharp chine and square transom to the tail extension, increasing the afterbody length, restoring the tail extension to its original form, and replacing the straight transverse step with a V-step which had the same position at the chines. Each model was tested at two values of gross load, and two of the models were also tested with a bow-down trimming moment which simulated the thrust moment.

Moving the step forward and removing the afterbody chine flare raised the trim at and above hump speed and increased the hump resistance. Adding the chines and transom to the tail extension lowered the trim near hump speed and reduced the hump resistance. The effect of the chines was not as great for the long afterbody as for the short afterbody. Adding a bow-down moment lowered the trim and reduced the resistance at speeds above hump speed. Increasing the length of the afterbody lowered the trim at low speeds and reduced the hump resistance. The model with the V-step had higher trim and greater resistance at hump speed, and lower trim and lesser resistance at high speeds than the model with the straight transverse step.

Pictures of the spray around the models are given and the speeds at which changes in flow around the model occurred are indicated. The amplitude of porpoising was reduced by using a horizontal tail surface which was set to similate up elevators to raise the trim of one model.

601. Robertson, James B., Jr.: A General Hydrodynamic Test of the P3M-1 Seaplane Hull, N.A.C.A. Model 18. NACA MR, Bur. Aero., Aug. 2, 1937.

General fixed-trim resistance tests were made of a $\frac{1}{6}$-size model of the hull of the P3M-1 flying boat and supplement those of abstract 131. The resistance characteristics of the model were compared with those of N.A.C.A. models 35-A (abstract 198) and 40-AC (abstract 197). The performance appeared to be similar to model 40-AC which was considered an average hull. Spray was not severe and would not be a serious consideration if the propellers were mounted ahead of the leading edge of the wing. The reported poor take-off performance of the P3M-1 flying boat evidently must be attributed to poor aerodynamic design as well as to unsatisfactory piloting technique rather than to excessive water resistance.

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602. Bell, Joe W., and Ebert, John W., Jr.: A General Tank Test of a Modification of the 1/8-Size Model of the Martin XPBM-3 Flying Boat (NACA Model No. 120-R). NACA MR, Bur. Aero., Aug. 2, 1941.

General fixed-trim resistance tests were made of a modification of the $\frac{1}{8}$-size model of the hull of the Martin XPBM-3 flying boat. The model tested was the model which was considered to be the best modification discussed in abstract 632 with the step moved aft, the tail cone profile straightened, and the afterbody narrowed above the chine near the second step.

The hump of the resistance curves occurred at a lower speed than that of the previous modification. At the hump, the resistance at low trims was slightly lower and at high trims slightly higher than the resistance of the previous modification. At high speeds the resistance was generally lower than the resistance of the reference model with the exception at 9° trim where the reference model showed more of a tendency to ride on the afterbody at light loads. Very heavy bow spray was encountered at high loads and low trims and water flowed across the top of the tail cone at high loads and high trim. Sticking of the afterbody was observed which resulted in two distinct conditions of flow at a trim of 3° and a speed coefficient of 2.2. A tendency of the model to yaw at speeds just prior to the hump was noted.

603. King, Douglas A., and Hill, Mary B.: General Tank Tests of a 1/10-Size Model of the Hull of the Boeing XPBB-1 Flying Boat - Langley Tank Model 175. NACA TN No. 1057, 1946.

General fixed-trim resistance tests of a $\frac{1}{10}$-size model of the hull of the Boeing XPBB-1 flying boat were made in Langley tank no. 1. Tests were made of the forebody alone; the forebody and afterbody; and the forebody, afterbody, and tail extension, which represented the complete hull.

In addition to the usual measurements of resistance and trimming moment, measurements were made of the length of the planing bottom which was wetted by the water. The draft of the forebody alone was measured using a method which eliminated errors caused by up-and-down surges of the water in the tank.

The application of the data to the determination of stability derivatives, frictional resistance, and the computation of the forces of the constituent parts of the hull is described briefly.

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604. Guidoni, A.: The Gliding Surface of Seaplane Floats. Aviation, vol. VIII, no. 9, June 1920, pp. 363-366.

By considering the fundamental equations of lift and resistance, expressions for the maximum resistance and the resistance during planing are developed for a cylindrical float seaplane with a separate planing surface placed under the floats. These expressions can be used to determine the optimum area of the planing surface.

605. Lorenzelli, Ezio: Graphical Investigation of the Coefficients of Resistance and of Hydrodynamic Moment of a Hydroplane and the Determination of the Best Wing Setting. Rep. No. 3645 S.383, British ARC, Seaplane Sub-Committee, July 23, 1938. Also L'Aerotecnica, Vol. 18, No. 1, Jan. 1938, pp. 64-77.

Towing-basin tests are frequently insufficient to enable the designer to study the take-off behavior when the seaplane is "on the step". In this paper the hydrodynamic drag of a hull on the step is determined graphically for given trim and speed conditions, the hull being provided with a wing of known aerodynamic characteristics. The angle between hull and wing for which the total drag is a minimum, and the most favorable manner of operation of the flaps in take-off are found. The coefficient of hydrodynamic moment about the center of gravity and the free trim angles of the hull are deduced.

Experimental data are used to provide characteristic coefficients and curves of general use to the designer.

*606. Lower, J. H.: The Hydrodynamical Efficiency of Flying-Boat Hulls and Seaplane Floats. The Aircraft Engineer, supp. to Flight, vol. XXI, no. 26, June 27, 1929, pp. 49-50.

Formulas are given for comparing efficiency of various models of flying-boat hulls and seaplane floats when carrying out tank tests; flying-boat hulls are more efficient than twin seaplane floats for major portion of speed range during take-off run.

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607. Ward, Kenneth E.: Hydrodynamic Tests in the N.A.C.A. Tank of a Model of a Large Flying-Boat Hull Fitted with Stub Wings - N.A.C.A. Model 54. NACA MR, March 4, 1938.

General fixed-trim resistance tests were made in Langley tank no. 1 of a model hull (NACA model 54) fitted with stub wings and generally similar to the hull of the Dornier Do.X flying boat. Tests to determine the static draft, trimming moment, and rolling moment were also made.

A now form for comparing the take-off performances of hulls is introduced. The comparisons are made on the basis of take-off factors developed from the usual distance and time equations in which nondimensional data from the model tests are used directly and certain basic variations are assumed which are consistent with modern design practice. Values of the distance and time factors are plotted against the beam factor for each hull form and the curves indicate the variations of take-off distance and time with size of hull for any particular gross load. Comparisons of corresponding curves show directly the relative merits of the hull forms based mainly on the water performances for the conditions assumed.

Comparison, by this method, of the take-off performance of NACA model 54, the Short Calcutta, and the Sikorsky S-40, indicates that model 54 has better take-off performance than the other two.

608. Jones, E. T.: Measurement of the Full Scale Water Resistance of a IIIF Seaplane in Steady and Accelerated Motion. R. & M. No. 1591, British ARC, 1934.

The resistance of a Fairey III F seaplane in steady and accelerated motion was determined by measuring the resistance of the floats with respect to the fuselage. The resistance in accelerated motion was also determined from measurements of acceleration and speed and from calculations of thrust and air drag. The apparatus and technique used in the tests and the determination of the accuracy of the results are discussed.

Comparisons are made between:

(a) The resistances in steady and accelerated motion

(b) The resistances of the seaplane in accelerated motion as determined by the two methods of measurement

(c) The resistances in steady motion of the seaplane and of $\frac{1}{10}$- and $\frac{1}{16}$-size models.

The resistance at planing speeds was almost constant and was about one-fifth of the gross weight. The trim was low at high speeds. At speeds greater than hump speed the resistance in accelerated motion at a mean acceleration of about 0.15g was about 10 percent less than that in steady motion when the two sets of data were compared at the same trim. Fair agreement was obtained in the resistances as determined by the two methods of measurement. When compared at the same trim the resistance of the full-size seaplane was about 10 percent greater than that of the models. It is pointed out that this difference in resistance was not necessarily due wholly to scale effect, but was influenced by the yawing of the full-size seaplane due to wind and tide, and by the fact that rivet heads, seams, and lap joints were not reproduced on the model. The effect of yaw on the resistance of the model is shown.

609. Hutchinson, J. L.: Measurements of the Water Resistance of a 1/2.4 Scale Singapore II C Hull. R. & M. No. 1781, British ARC, 1936.

A $\frac{1}{2.4}$-size model of the Short Singapore II C flying boat was used as the main float of a de Havilland Moth single-float seaplane. The resistance and load on the water were determined by measuring the forces on the float with respect to the fuselage during constant-speed taxi runs. A description of the testing apparatus is given. The results of the tests were compared with those of a $\frac{1}{12}$-size model and those of the full-size flying boat (abstract 670).

It was found that the resistance of the $\frac{1}{2.4}$-size model was about 50 percent greater than that of the $\frac{1}{12}$-size model at a high planing speed, and about 5 percent less than that of the $\frac{1}{12}$ size at hump speed. The resistance of the full-size flying boat was greater at high speeds and less at hump speed than that of the $\frac{1}{2.4}$-size model. The differences in resistances may be partly due to differences in the roughness of the three hulls.

610. Anon.: Model Experiments, Design No. 71 Hull Lines Modified. Rep. No. 235, USEMB, Sept. 1929.

Specific free-to-trim and fixed-trim resistance tests and tests of the longitudinal hydrostatic stability were made in the U. S. Experimental Model Basin of two modifications to a $\frac{1}{16}$-size model of the original hull and auxiliary floats of the Bureau of Aeronautics design no. 71 flying boat. The modifications consisted of changes in the angle of afterbody keel. For a comparison with the tests reported in abstract 570, one value of angle of afterbody keel was the same as that of the second alternative hull for design no. 71. The results of the tests are given in graphical form.

611. Anon.: Model Experiments with Seaplane Floats with Varying L/B and $B/\sqrt[3]{W}$ (B Beam; L LWL Length; W Normal Displacements in Lbs). Rep. No. 203, USEMB, Oct. 1928.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made at the U. S. Experimental Model Basin of five models of seaplane floats. The models formed two series of three models each; one of varying length-beam ratio L/B and constant beam to cube root of weight ratio $B/\sqrt[3]{W}$ and the other of constant L/B and varying $B/\sqrt[3]{W}$. The angle of dead rise and angle of afterbody keel were not constant in either series, and therefore analyses could not be easily made. In general, the longer floats gave better results than the shorter floats.

612. Anon.: O2U-1, Mark VI Single Float. Experiments with a Model of. Rep. No. 347, USEMB, Feb. 1933.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. VI float for the Vought O2U-1 seaplane. The results of the tests are presented in graphical form, and pictures of the spray of the Mk. VI and Mk. V (see abstract 613) floats are given. The hydrodynamic characteristics of the Mk. VI and Mk. V floats are compared.

613. Anon.: O2U Airplane Float, Mark V Lines. Experiments with a Model of. Rep. No. 254, USEMB, May 1930.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. V float for the Vought O2U seaplane. The results of the tests are given in graphical form. The hydrodynamic characteristics of the various floats for the O2U are compared. (See also abstracts 614, 615, and 616.)

614. Anon.: O2U Airplane Float, Mk. I, Deep Vee Bottom, Experiments with Modified Model. Rep. No. 222, USEMB, May 1929.

Specific free-to-trim and fixed-trim resistance tests were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. I float for the Vought O2U with the sternpost modified and with an auxiliary step on the afterbody. The sternpost modification reduced the hump resistance and lowered the roach, but had not as much effect on the roach as the combination of sternpost modification and auxiliary step, with which the roach remained quite high.

615. Anon.: O2U Airplane Floats, Mk. I and II. Model Experiments. Rep. No. 220, USEMB, May 1929.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of $\frac{1}{8}$-size models of the Mk. I and Mk. II floats for the Vought O2U seaplane and several modifications. The Mk. I float had a straight V-bottom with forebody chine flare and Mk. II had a hollow V-bottom. The high roach which formed at speeds near hump speed was lowered or eliminated by lowering the trim or adding a flare near the sternpost. Adding the flare decreased the hump trim and resistance. Removing a part of the afterbody near the sternpost increased the trim and resistance. The Mk. II float had slightly less hump resistance but greater resistance at planing speeds and more roach than the Mk. I float.

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616. Anon.: O2U Airplane - Mark IV Float. Experiments with Model. Rep. No. 247, USEMB, Jan. 1930.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. IV float for the Vought O2U seaplane. A specific free-to-trim resistance test of the model with the flare at the second step removed was also made. The results of the tests are given in graphical form.

617. Anon.: O2U Float - Mark VI, Modification I. Experiments with a Model of. Rep. No. 353, USEMB, April 1933.

Specific free-to-trim and fixed-trim resistance tests, and tests of the hydrostatic longitudinal stability were made of a $\frac{1}{8}$-size model of modification I of the Mk. VI float for the Vought O2U seaplane in the U. S. Experimental Model Basin. The float was modified by increasing the beam and displacement of the aft portion of the afterbody, and by adding chine flare to the afterbody. The increase in beam and displacement had very little effect on the trim and resistance but caused the appearance of two roaches which originated, one on each side, near the sternpost. The usual roach at the stern was also present. The afterbody chine flare reduced the amount of water flowing over the deck, decreased the hump resistance, and made the side roaches more vertical.

618. Anon.: O2U Float Series - Mark XI Float. Experiments with a Model of. Rep. No. 406, USEMB, Sept. 1935.

Specific free-to-trim and fixed-trim resistance tests and tests of the hydrostatic longitudinal stability were made in the U. S. Experimental Model Basin of a $\frac{1}{8}$-size model of the Mk. XI float [for the Vought O2U]. An additional test was made to determine the effects of removing the afterbody chine flare. The results of the tests are given in graphical form with photographs of the spray at several speeds. The Mk. XI float is considered to be as good as the Mk. X float (abstract 572) at planing speeds, and superior at hump and low speeds.

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619. Boev, V.: On the Problem of Scale Effect of Gliding Ships. Trans. Rep. No. 243, CAHI, (Moscow), 1935.

The results of tank tests of a series of geometrically similar models of seaplane floats, carried out with the aim of studying the scale effect, are discussed.

The reduction of model dimensions results in an increase of relative values of the water resistance and trimming angles and in a decrease of the center-of-gravity rise. When converted to full-scale according to Froude's law of similitude the maximum values of two first quantities and the minimum value of the last quantity move to higher velocities.

An analysis is given of the factors affecting the increase of the water resistance and the decrease of the center-of-gravity rise, with the decrease of the model dimensions. It is shown that for the conversion of model results to full-scale work the drag correction should be calculated not on the base of scale but on the base of absolute model dimensions.

The results of tests are compared with corresponding foreign data as obtained by Sottorf; Hermann, Kempf, and Kloess; Ogawa and Murata; and Jones.

The minimum admissible dimensions of the model are determined and it is found that the results of tank tests of these models may be converted to full-scale according to Froude's law with a sufficient degree of accuracy.

In conclusion a comparative analysis is given of several full-scale data showing that the tank data for the conditions of a free trimming of the model may be taken for a criterion of take-off characteristics of a seaplane. In order to determine the scale effect the conditions of tank tests should correspond to the full-scale conditions as nearly as possible.

*620. Anon.: Ploskaya Zadacha O Glissirovaniyi Po Poverkhnosti Tiazheloy Zhidkosti Konechnoy Glubiny. Izv. Akad. Nauk SSSR, no. 1-2, 1943, pp. 67-90.

Investigation of movement of smooth plate on surface of heavy liquid of limited depth.

Eng. Ind., 1943, p. 533

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621. Anon.: PN-7 - Additional Shoal Water Tests (Width of Channel Unrestricted). Rep. No. 192, USEMB, May 1928.

The tests reported in abstract 622 were repeated with an unrestricted width of the shallow-water portion of the tank at three depths of shallow water, the shallowest being that at which the hull just cleared the bottom. At low speeds the resistance was greater for the shallow water than for the deep water and increased with reduction of depth. At the hump the resistance of the model at the shallowest depth was slightly less than at the other depths. At planing speeds the effect of trim on resistance was more pronounced for the shallow water than for the deep water. The waves that ran ahead of the model at low speeds reported in abstract 622 were not observed in these tests with unrestricted width of shallow water.

622. Anon.: PN-7 Hull - Shoal Water Tests. Rep. No. 188, USEMB, March 1928.

Specific resistance tests were made at the U. S. Experimental Model Basin on a $\frac{1}{13}$-size model of the hull of the PN-7 flying boat at two depths of shallow water, and the results were compared with those of previous tests at the full depth of water of the tank. The width of the shallow-water area in the tank was small. The effect of the depth of water was most pronounced at about one-half of hump speed. Up to this speed, waves built up around the model and ran ahead of it. The depth of water had little effect on the hump resistance. At high planing speeds the resistance of the model at the lesser depth of water was greater than that at the greater depth of water and that at the full depth of water of the tank.

623. Parkinson, J. B.: A Pointed-Step Float Suitable for Use Under a 3800-Pound Single-Float Seaplane. NACA MR, Bur. Aero., June 12, 1937.

A seaplane float (NACA model 73) was designed to replace the Navy Mark V float. The float has a deep pointed step that is faired into a horizontal afterbody. A small discontinuity was maintained between the step and the fairing.

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The hydrostatic properties and take-off characteristics of a $\frac{1}{3.26}$-size model are compared with those of a model of the Mark V float. For the same reserve buoyancy (85 percent) when applied to a 3800-pound seaplane, the pointed-step float has slightly smaller over-all dimensions and frontal area and a lower initial trim. The trim at low water speeds is from 3° to 6° less than that of the Mark V float. The spray about the after end and the bow clearance were reduced. The difference in resistance between the two floats at best trim is negligible. A tendency for the pointed-step float to yaw at speeds just prior to hump was noted.

[More complete data are given in a later report (abstract 156).]

624. Olson, Roland E., and Land, Norman S.: Resistance Tests of a 1/8-Full-Size Model of the Consolidated PBY Flying Boat - NACA Model 124-D-1. NACA MR, Bur. Aero., May 9, 1941.

Specific free-to-trim resistance tests of a $\frac{1}{8}$-size dynamic model of the Consolidated PBY flying boat complete with wing and tail surfaces were made in Langley tank no. 1. The model differed from the original PBY in having a longer afterbody, no chine flare on the afterbody, and a 30° V-step (abstract 521). The tests were made at five gross loads which corresponded full-size loads from 25,000 to 45,000 pounds. The aerodynamic drag of the model was also measured. The results of the tests are given in graphical form.

625. Olson, Roland E., and Land, Norman S.: Resistance Tests of a 1/8 Full-Size Model of the Consolidated PB2Y-3 Flying Boat - NACA Model 116. NACA MR, Bur. Aero., May 7, 1941.

Specific free-to-trim resistance tests were made in Langley tank no. 1 of a model of the Consolidated PB2Y-3 flying boat. The model used was the dynamic model (complete with wing and tail surfaces) used for the tests reported in abstract 776 with the step in the aft position. The tests were made at gross loads ranging from 60,000 to 86,000 pounds, full size, with two elevator deflections. Similar tests were made of the hull alone, and of the hull with tail surfaces at one gross load. Directional instability appeared at heavy loads and high speeds. The aerodynamic drags of the models were determined at various trims and speeds. The results of the tests are given in graphical form.

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626. Woodward, David R., and Leventhal, Bernard E.: Resistance Tests of a 1/11-Size Model of the Hull of the Bureau of Aeronautics Design No. 22ADR Class VPB Airplane – Langley Tank Model 207 – TED No. NACA 2361. NACA MR No. L5H06a, Bur. Aero., 1945.

The resistance and spray characteristics of a $\frac{1}{11}$-size model of the hull of the Bureau of Aeronautics design no. 22ADR flying boat were determined for two values of the gross load (105,000 pounds and 125,000 pounds, full size) by specific tests in Langley tank no. 1. The models were tested free to trim to speeds beyond hump speed and with fixed trim at enough trims to include zero trimming moment at hump speed and best trim from hump speed to get-away speed.

Upon completion of the resistance tests of the basic model, similar tests were made of the model with chine flare added to the afterbody. The addition of chine flare improved the flow around the sides of the afterbody and the tail extension and reduced the hump resistance and trim.

The results of the tests of the basic model and the model with chine flare added to the afterbody are presented in the form of curves of resistance, trim, and trimming moment plotted against speed, and photographs of the spray. The bow spray characteristics at low speeds were satisfactory even at a load coefficient of 1.2 (about 210 percent of the design gross load coefficient).

627. Olson, Roland E., Posner, Jack, and Woodward, David R.: Resistance Tests of a 1/16-Size Model of the Hughes-Kaiser Flying Boat – NACA Model 183. NACA MR, Dept. Commerce, June 2, 1944.

General free-to-trim and fixed-trim resistance tests were made in Langley tank no. 1 of a $\frac{1}{16}$-size model of the hull of the Hughes-Kaiser cargo flying boat. Tests of the static properties were also made. The most recent changes in the hull form were incorporated in the model. Modifications to the model were made by successively increasing the chine flare near the sternpost and adding breaker strips to the tail extension.

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At hump speed, with the model free to trim, the trim and resistance were high, and the load-resistance ratio was about 4.0 for a gross load coefficient of 0.75. Increasing the chine flare near the sternpost reduced the positive trimming moments and reduced the speed at which the tail extension broke clear of the water. The addition of breaker strips on the tail extension caused a further reduction in the positive trimming moment and increased the hump load-resistance ratio to about 4.8 at a gross load coefficient of 0.75.

The results of the fixed-trim tests are presented in the form of working charts (see abstract 151). Take-off computations using these data and the estimated aerodynamic characteristics of the flying boat indicate that the maximum gross weight for take off with 16.6-foot four-blade propellers is 375,000 pounds, full size, and with 18.5-foot four-blade propellers is 400,000 pounds, full size. The take-off time and distance with a gross weight of 400,000 pounds are 69 seconds and 5600 feet, respectively.

If the variation of frictional resistance with Reynolds number is taken into account, the full-size hump resistance is reduced by 8 percent. A reduction of about 14 percent in hump resistance would be obtained if the trim at hump speed were lowered to the lower trim limit of stability. Best trim is below the lower limit and is accompanied by excessive positive trimming moments.

628. Wadlin, Kenneth L., and Adams, Clifford E.: Resistance Tests of a Model of a Seaplane Float Alternately Fitted with a "Gazda Nozzle" Step and a Conventional Transverse Step (NACA Models 57-B-6 and 57-B-7). NACA MR, Bur. Aero., July 31, 1944.

Specific free-to-trim and fixed-trim resistance tests were made in Langley tank no. 2 of a model of a seaplane float alternately fitted with a "Gazda nozzle" step (see figure) and a conventional transverse step. The model with the Gazda nozzle step had greater

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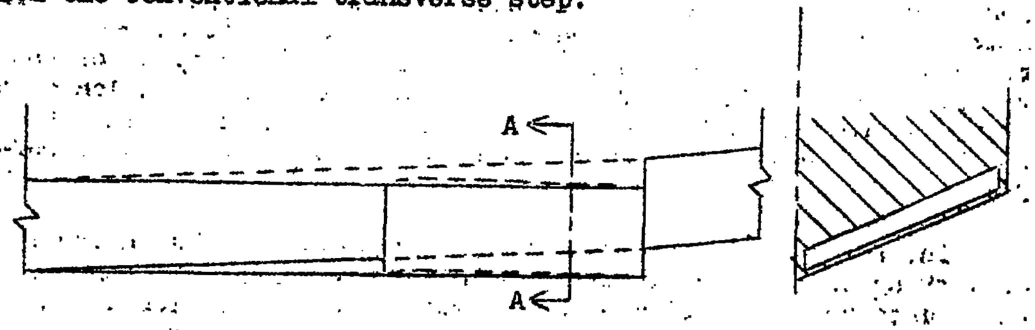
resistance and started to porpoise at a lower speed than the model with the conventional transverse step.



"Gazda nozzle" step Half-section A-A

629. Bell, Joe W.: Resistance Tests of Models of the Float of the NB-1 Seaplane with and without Winding Surfaces of the Bottom of the Forebody (NACA Models 153A and 153B). NACA MR, Bur. Aero., Dec. 17, 1942.

Tests were made in Langley tank no. 1 of two models of seaplane floats to determine the effects of warping the forward two-thirds of the forebody bottom (increasing the angle of dead rise of the forward sections to a greater value than that of the sections near the step). A $\frac{1}{4}$-size model of the float of the NB-1 seaplane and a similar model on which the angle of dead rise was constant along the forebody were used. Specific free-to-trim resistance tests, and a free-to-trim resistance test at a constant load were made of both models. There were no significant differences between the hump resistance, resistance at best trim, or spray characteristics of the two models. At high speeds and low trims part of the warped forebody was in the water and the resistance of the model with constant dead rise was less than that of the model with the warped forebody. The effect of step ventilation on the resistance near hump speed was investigated and was found to be negligible. (See also abstract 598.)

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630. Sedov, L.: Scale Effect and Optimum Relations for Sea Surface Planing. NACA TM No. 1097, 1947.

From the general dimensional and mechanical similarity theory it follows that a condition of steady motion of a given shaped bottom on the surface of water is determined by four nondimensional parameters. The various systems of independent parameters which are applied in theory and practice and in special tests are considered and their interrelations and suitability as planing characteristics are determined. In studying scale effect on the basis of the Prandtl formula for the friction coefficient for a turbulent boundary layer, the order of magnitude is given of the error in applying the model data to full scale in the case of a single-step bottom. For a bottom of complicated shape it is shown how to obtain, by simple computation from the test data of the hydrodynamic characteristics for one speed with various loads or one load with various speeds, a good approximation of the hydrodynamic characteristics for a different speed or load. The extrapolation of the curve of resistance against speed for large speeds, inaccessible in tank tests or for other loads which were not tested is thereby possible. The data obtained by computation are in good agreement with the test results. Problems regarding the optimum trim angle or the optimum width in the case of planing of a flat plate are considered from the point of view of the minimum resistance for a given planing speed and load on the water. Formulas and graphs are given for the optimum value of the planing coefficient and the corresponding values of the trim angle and width of the flat plate.

*631. Sottorf, W.: Der Schwimmer mit hoher Längsstufe (Float with High Longitudinal Step). FB No. 719, Z.W.B., Nov. 7, 1936.

The results are given of the investigation of a float with a longitudinal step which is extremely high, compared with the DVL single float of the B family (25° angle of dead rise). As a result of these tests, which confirm the results of previous tests with low and with medium high steps in the planing surface and in the front part of the floats, any longitudinal steps must be considered as unsuitable.

Author

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632. Bell, Joe W., and Ebert, John W., Jr.: Specific and General Tank Tests of Modifications of a 1/8-Size Model of the Hull of the Martin XPBM-3 Flying Boat (NACA Model 120.) NACA MR, Bur. Aero., Dec. 19, 1940.

Specific free-to-trim and fixed-trim resistance tests were made in Langley tank no. 1 of a $\frac{1}{8}$-size model of the hull of the Martin XPBM-3 flying boat and several modifications. The modifications included moving the step aft, replacing the straight transverse step by a V-step which had the same position at the chines, adding chine flare to the afterbody, widening the afterbody, adding planing surfaces (called "squat boards") to the afterbody near the sternpost, changing the tip of the tail extension, adding either a transverse step or breaker strips to the tail extension, and adding hydrofoils either at the sternpost or just aft of the step.

The breaker strips on the tail extension kept spray from wetting the top of the tail extension. Moving the step aft raised the trim at low speeds and lowered the trim at high speeds. The plan form of the step had no significant effect on the hydrodynamic characteristics. The addition of chine flare to the afterbody lowered the hump trim and reduced the hump resistance. Widening the afterbody or adding planing surfaces near the sternpost lowered the hump trim slightly, increased the hump resistance, and caused no improvement in resistance at high speeds. The hydrofoil added just aft of the step lowered the trim and increased the resistance at high speeds.

One model, which incorporated the modifications of chine flare on the afterbody, revised tip of the tail extension, and a breaker strip on the tail extension, was considered to be the best modification, and specific free-to-trim, fixed-trim, and general fixed-trim resistance tests were made of it at several gross loads and positions of the center of gravity.

633. Benson, James M., and Willis, John M., Jr.: A Specific Tank Test of a Model of the Hull of the Bureau of Aeronautics Design 7449 Flying Boat - NACA Model 121. NACA MR, Bur. Aero., Feb. 7, 1941.

Specific fixed-trim and free-to-trim resistance tests were made of a $\frac{1}{12}$-size model of the hull of a flying boat designated by the Bureau of Aeronautics as plan no. 7449. The model was tested in 6 feet of water at two gross loads. Porpoising was observed over a narrow speed range in the region of hump speed when the model was free to trim and undamped. Resistance, trim, trimming moment, load-resistance ratio, and load are plotted as a function of speed and a few photographs of the model underway are included.

634. Bell, Joe W., Ebert, John W., Jr., and Lina, Lindsey J.: Specific Tank Tests of Additional Modifications of Two Models of Floats for the SB2U-3 and OS2U-1 Seaplanes - N.A.C.A. Models 106-D to 106-M, Inclusive and 107-D to 107-M, Inclusive. NACA MR (Supplement), Bur. Aero., Oct. 11, 1941.

The specific resistance tests described in abstracts 178 and 642 were extended to include additional modifications to the $\frac{1}{4}$-size models of the two floats designed by Edo Aircraft Corporation for use with the SB2U-3 and OS2U-1 airplanes. The modifications included an increase in the depth of step, a reduction of the curvature of the flutes both of the forebody and the afterbody, a change in the fluted bottom of the afterbody to a single curved bottom, and a change in the afterbody to a straight V-bottom. The effect of changing the position of the step was also investigated.

An increase in the depth of step raised the free-to-trim trim, increased the resistance at the hump and reduced the resistance at high speed both in the free-to-trim and fixed-trim tests, and increased best trim at high speed. By moving the step $1\frac{1}{2}$ inches aft the free-to-trim trim increased up to and including hump speed but decreased at higher speeds, the resistance at the hump during free-to-trim tests increased, and the fixed-trim resistance at high speed decreased. The small reduction in the depth of the flutes of the forebody did not cause any significant changes in the measured results of the tests. The reduction of the depth of the flutes of the afterbody caused a small reduction of the free-to-trim resistance at the hump and at high speed. The best-trim resistance of this modification was reduced at high speed. The change of the forebody from a fluted bottom to a flared bottom without flutes caused, in general, a slight decrease in the free-to-trim resistance at high speed. The change of the afterbody from a fluted bottom to a straight V-bottom caused a large increase in free-to-trim trim and resistance through most of the speed range.

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635. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of a Model of a Modification of the Hull of the Martin Design 160 Flying Boat - N.A.C.A. Model 77-A. NACA MR, Bur. Aero., April 1, 1938.

Specific free-to-trim resistance tests were made of a $\frac{1}{10}$-size model of a modification of Martin design 160. The model was the same as that referred to in abstract 644 but with the kicker plates removed. Three gross loads and their corresponding get-away speeds were investigated.

A discontinuity was observed in the trim and resistance curves just above hump speed. Suction actuated by a flow of water over the rounded after end of the tail caused high trim and when the flow was interrupted at higher speeds the trim dropped abruptly. Lateral instability was noticed just prior to hump speed. Motion pictures were taken of the model during an accelerated run with and without thrust moment for each of the loads tested.

636. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of a Modification of the Hull of the Martin Design 160 Flying Boat - N.A.C.A. Model 77-F (Supplement). NACA MR, Bur. Aero., April 29, 1938.

The specific free-to-trim resistance tests of abstract 635 were extended to include modifications which consisted of the addition of a step near the after end of the tail extension and the provision of ventilating ducts at the main step.

A reduction in hump trim and hump resistance was effected but the directional instability noted with the other model still persisted. Ventilation appeared to have little effect on the resistance in the region of the hump.

637. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of Modifications of the Hull of the Martin Design 160 Flying Boat - N.A.C.A. Models 77-G, 77-H, 77-J, and 77-K. NACA MR (Supplement), Bur. Aero., June 6, 1938.

The specific free-to-trim resistance tests of abstracts 635, 636, and 644 were repeated for four more modifications of the model. The modifications included, successively, the modification of abstract 644 with chine flare added to the afterbody, the step removed from the tail extension and chines added the full length of the tail extension, the chine flare removed from the afterbody, and the dead rise increased on the forward part of the tail extension. A few tests were made with the ventilation ducts closed in order to determine the effect of ventilation.

Although the step did not break the suction that occurred when the water flowed over the tail, the added chine flare reduced the hump resistance somewhat. Substitution of chines for the step on the tail extension caused an appreciable decrease in the hump resistance. The removal of the chine flare from the afterbody caused a substantial increase in the hump resistance. The resistance was not affected by increasing the dead rise on the forward part of the tail extension but there was a substantial improvement in the spray characteristics.

638. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of a Model of the Proposed Hull of the XPB2M-1 Flying Boat - NACA MR, Bur. Aero., Feb. 24, 1939.

Specific fixed-trim and free-to-trim resistance tests were made in Langley tank no. 1 of several modifications of a $\frac{1}{10}$-size model of the hull proposed for the Martin XPB2M-1 flying boat. The modifications consisted of adding chine flare to the afterbody first near the sternpost and second near the sternpost and at the step. Each test, except that of the second modification, was made at three combinations of gross load and position of the center of gravity. Some fixed-trim resistance tests were made at very heavy loads and at speeds near get-away speed of two additional modifications that involved the location of the step. The results of all tests are presented in graphical form.

639. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of a Model of a Modification of the Hull of the Sikorsky Design MO-7032 Flying Boat - N.A.C.A. Model 78-B. NACA MR, Bur. Aero., May 4, 1938.

The resistance tests of a $\frac{1}{10}$-size model of Sikorsky design MO-7032 reported in abstract 650 showed that at high speeds the afterbody of the model would "suck down" and cause abnormally high trims. It was also shown that strips placed on the tail extension alleviated the suction forces. Spray strips which extended from the main step to the second step were added to the afterbody of the model and a sharp chine was fitted to the tail extension for about 1 foot from the after end.

Specific free-to-trim resistance tests were made at four gross loads with simulated propeller thrust moment. No evidence of "sucking down" was observed. Resistance, load, trim, and load-resistance ratio are plotted as a function of speed.

640. Dawson, John R., and Drumwright, Arthur L.: Specific Tank Tests of a Model of the Hull of the XPBM-1 Flying Boat - N.A.C.A. Model 95. NACA MR, Jan. 10, 1939.

Specific free-to-trim and fixed-trim resistance tests were made of a $\frac{1}{6.8}$-size model of the hull of the Martin XPBM-1 flying boat in Langley tank no. 1. The tests were made at three values of gross load, each load requiring a different position of the center of gravity. The results of the tests are given in the form of curves of resistance, load, trim, trimming moment, and load-resistance ratio plotted against speed. Photographs of the spray around the model are presented.

641. Dawson, John R.: Specific Tank Tests of a Model of the Martin Model 160 Flying-Boat Hull. NACA MR, April 13, 1937.

Tank tests were made of a model of the Martin model 160 flying-boat hull. The resistance and trimming moment were determined at certain speeds, loads, and trims representing a take-off condition. Some contact prints of photographs of the model taken during the tests are included.

642. Bell, Joe W., and Ebert, John W., Jr.: Specific Tank Tests of Modifications of Two Models of Floats for the SB2U-3 and OS2U-1 Seaplanes - N.A.C.A. Models 106, 106-A, 106-B, 107, and 107-A. NACA MR (Supplement), Bur. Aero., Jan 27, 1941.

The specific resistance tests described in abstract 178 were checked at a water depth of 6 feet and extended to include several modifications of the float models. The step was moved aft in both NACA model 106 and NACA model 107 and the curvature of the flutes on the bottom was decreased. An aft movement of the step increased the depth of step and length of forebody and decreased the length of the afterbody.

An aft movement of the step increased trim and resistance at hump speed, decreased trim and resistance at planing speed, and increased resistance at speeds near get-away. A decrease in the curvature of the flutes on the bottom reduced the trim below hump speed, increased the trim above hump speed, and increased the resistance throughout the entire speed range.

The results are plotted as a function of speed and some photographs that show the spray around the model at specially selected speeds are included.

643. Bell, Joe W.: Tank Tests of a Model of the Float System of the Rohrbach Romar Flying Boat. N.A.C.A. Model 55. NACA MR, Mar. 15, 1938.

A $\frac{1}{7}$-size model of the float system of the Rohrbach Romar flying boat was tested in Langley tank no. 1. The test data for the complete float system (including inboard side floats) and for the main hull alone are presented in the form of curves plotted in nondimensional units.

The resistance of the model was relatively high, both with and without side floats. The best trim had low values throughout the range of speeds at which the model was tested.

A comparison of the test data with and without the side floats shows the following: the side floats carry about one-third of the load on the water at hump speed, the hump resistance is lower with the side floats than without them, and the resistance hump occurs at a lower speed with the side floats than without them.

644. Dawson, John R., and Olson, Roland E.: Tank Tests of Model of the Hull for Martin Flying Boat Designs 160 and 162. NACA MR, June 21, 1937.

Resistance tests were made of a model of a flying-boat hull as it was originally designed and as it was modified. The resistance and trimming moment were determined at certain speeds, loads, and trims representing a take-off condition. Specific free-to-trim resistance tests were also made. The maximum beam was increased from 15 to $15\frac{1}{8}$ inches by adding vertical spray strips to the sides

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of the model. The afterbody was modified by adding tapered plates at the sternpost (kicker plates) that increased the planing area and the effective angle of attack of the afterbody near the sternpost.

645. Parkinson, J. B.: Tank Tests of a Model of the Hull of a Flying Boat for C. L. Ofenstein. NACA MR, June 25, 1937.

Specific free-to-trim and general fixed-trim resistance tests and hydrostatic heel-stability tests were made of a $\frac{1}{8}$-size model of a flying-boat hull. The model was fitted with stub wings which were varied in span, angle of attack, and height.

Above $\frac{3}{4}$-get-away speed suction developed on the afterbody which pulled the forebody entirely clear of the water. The water flowed up over the rounded chines near the second step and enveloped the entire after portion of the hull in heavy spray.

646. Bell, Joe W.: Tank Tests of a Model of the Hull of Bureau of Aeronautics Design No. 137 Flying Boat (N.A.C.A. Model 59). NACA MR, Bur. Aero., Dec. 7, 1937.

Specific free-to-trim and general fixed-trim resistance tests were made in Langley tank no. 1 of a $\frac{1}{8}$-size model of the Bureau of Aeronautics design no. 137 flying boat and several modifications. Tests of the static buoyancy and trim of the original model were also made. The successive modifications included increasing the dead rise at the second step, increasing the length of the straight buttock lines of the forebody, lengthening the afterbody, adding spray strips to the afterbody, replacing the V-step by a straight transverse step, increasing the beam of the forebody, straightening the afterbody buttock lines, moving the center of gravity forward, and increasing the gross load. The results of the tests are presented in graphical form.

647. Allison, John M.: Tank Tests of a Model of the Hull of the Boeing 314 Flying Boat (N.A.C.A. Tank Model 72.) NACA MR, Sept. 16, 1936.

Specific resistance tests of a $\frac{1}{10}$-size model of the hull of the Boeing 314 flying boat and of the hull fitted with two types of stub wings were made at Langley tank no. 1 to determine the best hull-stub-wing combination and best setting of the selected stub wing consistent with the requirements that had been established as to air drag, structural arrangement, and lateral stability. General resistance tests of two selected configurations, and hydrostatic rolling stability tests of one configuration were also made. The flow of water along the bottom of one configuration was observed at several speeds. Adding stub wings to the hull lowered the trim at medium speeds, did not materially reduce the hump resistance, and decreased the hump speed. The leading edges of the stub wings should be high to prevent bow waves from breaking over them at heavy loads and low speeds.

648. Parkinson, John B., and Allison, John M.: Tank Tests of a Model of the XPB2Y-1 Flying-Boat Hull. NACA MR, Bur Aero., Feb. 5, 1937.

General fixed-trim and specific fixed-trim and free-to-trim resistance tests were made of a $\frac{1}{8}$-size model of the hull of the XPB2Y-1. The hull had a long straight forebody keel, a short afterbody, a transverse step, and a long tail extension. The afterbody was hooked at the forward end so as to act as a partial fairing for the step. Tests of the model with the chine flare removed from both the forebody and afterbody were also made. Tests to determine the static properties of the original design were made and the results are plotted. Contact prints of photographs taken during the tests are included. The removal of the chine flare allowed spray to be thrown considerably higher and the rising wake from the step wet the afterbody at lower speed. The addition of step ventilation had a negligible effect on resistance and trimming moment.

A special plot of load coefficient as a function of the square of the speed coefficient with load-resistance ratio and trimming-moment coefficient as a parameter is presented for the best trim condition.

649. Bell, Joe W., and Benson, James M.: Tank Tests of the Martin No. 156 Flying-Boat Model (N.A.C.A. Tank Model 70). NACA MR, Aug. 7, 1936.

General fixed-trim and specific fixed-trim and free-to-trim resistance tests were made of a $\left[\frac{1}{8}\text{-size}\right]$ model of Martin no. 156

flying boat to determine the effect on the hydrodynamic characteristics of changes in gross weight and modifications to the stub wings. The model hull without stub wings was understood to be NACA model 24 (abstract 212). The model was complete with stub wings and included fittings for varying the span, height, angular setting, and dihedral. Three modifications were made to the chines near the step and corrugations were fitted to the forebody.

The values of load, resistance, draft, and trimming moment measured during the general test are tabulated and plotted as functions of speed. The values of resistance, rise, trim, load, and load-resistance ratio in the specific free-to-trim tests and resistance, rise, trimming moments, load, and load-resistance ratio in the specific fixed-trim tests are plotted as functions of speed. A large number of contact prints of photographs taken during the tests are included.

The flow of water over the bottom of the hull was investigated by applying spots of lampblack solution to the bottom and by photographing the streaks caused by the flow of water.

650. Dawson, John R., and Olson, Roland E.: Tank Tests of Three Models (Models 77, 78, and 79) Representing the Hulls of Large Flying Boats. NACA MR, Bur. Aero., July 9, 1937 and Aug. 5, 1937.

Specific free-to-trim and general fixed-trim resistance tests were made of $\frac{1}{10}$-size models of three flying-boat hulls (Martin 160, Sikorsky MO-7032, and Consolidated XPB3Y-1). Trimming-moment coefficient and draft coefficient as a function of load coefficient and trim were determined for each model at rest. The results are plotted and a few photographs that were taken of the models underway are included. Best-trim and zero-trimming-moment data are also presented.

651. Dawson, John R., and Drumwright, Arthur L.: Tank Tests of Two Models of Hulls of the Pointed-Step Type (Designed for Consolidated Aircraft Corporation XPB3Y-1 Flying Boat) – N.A.C.A. Models 79-A and 79-B. NACA MR, Bur. Aero., April 25, 1938.

Specific free-to-trim and general fixed-trim resistance tests were made of a $\frac{1}{10}$-size model of a hull developed for the XPB3Y-1 flying boat. The model was the same as that referred to in abstract 650 converted into a pointed-step type hull. Pointed steps of two different lengths were investigated. The free-to-trim tests were made at several positions of the center of gravity in order to determine an optimum position. The resistance data were plotted as a function of speed coefficient. Data on the hydrostatic forces were taken and the results are presented as trimming-moment and draft coefficient plotted against load coefficient with trim as a parameter.

652. Dawson, John R., Walter, Robert C., and Hay, Elizabeth S.: Tank Tests to Determine the Effect of Varying Design Parameters of Planing-Tail Hulls. I - Effect of Varying Length, Width, and Plan-Form Taper of Afterbody. NACA TN No. 1062, 1946.

Specific fixed-trim resistance tests were made in Langley tank no. 2 of several different configurations of planing-tail hull (see abstract 106). The tests were made with afterbodies of two widths, two lengths, and two types of plan-form taper while the depth of step (0.346 beam) and the angle of afterbody keel (4°) were held constant. In each case the center of gravity was chosen so that the trims at the free-to-trim and best trim hump speeds were identical.

The results of the tests of the planing-tail hull were compared with the results of a hull with a transverse step and conventional proportions. The comparison showed that the conventional hull had 40 percent greater resistance at the hump speed and from 75 to more than 100 percent greater resistance near get-away. It should be noted, however, that in an actual application the center of gravity of the planing-tail hull would have to be located aft of the step in order to obtain the reduction in resistance at the hump speed.

Decreasing the width of the afterbody increased the resistance and trim at hump speed, decreased the trimming moments required to obtain best trim, and moved forward the location of the center of gravity required to give best trim at the hump speed. Increasing the length of the afterbody decreased the resistance and increased the trim over almost the whole speed range and moved aft the location of the center of gravity required to obtain best trim at the hump speed. Tapering the plan form of the afterbody reduced the resistance over the lower half of the speed range and had little effect on the resistance at high speeds. Plan-form taper also moved forward the location of the center of gravity required to obtain best trim at the hump speed.

652a. Dawson, John R., McKann, Robert, and Hay, Elizabeth S.: Tank Tests to Determine the Effect of Varying Design Parameters of Planing-Tail Hulls. II - Effect of Varying Depth of Step, Angle of Afterbody Keel, Length of Afterbody Chine, and Gross Load. NACA TN No. 1101, 1946.

The second part of a series of tests made in Langley tank no. 2 to determine the effect of varying design parameters of planing-tail hulls is presented. Results are given to show the effects on resistance characteristics of varying angle of afterbody keel, depth of step, and length of afterbody chine. The effect of varying the gross load is shown for one configuration. The resistance characteristics of planing-tail hulls are compared with those of a conventional flying-boat hull. The forces on the forebody and afterbody of one configuration are compared with the forces on a conventional hull.

Increasing the angle of afterbody keel had small effect on hump resistance and no effect on high-speed resistance but increased free-to-trim resistance at intermediate speeds.

Increasing the depth of step increased hump resistance, had little effect on high-speed resistance, and increased free-to-trim resistance at intermediate speeds.

Omitting the chines on the forward 25 percent of the afterbody had no appreciable effect on resistance. Omitting 70 percent of the chine length had almost no effect on maximum resistance but broadened the hump and increased spray around the afterbody.

Load-resistance ratio at the hump decreased more rapidly with increasing load coefficient for the planing-tail hull than for the representative conventional hull, although the load-resistance ratio at the hump was greater for the planing-tail hull than for the conventional hull throughout the range of loads tested. At speeds higher than hump speed, load-resistance ratio for the planing-tail hull was a maximum at particular gross load and was slightly less at heavier and lighter gross loads.

The planing-tail hull was found to have lower resistance than the conventional hull at both the hump and at high speeds; but at intermediate speeds there was little difference. The lower hump resistance of the planing-tail hull was attributed to the ability of the afterbody to carry a greater percentage of the total load while maintaining a higher value of load-resistance ratio.

653. Anon.: Test Float with Variable Keel Angle. Report on Experiments with Model No. 2602. Rep. No. 113, USEMB, March 1925.

Specific resistance tests were made at the U. S. Experimental Model Basin on a twin-float seaplane model for afterbody keel angles of 4°, 6°, 8°, and 10°. The longitudinal and transverse righting moments at rest were also determined. For each angle of afterbody keel, the longitudinal position of the center of gravity was that which gave a static trim of 3°. Below planing speeds, increasing the angle of afterbody keel appeared to lessen the lifting power of the stern and resulted in an increase of resistance.

654. Truscott, Starr: Tests of a Model of Hull of Sunstedt Aircraft Corporation Design HS-340. (N.A.C.A. Tank Models 63 and 63-A). NACA MR, Oct. 12, 1935.

Specific resistance tests were made in Langley tank no. 1 of a model representing the hull of a large flying boat, the Sunstedt HS-340. The hull, which was of the catamaran type, consisted of two half hulls with vertical inboard sides set apart and connected by a flat-bottomed joining structure. It was found that the joining structure was wetted at certain ranges of speed, producing a large increase in resistance and sucking the tail down.

655. Bell, Joe W., and Ebert, John W., Jr.: Tests of a Series of Modified Forms of a 1/4-Size Model of a Float for the XSB2C-2 Airplane - N.A.C.A. Model 125. NACA MR, Bur. Aero., Oct. 30, 1941.

Resistance tests were made in Langley tank no. 1 of a $\frac{1}{4}$-size model of one of a pair of floats designed by the Edo Aircraft Corporation for use with the XSB2C-2 airplane. The tests included investigations of the effects of variations of the angle of afterbody keel (6.1°, 7.6°, and 9.1° to forebody keel), changes in the beam of the forebody (12.5, 14.0, and 15.5 inches), and a change in the depth of the flutes of the forebody. Tests were also made of the basic forebody without an afterbody and of the forebody with increased depth of flutes without an afterbody. The tests were made both by the specific fixed-trim and specific free-to-trim methods. Wetted length and depth of the trough were measured in the tests of the forebody alone. Rise was measured in all of the tests.

An increase in angle of afterbody keel resulted in higher trims at the hump in the free-to-trim test, higher resistance at the hump both in free-to-trim and fixed-trim tests, lower resistance at high speeds, larger positive trimming moments at the hump, and smaller negative trimming moments at high speed. A decrease in the beam of the forebody caused little change in the resistance but the hump speed was increased, the trimming moments became more positive, and both the height and the volume of the spray increased. The increase in the depth of the flutes of the forebody did not cause any important changes in the data obtained from the test. The tests of the forebodies without afterbodies showed that a very large portion of the resistance of a complete model near get-away speed was caused by the afterbody.

656. Parkinson, John B., and Dawson, John R.: Tests of Model of Edo No. 49 Float Model. NACA MR, Edo, Feb. 26, 1936.

Specific fixed-trim and free-to-trim resistance tests were made of a $\frac{1}{3}$-size model of Edo float no. 49. The model had two steps with a wheel well just aft of the forward step but forward of the center of gravity. The model was towed from a point representing the center of gravity of the complete seaplane. Modifications to the original design included wheel well closed off, pivot moved 4 inches forward and 4 inches aft, tail section rotated up $4\frac{1}{4}^{\circ}$ and down $4\frac{1}{4}^{\circ}$, forebody rotated up 2° and down 2°, and a straight portion added between the two steps.

The values of load on the water, resistance, rise, load-resistance ratio, and trim for the free-to-trim tests and load on the water, resistance, rise, load-resistance ratio, and trimming moment for the fixed-trim tests are given in tables and are plotted as functions of speed. Contact prints of photographs taken during the tests are included.

657. Brown, F. G., and Coombes, L. P.: Tests of the NACA 11-A Model Hull in the RAE Seaplane Tank. R. & M. No. 1784, British ARC, 1936.

An exchange of models was arranged with the NACA tank at Langley Field in order that the results obtained in the two tanks might be compared. As the American model was large for the R.A.E. tank, the tests also served as a check on the results of the tank calibration made previously (abstract 388). The tests of NACA model 11-A hull are described.

Measurements of resistance, trimming moment, and depth of immersion were made at four trims and several different loads. The range covered was considered to be sufficiently wide to make a reliable comparison possible.

The differences between the R.A.E. and NACA results, based on mean values, was generally very much less than 5 percent for resistance and $7\frac{1}{2}$ percent for trimming-moment measurements. The agreement is considered satisfactory, and can be accounted for by experimental errors. No evidence of wall interference or depth effect was found and the conclusions of the tank calibration tests were thus supported.

*658. Richardson, H. C.: The Trend of Flying Boat Development. Jour. Am. Soc. Nav. Engrs., vol. 38, no. 2, May 1926, pp. 231-253.

Model basin tests; V bottoms, hydrovanes or blades; conclusions.

Eng. Ind., 1926, p. 332

659. Harshman, J. D.: Trim Curves for 314 Tank Model with Configuration, 72-N. BAC Rep. No. D-2525, Feb. 1940

The results of general resistance tests of a $\frac{1}{10}$-size model of the Boeing 314 flying boat (abstract 647) are presented in the form of the working charts described in abstract 151.

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*660. Sottorf, W.: Untersuchung des Zentralschwimmer des Vought-Corsair Flugzeuges (Investigation of the Central Float of the Vought-Corsair Airplane). PB No. 323, Z.W.B.

The model of the central float of the Vought-Corsair is examined and compared with the model DVL 1a. The latter is superior as far as resistance and water-spray formation are concorned. For this reason a replacement float is designed for the Vought-Corsair at the disposition of the division. It is intended to test the seaworthiness of the DVL 1a float with further full-scale tests. The comparison shows that the differences in resistances with the angle of attack determined and with optimum angle of attack are relatively small. The difference between the two angles themselves is less than 2°, so that it will be possible, by the action of the elevator, to bring the airplane to a position of optimum angle of attack. The assumed position of the replacement float can therefore be kept.
Author

661. Sottorf, W.: Die "vollständige" Schleppmethode zur Bestimmung der Eigenschaften eines Schwimmwerkes unabhängig vom Flugzeugentwurf. Entwurf und Untersuchung der Modelle DVL 1 und 1a (The Comprehensive Towing Method for the Determination of the Quality of Float Gear Independent of Aircraft Design. Design and Investigation of Models DVL 1 and 1a). Forschungsbericht Nr. 156, Deutsche Luftfahrtforschung (Hamburg), 1934. (Available as Rep. No. ZH-016, CVAC, and Misc. Rep. No. 164, GIM.)

The specific fixed-trim resistance test method and the general fixed-trim resistance test method are discussed. Some of the reasoning involved in the design of DVL models 1 and 1a (length-beam ratio 6.04) is given. The instrumentation used in the general fixed-trim resistance tests is examined in detail and the results of the tests of a $\frac{1}{6}$-size model with an angle of dead rise excluding chine flare of 20° are given graphically. The results are compared with those of the HE 59 and NACA models 11A and 22; the DVL models are shown to be the most satisfactory.

[redacted]

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662. Perring, W. G. A.: The Water Performance of Seaplanes. Application of Tank Data to Determine the Effect of Wind, Variation of Loading or a Change of Air Structure upon the Performance. R. & M. No. 1657, British ARC, 1934.

A method is outlined for presenting the results of specific resistance tests in such a manner that the effects on take-off performance of wind, gross load, or changes in the aerodynamic structure of a seaplane may be determined.

From a consideration of the frictional and wave-making resistances it is considered that the water resistance of a seaplane at low speed may be expressed in the coefficient form $D/(L^{2/3}V^2)$, which should be a function of the Froude number $V^2/L^{1/3}$. It has already been shown (abstract 84) that, when a seaplane is operating at planing speeds, the resistance can be related to the load on the water by an equation of the form $D/V^2 = D_o + \beta L/V^2$ and that, for the trimming moment, M/V^2 is a function of L/V^2 and trim. The symbols used are defined as follows:

D	resistance
M	trimming moment
L	load on the water
V	speed
D_o and β	constants that depend on trim

The results of tests of models of flying-boat hulls show that the hydrodynamic forces and moments are satisfactorily represented when the data are presented in the forms mentioned.

663. Hamilton, J. A., and White, H. G.: Water Resistance Measurements on a Half-Scale Sunderland Hull. Rep. No. H/Res/187. British M.A.E.E., March 9, 1945.

Tests have been made of a half-scale model Sunderland hull attached to a modified Scion aircraft to determine by direct measurement the water resistance and the effect on water resistance

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of adding a step fairing. The tests included a series of steady runs at various speeds over a range of elevator angles.

Over most of the speed range the addition of a 1 to 6 fairing increased the water drag by 15 percent. Comparison with tank tests of a $\frac{1}{12}$-size model reveals that, depending on elevator position, the resistance of the half-scale model is from 0 to 20 percent greater than that of the $\frac{1}{12}$-size model.

[The accuracy of the results is questionable.]

(See also abstracts 413, 422, 439, 449, 518, 533, 534, 575, 754, 755, 755a, 759, 759a, 765, 782, 783, and 819.)

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664. Anon.: A Comparison of Stevens and NACA Tests in the Planing Range of the Navy Mark V Seaplane Hull. TM No. 47, SIT, March 14, 1940.

Results of resistance tests made at Stevens Institute of Technology and at Langley tank no. 1 (abstracts 195 and 215) of models of the Navy Mark V seaplane float, of 5.45 inches and 12.00 inches beam, respectively, are compared at one value of speed coefficient in the planing range. The discrepancy of the two results is considered to be caused primarily by the lack of similarity in the wetted areas, the wetted areas of the Stevens model being greater than those of the NACA model. The NACA test data are used to show that Schröder's method of hydrodynamic reduction (abstract 86) is reasonably reliable.

665. Anon.: Correlation of Stevens and DVL Model Tests of the DVL-1A Flying Boat Hull, TM No. 32, SIT, Sept. 9, 1938.

Results of resistance tests made at the DVL (abstract 15) of the DVL-1A hull with a beam of 0.958 foot are compared with results of tests made at Stevens tank of models of the DVL-1A hull, with beams of 0.500 foot. When the variation of frictional resistance with Reynolds number is neglected, the resistance of the Stevens model is greater than that of the DVL model in the displacement range, and is about the same as that of the DVL model in the planing range. When the variation of frictional resistance with Reynolds number is taken into account, the correlation between the Stevens model and the DVL model is improved in the displacement region and impaired in the planing range.

*666. Sottorf, W.: Einfluss der Heckquerstufen auf den Start (Influence of Transverse Afterbody Steps on Take-Off). Rep. No. H 75, Inst. für Seeflugw. der DVL, Oct. 26, 1940.

Tests were made of a flying boat with transverse steps on the afterbody. Three different sets of wedges (steps) that had inclines of 1:6, 1:10, and 1:14 were investigated. The second set of wedges (1:10) reduced the second resistance hump 45 percent as compared with an afterbody without transverse steps. Some reduction in resistance was noticed at the first resistance hump. The three investigations proved that transverse steps on the afterbody are simple and certain to improve the take-off of flying boats as regards to longitudinal stability and resistance. These results were confirmed full scale by Full. Author

*667. Sottorf, W.: Einfluss von Längsstufen im Vorschiff und Querstufen am Heck auf den Startwiderstand (Effect on Take-Off Resistance of Longitudinal Steps at Bow and Transverse Steps at Stern). FB No. 330, Z.W.B, May 13, 1935.

Large stern areas on a float have a very unfavorable effect on resistance before take-off because of increased friction due to wetted surfaces. Two possibilities of reducing the wetted area were considered. The longitudinal steps on the bow were consistently unfavorable in their effect on resistance. Transverse steps at the stern, however, cause an appreciable area of stern to remain dry. Investigation showed a reduction of resistance amounting to 45 percent. Author

668. Locke, Fred W., Jr.: The Frictional Resistance of Planing Surfaces. TM No. 40, SIT, July 25, 1939.

In predicting the resistance of a seaplane from the results of model tests, the effect of Reynolds number on the frictional resistance is customarily neglected. A correlation of existing information on the frictional resistance of planing surfaces and models of seaplane floats shows that, when no means are taken to control the boundary layer, it could be laminar, turbulent with laminar approach, or fully turbulent at Reynolds numbers up to about 10^7. Tests were made in the Stevens tank of a model with and without a strut towed in the water ahead of the model. Struts of various sizes at various distances ahead of the model were used. The strut tended to make the boundary layer completely turbulent, and made the spray and wake of the model resemble those of a full-size hull more closely.

669. Jones, E. T., Johnston, L., and Hanson, J.: Full Scale and Model Resistances of a Southampton II Hull. R. & M. No. 1724, British ARC, 1935.

The water resistance of a full-size Supermarine Southampton II flying boat was measured in steady and accelerated motion. The resistance of a $\frac{1}{7}$-size model of the hull was also measured over a range of loads, trims, and speeds corresponding to those of the full-size tests. The effect of longitudinal acceleration on the resistance was small and inconclusive for the range of acceleration tested (0, 0.02, and 0.06g). It was found that the resistance of the full-size flying boat was greater than that of the model by about 10 ± 5 percent at 35 feet per second (hump speed) and by about 25 ± 10 percent at 70 feet per second. It is possible that an appreciable part of this difference in resistance between the full-size flying boat and the model is attributable to the spray on the superstructure and the rivet heads and lap joints of the full-size flying boat.

670. Hanson, J.: Full Scale Water Resistance of the Singapore IIC in Steady Motion. R. & M. No. 1805, British ARC, 1936.

The full-scale resistance of a Short Singapore IIC flying boat was determined from values of accelerating force, air drag, and the horizontal component of the effective thrust measured during taxiing and in wind tunnel tests of a model. The resistance was compared with the results of resistance tests of $\frac{1}{16}$- and $\frac{1}{12}$-size models made in three tanks.

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It was found that the resistance of the full-size flying boat was the same as the resistance of the models at a medium planing speed, was less than that of the models at lower speeds, and was substantially greater than that of the models at high planing speeds. Previous comparisons between the resistances of full-size seaplanes and models have shown the same trend, which may not be entirely caused by scale effect, but may be partly attributable to the effects of rivet heads and lap joints on the full-size seaplanes.

671. Hugli, W. C., Jr.: High-Speed Resistance Tests on Modifications of the XPB2M-1 Flying Boat. Rep. No. 211, SIT, Oct. 1942.

Resistance tests of a number of minor modifications designed to decrease the high-speed resistance from afterbody wetting. Photographs of afterbody clearance from spray at several trim angles near get away.

672. Stout, E. G.: Investigation of Pointed Step Hulls — Appendix II, Rep. No. M-1618, CVAC, Sept. 1937.

Data from tests made in Langley tank no. 1 are used to show that with the same angle of dead rise, the pointed step type of flying boat hull has much lower resistance than a conventional hull chosen for comparison. Calculations indicate that by using a pointed step type hull for a 100,000-pound flying boat the beam can be reduced from 14 to 12 feet and at the same time the maximum overload can be increased 7.8 percent and the take-off time reduced 27 percent.

673. Ogawa, Taitiro, and Murata, Yosiro: Motion of Flying Boats During Take-Off and Landing Run. Rep. No. 105, Aero. Res. Inst., Tokyo Imperial Univ., April 1934.

Full scale take-off and landing tests were made of the N and Dornier Wal Flying boats to determine whether the water resistance, trim, draft, and hump speed as measured in tank experiments are in agreement with full-scale conditions. Motion pictures were taken of the take-offs and landings and data were taken directly from the film. The resistance was calculated from

$$R = T - \frac{W}{g}a - D \quad \text{for take-off}$$

and

$$R = \frac{W}{g} a - D \quad \text{for landing}$$

where R is the resistance, T is the thrust, W is the weight of the seaplane, g is the acceleration of gravity, a is the longitudinal acceleration, and D is the air drag. The data are presented in tables and in curves.

From the results the following conclusions are reached:

1. The water resistance curve obtained from the take-off run of the actual flying boats has about the same value at its maximum point as that obtained from the tank experiment.

2. The water resistance curve for the take-off run of the N flying boat has two humps, the first hump speed being smaller than that obtained in the tank experiments.

3. For speeds greater than the hump speed the water resistance is much less than that expected from the results of tank experiments.

4. The water resistance curve for the landing run differs considerably from that for the take-off run.

5. The hump speed is less for the flat-bottom(Dornier Wal) than for the V-bottom (N) flying boat.

6. The trim angle is almost constant for the planing stage.

7. The draft curves for both the full-scale and the tank experiment show fair agreement.

674. Sottorf, W.: New Method of Extrapolation of the Resistance of a Model Planing Boat to Full Size. NACA TM No. 1007, 1942.

The previously employed method of extrapolating the total resistance to full size with λ^3 $\left(\frac{1}{\lambda}\text{ is the model scale}\right)$ and thereby foregoing a separate appraisal of the frictional resistance, was permissible for large models and floats of normal size. But faced by the ever increasing size of aircraft, a reexamination of the problem of extrapolation to full size is called for. A method is described by means of which, on the basis of an analysis of tests on planing surfaces, the variation of the wetted surface over the take-off range is analytically obtained. The frictional resistance coefficients are read from Prandtl's curve for turbulent boundary layer with laminar approach. With these two values a correction for friction is obtainable.

The results of a series of models tested previously to determine the effect of scale were corrected and the results were in good agreement. The friction coefficient is subject to a relatively small increase during the jump from a 10-ton to a 100-ton flying boat but the increase is not found to be critical for extrapolation from a model of customary size at the present time.

675. Gruson, M. F.: Similitude in Hydrodynamic Tests Involving Planing. NACA TM No. 795, 1936.

The resistance of a partially immersed hull may be considered as composed of wave-making resistance and viscous (frictional and eddy-making) resistance. The usual method of scaling up the forces from a model to a hull of linear dimensions n times greater is to consider only the wave-making resistance and to multiply the forces by n^3 and the speed by n. The results of two series of tests of seaplane float models of various scales (abstracts 171 and 199) made at the Hamburg tank are presented to show that scaling up the resistance by n^3 is inadequate at speeds greater than hump speed. If the resistance at planing speeds is assumed to be wholly frictional, and Gebers' formula for frictional resistance is used, the resistance of the model should be multiplied by $n^{2.8125}$ instead of n^3, and the speed by $\sqrt{n}$. It is shown by the previously mentioned results that this method of scaling up the resistance at planing speeds gives a good correction for the scale of the model.

675a. Gruson, M.: Remarque sur les corrections d'echelle dans les essais de coques et flotteurs d'hydravions sur maquettes. Rep. No. 1/AH, Inst. Aero. de St. Cyr, April 1932.

The information given in this report is substantially the same as that reported in abstract 675.

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676. Bladen, D. H.: Study of Change in Water Resistance due to Change of Trim. Rep. No. 831, Edo Aircraft Corp., Nov. 6, 1941.

Two methods of computing the change in water resistance due to a change in trim are derived, based on the change in load on the water due to the change in trim. The first, an approximate method, is limited to small changes in trim. In the second method some of the approximations of the first method are eliminated or reduced in effect. An illustrative example is worked out using the second method. In the example a decrease in trim of 2° increased the resistance by 13 percent and 300 percent at 63 percent and 94 percent of get-away speed, respectively.

677. Robertson, James B., Jr.: Tank Tests of Various Devices for Reducing the Landing Run of Seaplanes. NACA MR, Bur. Aero., Feb. 15, 1937.

Resistance tests were made in Langley tank no. 1 on a $\frac{1}{6}$-size model of the hull of the Martin P3M flying boat fitted with various devices intended to reduce the landing run of flying boats. The devices were of three forms: rakes projecting downwards from the forebody bottom at the step; plate rudders on the sides of the forebody at the step; and step fairings, with straight or convex longitudinal sections, extending over part of the beam. None of the devices investigated showed properties as desirable as had been anticipated, the maximum reduction in landing distance being only about 15 percent. The models with the step fairings hunted vertically at high speeds, and those with the rakes had large bow-down trimming moments.

*678. Barrillon, E. G.: Towing Resistance of a Float due to the Formation of a Field of Waves. Comptes Rendus, vol. 182, Jan. 4, 1926, pp. 46-48.

The float on which the dynamometer measurements are made is placed in a field of artificial waves formed by one or several other floats. In order to apportion the resistance between friction and wave formation various arrangements were employed:

1. A float navigating in the wake of another axial float generating the waves

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2. A float navigating in the system of divergents of a generating float, these divergents being reflected from fixed walls so as to form a new divergent system at a point distant from the generating float

3. A float navigating in the system of divergents of two lateral semifloats

4. A float navigating in the field of combined waves resulting from the simultaneous formations of systems 1 and 3

The experiments show that it is possible to annul the direct towing resistance by placing the float in a suitable artificial field of waves, and that the interference between divergents are as important as between transverses, the latter having hitherto been taken as the sole basis for explaining the variations of resistance at constant speed observed on floats with a variable cylindrical portion.

Sci. Abstr., 1926, abstr. 1220

*679. Weinblum, G.: Wave Resistance and Its Practical Application. Z.V.D.I., vol. 75, no. 6, Feb. 6, 1932, pp. 127–131.

Michell's expression for wave resistance is quoted and the physical assumptions on which it is based are recapitulated. A nondimensional resistance coefficient is defined, and its values, when plotted against a nondimensional velocity coefficient, show marked oscillations. Observed values plotted on the same scale for comparison show much less marked oscillations. The center of pressure and distribution of pressure on a hydroplane surface are also discussed.

Fifteen references are given.

Jour. R.A.S., June 1932, p. 475

(See also abstracts 888 and 905.)

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680. Zeck, Howard: Hydrodynamic Lift Characteristics of Three 1/10-Size Models of Outboard Floats for the HK-1 Cargo Flying Boat. NACA MR, Dept. Commerce, Aug. 19, 1944.

The hydrodynamic lift characteristics of three $\frac{1}{10}$-size models of outboard floats for the HK-1 cargo flying boat were determined by tests in Langley tank no. 1. Float 1 was basically a streamline body with chines and a V-bottom planing surface added. Float 1-A differed from Float 1 by the addition of a step near the stern. Float 1-B differed from float 1 by the addition of a small cove near the stern and breaker strips along the sides of the float. The models were tested by towing them at constant speeds with fixed values of trim and draft. The test runs at each constant speed were made by two procedures: first, by starting the run with the model above the water and investigating several fixed draft conditions in order of increasing draft; and second, by starting with the model submerged and investigating the same draft conditions in order of decreasing draft. A comparison of the results of the tests indicated that at increasing values of the draft, at speeds from 0 to 20 feet per second, the hydrodynamic lifts of the three models were about the same. For decreasing values of the draft at speeds from 8 to 20 feet per second and at drafts where the water flowed over the bow, the lifts of floats 1 and 1-A were about the same, but the lift of float 1-B was considerably greater. At high speeds and shallow drafts float 1-A produced the greatest lift.

681. Dawson, John R., and Drumwright, Arthur L.: Tank Tests of Modifications of a Model of the PBY-Type Outboard Float – NACA Model 104 Series. NACA MR, Bur. Aero., April 23, 1941.

Tests were made in Langley tank no. 1 of a $\frac{1}{5}$-size model of a PBY-type outboard float and several modifications to determine whether the modifications would effect an increase in the hydrodynamic lift of the float. It was found that when the model of the basic form was immersed at certain speeds, it would fail to emerge when the load was removed and would have to be lifted out. It was also found that the type of strut used to support the model influenced this hysterosis effect that was observed on the float to a considerable degree.

General increases in the hydrodynamic lift were obtained by the addition of horizontal fins to the model, by modifying the bow, by adding a step to the bottom, and by providing hydrofoils beneath the model.

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682. Peck, W. C.: Accelerations and Water-Pressure Data Obtained during Acceptance Trials with XPTBH-2 Seaplane. NACA MR, Bur. Aero., Sept. 30, 1937.

Rough-water acceptance trials were made with a Hall XPTBH-2 twin-float seaplane by the Experimental Division, Operations Department of the Hampton Roads Naval Air Station. During these trials, records were obtained of the accelerations and the distribution of the water loads on the forebodies of the floats. Maximum water pressures were recorded near the bow and pressure histories were obtained over the remaining portions of the forebodies.

The acceleration records indicated that relatively severe loading conditions were encountered during the rough-water trials in waves estimated to have been $4\frac{1}{2}$ feet from crest to trough. The maximum accelerations recorded were 4.19g normal and 0.62g parallel to the direction of the thrust axes.

The water-pressure data indicated that the peak of the maximum pressures occurred slightly forward of midway between the bow and the step. The data also indicated that despite apparent mutual interference between the twin floats, the pressures generated were practically the same on the inboard and outboard sides of the float bottoms. The pressure-history data indicated that pressures greater than 5 pounds per square inch usually lasted less than 0.02 second.

*683. Sydow, J.: Beanspruchungsmessungen am Flugboot Dornier Wal (8t) bei Starts und Landungen im Seegang. Vergleich der Ergebnisse mit denjenigen der Messungen am 10t Wal. (Strain Measurements on an 8-Ton Dornier Wal Flying Boat during Take-Offs and Landings in a Seaway. Comparison of the Results with those of Measurements on a 10-Ton Wal). PB No. 398, Z.W.B., May 26, 1936.

The stresses in the most important structural parts of the hull, stub wings, nacelles, and wing struts of two Dornier Wal

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flying boats (the 8-ton and the 10-ton Wal) were determined during take-offs and landings in a seaway. Author

*684. Behrens, W.: Beanspruchungsmessungen am Zweischwimmerflugzeug Ha 139 in Atlantikbetrieb (Stresses Occurring in the Twin Float Aircraft Ha 139 in Transatlantic Traffic). FB No. 1135, Z.W.B.

Stress measurements were made on the float strut connections of the construction model Ha 139 used in transatlantic traffic by Deutsche Luft-Hansa. The measurements gave data on the effect of transatlantic traffic on the stresses introduced in the float attachment struts. The maximum stresses occurring are compared with the stresses measured at the seaport, Travemünde. Author

*685. Sydow, J.: Beanspruchungsmessungen an den Schwimmergestellstreben einer He 42 mit und ohne Schwimmerfederung (Stress Measurements in the Float Struts of a He 42 with and without Float Springs). UM No. 476, Z.W.B.

Take-offs and landings in rough seas were made with a He 42 seaplane, and the stresses in the float gear were measured. In the first test series the gear was directly connected with the float; in the second series a shock-absorbing arrangement was introduced between the gear and the float. The stresses observed in both cases were compared. By the introduction of spring arrangement between the float and the gear, the usually irrelevant tension stresses were increased, but the stresses in compression were decreased by an average of 16 percent. Because of the disturbances of the sea, the measured values showed so great a dispersal that the indicated values for the decrease of the compression stresses are not very accurate. The theory gives approximately the same results. Author

*686. Ehring, and Sydow: Beanspruchungsmessungen im Schwimmergestell des Zweischwimmerflugzeuges Heinkel He 114 V2 (Stress Measurements in the Float Gear of the Twin-Float Seaplane Heinkel He 114 V2). FB No. 1057, Z.W.B.

The stresses in the struts of the float gear on a twin-float seaplane of the type He 114 of the Ernst Heinkel Flugzeugwerke were measured during take-offs and landings for various wave conditions in the Baltic Sea and North Sea. For the hardest operational conditions, buckling appeared in the monocoque construction of the fuselage above the float gear connections as a consequence of the take-off and landing impacts. The float gear was not damaged; however, by this test longitudinal forces were found in the front strut that were considerably larger than the values calculated according to the expected load for the most unfavorable cases of impact. Taking the calculated bending moments into consideration, dimensions were selected for the struts that provided a high safe buckling load which in the front strut were only slightly exceeded by the greatest longitudinal force measured. The largest bending moments measured in both struts only slightly exceeded the moments calculated in advance for the unfavorable cases of impact and did not differ greatly from the safe values. The strain distribution for the struts of variable cross section, which was ascertained according to the test, showed good agreement with the precalculation of the manufacturer. Author

*687. Sydow, J.: Beanspruchungsmessungen im Schwimmergestell des Zweischwimmerflugzeugs Heinkel He 115, D-AKPS (Strain Measurements in the Float Landing Gear of the Twin Float Aircraft Heinkel He 115, D-AKPS). FB No. 1403, Z.W.B., June 17, 1941.

Strains in the struts of the float landing gear were measured on a twin-float aircraft of the type He 115 of the Ernst Heinkel-Flugzeugwerke during take-off and landing under various sea conditions in the Baltic Sea and the North Sea. During all these experiments the main struts possessed the required safety, but the safe loads in the diagonal and fuselage struts were in part slightly exceeded. Author

*688. Ehring, H.: Beanspruchungsmessungen im Schwimmergestell des Zweischwimmer-und des Zentralschwimmerflugzeuge Arado 196 (Strain Measurements in the Float Landing Gear of the Twin-Float and Central-Float Airplanes Arado 196). FB No. 959, Z.W.B., Aug. 16, 1938.

In connection with the testing of the Ar 196, of the Arado Flugzeugwerke G.m.b.H. by the Erprobungsstelle der Luftwaffe Travemünde the strains in the float landing gear struts at take-off and landing were measured at sea. The stresses in the two float landing gears wore compared with the calculated stresses and the ultimate stresses. Both aircraft were subjected to sea tests to stresses up to the limits occurring in their use. Author

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*689. Ehring: Beanspruchungsmessungen im Schwimmergestell einer mit Sonderschwimmern ausgerüstetsn He 42 (Measurement of Stresses in the Float Gear of a He 42 Equipped with a Single Float). UM No. 454, Z.W.B.

Stress measurements were made during landing on rough sea and on ice by aircraft equipped with a single float and provided with shock-absorber suspension. The measurements showed uniform load in the most important struts of the float gear. Also during take-off from ice, no high stresses are produced in the float.

Different load distribution was observed during landing on ice than on water. Author

*690. Mewes: Beanspruchungsmessungen im Schwimmergestell eines Zweischwimmer Schulflugzeuges für Binnengewasser (Strain Measurements in the Float Under-Carriage of a Twin-Float Trainer Aircraft for Inland Waters). KB No. 8, Z.W.B.

Strain measurements at take-off and landing were carried out. The evaluation of the measurements of the reliability of the construction are given. The character of the landing shock forces involved will be discussed in a later report. Author

*691. Teichmann, and Schlünz: Belastungsvorsuche mit einem Schwimmer aus Hydronalium (Loading Tests of a Hydronalium Float). PB No. 308, Z.W.B.

In the loading cases investigated - impact on bow, step, and stern - the ultimate strength was greater than the value specified. The measured strains and the stresses computed therefrom, showed appreciable deviations from the theoretical values. It is impossible to draw conclusions from the data since they represent only a single test on one cross section. Author

*692. Michael: Bericht über die Nachprufung der Festigkeit des Schwimmergestelles des Flugzeuges D 2325, unter besonder Berücksichtigung der neuren Belastungsannahmevorschläge (Report of the Check of the Strength of the Float Strutwork of the Aircraft D 2325 with Special Regard to Recent Proposals for Assumed Loads). PB No. 30, Z.W.B.

An airplane accident in a landing run at sea led to a numerical check of the strength of the float strutwork of the plane. On this occasion, an examination was to be made of the effect of recent proposals upon the dimensions as compared with the presently obtained assumed loads. The main cause was, with great probability, an off-center bow impact. An error in the dimensions of the floats could not be established. Neither did the result of the buckling test indicate under-dimensioning. Relative to the assumed loads, it can be inferred from the investigation of the accident that the presently postulated bow impact resulted in under-dimensioning. The recent proposals for the assumed loads on the floats, used in the investigation, were found to be not yet in use. Author

*693. Mewes, and Behrens: Bestimmung der Landestösse für 2 Schwimmerformen bei Starts und Landungen in Seegang (Junkers Schwimmer/DVL-Einheitsschwimmer) (Determination of Landing Impacts for Two Float Shapes During Take-Offs and Landing on Rough Sea (Junkers Float and DVL Single Float)). FB No. 838, Z.W.B., July 7, 1937.

Take-off and landing tests were made in rough water with two Junkers seaplanes. During these tests strain measurements were made on the float struts. The seaplanes were provided with two different floats; one float was the original Junkers float, and the other was the replacement float - the DVL single float. The comparison of the measured stresses in the two seaplanes shows that it is not possible to derive any definite advantages for one float shape in regard to landing impacts. As a matter of fact, the differences in stress produced by different piloting, and so forth, are greater than the differences produced by different float shapes. Author

*694. Mewes, E.: Bestimmung der Schwimmerstösse an eine Flugzeug vom Arado Ar 66B (Determination of the Float Impacts on an Aircraft of the Type Arado Ar 66 B). FB No. 42, Z.W.B.

By means of strain measurements in the float struts, the resultant impact forces are determined as to magnitude, direction, and position. Using these forces, the results of the measurements are to be compared with the assumed loads. A complete critical examination of the strength specifications is not possible as yet on the basis of these studies. Author

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*695. Behrens, W.: Bestimmung der Stosskräfte an einer He 60 mit enseitig gekielten Schwimmern (Determination of the Impact Forces on a He 60 with Unsymmetrical Floats). FB No. 882, Z.W.B., Nov. 11, 1937.

A full-scale pair of unsymmetrical floats has been produced by the Kieler Loichtbau G.m.b.H. for the aircraft model He 60 according to a design developed by the DVL on the basis of model tests. The full-scale float has been tested at sea. In order to control the landing characteristics of a seaplane equipped with such floats, strain measurements have been carried out on the different struts of the float structure. These strain measurements were intended to also provide data for the maximum loads permissible for seaplanes equipped with such floats. Author

*696. Behrens, W.: Durchfederungsmessungen am gefederten Schwimmergestell eines Zweichwimmerflugzeugs He 42 bei Landungen im Wasser und auf Eis (Landing Tests of a Spring-Provided Float Bracing of a Twin-Float He 42 Seaplane on Water and on Ice). UM No. 528, Z.W.B.

The deflections that occurred in resiliently attached special floats of a He 42 seaplane, during landing on water and on ice, were measured. By simultaneously measuring the deflections at several points of attachment of the float bracing, the magnitude and location of the vertical component of the resultant impact force could be ascertained. The lateral forces could be determined from a one-float landing on ice. Basically different deflections are obtained in landing on ice than on water. The deflection along the normal axis decreases appreciably, whereas the transverse deflections, hardly noticeable when landing on water, increase extraordinarily for ice landings. Author

*697. Weible, A.: Der Eindringwiderstand von Körpern mit verschiedenen Kopfformen bei senkrechtem Aufschlag auf Wasser (The Penetration Resistance of Bodies with Various Head Forms in Vertical Impact Upon Water). UM No. 4541, Z.W.B., Aug. 1943.

Computations are made to gain a conception of the order of magnitude of the path of bodies with various head forms. The computations are based on results of the investigations of Wagner and Schmieden and are compared with measurements of the penetration resistance by Watanabe and Majer. Author

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*698. Sydow, J.: Eine einfache Methode zur Bestimmung der reduzierten Masse bei Landestössen von Seeflugzeugen (A Simple Method for Determining the Reduced Mass in Landing Impacts of Seaplanes). FB No. 233, Z.W.B.

In computing the impact forces in landing of landplanes or seaplanes, the magnitude of the reduced mass is determined for various load cases. Hitherto this required a relatively large amount of graphical and numerical computations. The present report shows how the mass reduction factor can be determined by use of graphs and a simple computation. Author

*699. Behrens, W.: Erprobung eines Maximal-Beschleunigungsmessers von Langer-Thome zur Messung der bei Start und Landung von Seeflugzeugen auftretenden Stossbeschleunigungen (Testing of a Langer-Thome Maximum Acceleration Meter for the Measurement of the Impact Accelerations Occurring During Take-Off and Landing of Seaplanes). FB No. 1534, Z.W.B., Aug. 28, 1941.

With a set of Langer-Thome maximum acceleration meters at the center of gravity and in the floats, the impact accelerations during take-off and landing of a two-float aircraft are measured. The experiment demonstrates the fitness of the acceleration meter for the measurement of impact accelerations on seaplanes. Author

*700. Ehring: Haufigkeitsauswertung von Dehnungsmessungen zum Vergleich der Beanspruchungen im Schwimmergestell des Baumusters Ar 196 beim Einsatz mit normal und mit unsymmetrisch gekielten Schwimmern (Averaging of Test Results in Expansion Measurements for Comparison of the Stresses in the Float Gear of the Model Ar 196 when Using Normal Floats and when Using Unsymmetrically Keeled Floats). Reps. No. Hf 311/1, 311/2, and 311/3, Inst. für Seeflugw. der DVL, March 1942.

Based on the averaging of test results, the forces and moments measured in the main struts of the float gear at take-off and landing are compared for two twin-float seaplanes of the type Ar 196 which were provided with unsymmetrically - and with normally (symmetrically) - keeled floats.

The questions arising in the course of the averaging of the test rosults are treated in detail; suggestions are made for simplifications of such measurements and evaluations. Author

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*701. Mewes, E.: Die Höchstdahnungen im Schwimmergestell des Zentralschwimmerflugzeuges Vought-"Courior". (Maximum Elongation in the Float Gear of the Single Float Aircraft Vought Courier). PB No. 309, Z.W.B.

Take-offs and landings were made with a single-float aircraft Vought Courier on seas of different roughness, with roughness index up to two. On all streamlined struts and streamlined wires of the gear connecting the main float with the fuselage, the deformations were recorded. The maximum elongations indicative of the strength of the gear are evaluated and compared with the calculated ultimate strength. By means of small alterations an exceptionally strong gear for the main float can be made. During tests there appeared, for certain specific conditions, some unfavorable characteristics of the airplane, and these restricted full utilization of the strength of the gear. Author

702. Pierson, J. D.: JRM-1 - Landing Impact Characteristics from Model Tests. NACA ARR No. 5L03, 1946.

An investigation to determine the impact and trimming characteristics of the Martin JRM-1 flying boat by tests of a $\frac{1}{30}$-size model at Stevens Institute of Technology is described. The tests were made by landing the model at several trims in waves of various sizes, and recording the impact accelerations at the center of gravity and bow, and the variation in trim during and after impact. Most of the tests were made at one forward speed and one sinking speed.

The average peak acceleration of the center of gravity increased with increasing wave height, and was practically unaffected by wave length, trim at contact, center-of-gravity position, and pitching moment of inertia. The peak angular acceleration increased with increasing wave height and length, and increased with decreasing trim. The longitudinal position of the hull with respect to the wave at the time of contact had a large influence on accelerations at the center of gravity and bow, and on the angular acceleration. The variation of trim during and after impact was mainly a function of the trim at contact, increased with the wave height, and was a minimum at a contact trim of about 5°.

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703. Peck, William C.: Maximum Water Pressure and Accelerations on a J2F-1 Amphibian during Rough-Water Acceptance Trials. NACA MR, Bur. Aero., Nov. 18, 1936.

Measurements were taken of the longitudinal and normal accelerations (with respect to body axes) and the water pressures on the forebody of the hull of the Grumman J2F-1 amphibian during rough-water acceptance trials in the vicinity of the Hampton Roads Naval Air Station. A normal acceleration of 4.2g accompanied by a longitudinal deceleration of 1.55g was encountered in a landing on a sea with waves about 4 feet high and a head wind of about 18 knots. During this landing a structural failure occurred in the forebody despite the reinforcement of the hull by six longitudinal stiffeners. After further reinforcement of the forebody by replacing the $\frac{1}{32}$-inch hull covering with $\frac{1}{16}$-inch covering, the amphibian successfully withstood a series of tests wherein a normal acceleration of 3.8g and a longitudinal deceleration of 0.75g were encountered. A comparison of the water pressures and the acceleration data showed that both the positive and the negative pressure must be considered in order to realize a rough estimation of the effect of the loads on the whole amphibian.

704. Peck, W. C.: Maximum Water Pressures and Accelerations on the XOSU-1 Seaplane during Acceptance Trials. NACA MR, Bur. Aero., Sept. 20, 1937.

Rough-water acceptance trials were made with a Vought XOSU-1 float seaplane by the Experimental Division of the Operations Department, Hampton Roads Naval Air Station. During these trials, records of the magnitudes and the distribution of the loads imposed in landings and take-offs were obtained in the form of accelerations of the seaplane as a whole and the maximum water pressure generated at several locations on the forebody of the float. The maximum accelerations recorded during the rough-water trials (wave height approximately $2\frac{1}{2}$ feet) were 3.4g parallel to the normal axis and 0.28g parallel to the longitudinal axis of the seaplane. The magnitudes of the component accelerations attributable to the hydrodynamic forces were estimated to be 2.55g and 0.16g, respectively. The maximum water pressures recorded during the rough-water acceptance trials occurred in the neighborhood of the keel at the step. These pressures were in excess of 40 pounds per square inch. Pressure history records taken during the semismooth water trials indicated that maximum pressures were of very short duration.

705. Parks, John, Murphy, Maude A., and Irwin, Ruth L.: Model PBM-3 - Measurement of Load Factors during Flight and Water Maneuvers. Eng. Rep. No. 1785, GLM, April 1943.

Acceleration and stress measurements made during normal take-offs and landings, dive pull-outs and stalls, and rough-water take-offs and landings on the PBM-3 flying boat have been summarized. In all cases, the accelerations measured during take-offs in calm water were very small, varying between 0 and 2g. The hull, from bow to sternpost, reacted to landing shocks as a semirigid body; the acceleration in this region being essentially linear. The tail cone underwent a complex variation in acceleration, with a definite time lag (approximately 0.03 second) between a peak landing shock at the step or nose and the corresponding peak shock at the tail. Wing-tip accelerations as high as 12g were recorded during several rough-water landings and take-offs with the variation along the span proportional to the deflection shapes of the first and second symmetrical bending modes of the wing.

706. Paine, Joseph P., Murphy, Maude A., and Irwin, Ruth Lee: Model XPB2M-1 and XPB2M-1R - Acceleration Measurements. Rep. No. 1894, GLM, Jan. 1944.

The results obtained from an acceleration-measurements program on the "Mars" airplane performed between December 1941 and September 1943 are summarized. The measurements covered air and water maneuvers normally performed in the flight tests and demonstrations of this type of airplane. The vertical accelerations acting on the hull were within design limitations, but the negative angular accelerations exceeded the design limit in several cases on the XPB2M-1 version. Upon removal of the "hook" on the second step, the angular accelerations were decreased to normal values. Curves of the acceleration distributions along the hull of both the XPB2M-1 and the XPB2M-1R are shown. The accelerations acting on the wing tip and stabilizer tip were larger than those on the center of gravity and tail of the hull, respectively, but were not excessive at any time. No rough-water maneuvers were made; consequently, the magnitudes of the accelerations acting on the airplane under such conditions are not known. Plots of acceleration distributions throughout the hull, time histories of landings, and statistical plots have been made to present the data in the simplest manner. The results have been compared with tests under similar conditions on the PBM-3 airplane. A forced-frequency survey of the wing in flight was made and gave good results in the variation of the frequency-response curve, damping coefficient, and torsional frequency. There was no indication of any approach to a flutter instability in the airspeed range covered (0 to 200 mph indicated airspeed).

*707. Anon.: Naogot om Islanding med Flottorflygplan (Landing on Ice with Pontoon Equipped Plane). Flygning, vol. 8, no. 6, June 1930, pp. 128-129.

Brief analysis of forces induced by landing shock and notes on strength of float structure.

Eng. Ind., 1930, p. 1573

*708. Spaak, G.: Om flottörer för sjöflygplan med särskild tanke pa vera mordiska förhallanden (Seaplane Floats with Special Reference to Northern Conditions). Teknisk Tidskrift (Allmänna Avdelningen), vol. 57, no. 28, July 16, 1927, pp. 237-240.

Comments on various conditions hydroplane has to meet in taking off and in landing; importance of seaworthiness and capability of maneuvering on water; resistance to shocks; repairs and materials best suited therefor. [See also Ing. Vet. Akad. (Stockholm), no. 77, 1927, pp. 21-33.]

Eng. Ind., 1927, p. 728 and 1928, p. 1659

709. Bennon, M., Weiss, D., and Morrel, J. S.: Rough Water Landing Tests of Model SC-1 Airplane #35298 - Instrumentation of. Rep. TED No. NAM 2464, Part I. Naval Air Experimental Station, Dec. 18, 1944.

Two series of six landings each were made with model SC-1 airplane no. 35298 at NAS, Patuxent River on Aug. 24, 1944 and Oct. 21, 1944. The first series of landings was made in insufficiently rough water (3 to 4 ft), but the second series of landings was made in a sea judged by the NAS personnel to be adequately rough (3 to 5 ft). This part describes the instrumentation, interprets the acceleration data, and presents the laboratory strain-gage data.

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During the test of October 21, a peak center of gravity normal acceleration of 4.5g was recorded with a pitching acceleration of 18.7 radians per second^2 (computed) occurring simultaneously. In the earlier tests of August 24, a peak center-of-gravity normal acceleration of 6.6g was recorded but the peak acceleration was of relatively shorter duration. The computed pitching acceleration was 20.8 radians per second^2.

The pitching accelerations were computed from the responses of two normal accelerometers and agree very well with the values recorded directly by an experimental angular accelerometer devoloped at NAES. These latter values, however, were based on a laboratory calibration at 0.77 cycle per second. Since the pitching accelerations during landing occurred at a frequency of 8 cycles per second, a consideration of the dynamic characteristics of this instrument indicates that its readings are too low by approximately 14 percent. From these facts, it is considered that the pitching accelerations computed from the normal accelerations are also too low by approximately this amount, due, presumably, to bending of the fuselage.

710. Morrel, J. S.: Rough Water Loads on Model SC-1 Airplane - Laboratory Calibration and Service Landing Loads. Rep. TED No. NAM 2464, Part II, Naval Air Experimental Station, Mar. 2, 1945.

The laboratory calibration of the strain gages used in determining the water loads on a Curtiss SC-1 seaplane during rough-water landings (abstract 709) is described in detail, and the method of calculating the loads on the main float from the strain-gage readings is given. The agreement between the calculated loads and the linear accelerations was qualitatively good, except for vertical loads and accelerations where the calculated vertical load was consistantly about 100 percent greater than the corresponding vertical acceleration indicated. The pitching accelerations obtained from measurements of angular acceleration, from correlated measurements of normal acceleration at the center of gravity and tail, and from calculated loads and moments were in good agreement.

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711. Hathaway, Melvin E.: Rough-Water Tests of an XPBS-1 Flying Boat, Bureau Project No. 3506. NACA MR, Bur. Aero., Nov. 22, 1939.

The results of measurements of hull loads and stresses made during two rough-water landings of a Sikorsky XPBS-1 flying boat at a gross weight of approximately 40,000 pounds are presented in the form of time-history plots of trim, air and water speed, bottom pressures at 22 stations, stringer stresses at eight stations, and accelerations measured near the center of gravity, at the bow, and near the outer engine nacelles. The waves were estimated to be from 3 to 4 feet high. During the second and more severe landing, structural failures occurred at the inboard engine mounts and at the bow.

When the bow was immersed simultaneously with the step, the pressures at the bow were the same as or greater than those at the step. Large angular and linear components of acceleration occurred simultaneously, both when tho impact occurred over the whole forebody bottom and when the impact occurred primarily at the bow. The local failure of the hull near the bow was probably caused by a high average pressure extending over a large area and associated with a peak pressure of about the dynamic pressure (about 50 pounds per square inch). The failure of the engine mounts was attributed to the effect of a large angular acceleration superposed upon that of a moderately large linear acceleration at the center of gravity. From the nature of the impact in the severe landing, it is considered that loads imposed in rougher water would not have been greater than those imposed in this landing.

*712. Mewes, E.: Seefähigkeit eines Zweischwimmerflugzeugs. Teilbericht: Stosskraftbestimmungen im Schwimmwerk (Seaworthiness of a Twin-Float Seaplane. Partial Report: Determination of Dynamic Loads in the Flotation Gear). FB No. 339, Z.W.B.

Stress measurements were made on the float struts and impact pressure measurements were made at various points on the bottom of a float during various take-offs and landings. The transmitted forces were determined by DVL strain gages with scratch stylus on all undercarriage struts attached to the floats. Author

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713. Anon.: Shock Absorbers for Flying Boats. Aviation, vol. 19, no. 13, Sept. 28, 1925, pp. 386-387.

The liability of seaplane floats and hulls to failure as a result of the impact of landing and high-speed taxying in a rough sea is discussed. The hulls designed by Linton Hope (abstract 451) were of flexible construction to absorb landing shocks. Tests were made during World War I by the British of a hull with the forebody planing bottom hinged to the hull at the bow and supported by compression springs near the step. The results were not entirely satisfactory. A more satisfactory hull shock absorber was in the form of a series of individual cantilever slats each extending across the hull and fastened to the hull at the leading edges of the slats.

*714. Hubrich, C.: Spannungsmessungen an einem Schwimmergestell (Strain Measurements on a Float Gear). FB No. 76, Z.W.B.

The strains in the float gear appearing on several models at take-off and landing in various wave conditions were measured. The strain measurements form a part of a program to establish new loading criterions. The test results are compiled in tables and compared with calculated values. Author

*715. Sydow, J.: Spannungsmessungen an einen 10t-Flugboot bei Starts in Seegang (Stress Measurements on a 10-Ton Flying Boat for Sea Take-Off). FB No. 393, Z.W.B.

Take-offs and landings of a 10-ton flying boat were made on the Potenitzer Wiek near Travemünde, in the Bay of Lübeck, and in the North Sea, and the stresses at various places in the structure were measured. On long waves (estimated roughness of the sea 3), the safe load limits reached in the weakest members were determined by the measuring instruments. On short, steep waves (estimated roughness of the sea 2), one part of the strut between the keel and engine support of the front transverse frame exceeded the safe load limit. Author

*716. Boccius, W.: Stosskraftermittlungen auf Grund der Festigkeit des Schwimmergestells (Determination of Force of Impact on the Basis of the Strength of the Float Undercarriage). FB No. 358, Z.W.B.

For the purpose of establishing a basis for new load assumptions on float structures the highest permissible impact forces were determined on the basis of the arrangement and the dimensions of the float undercarriage. The impact forces were subdivided into symmetrical, asymmetrical, and lateral impacts. The inertia forces which are created by the impact and are derived from the airplane, which is assumed to be rigid, and the lift and weight forces of the condition of flight are taken into consideration. In the diagrams, the impact forces for a factor of safety of 1.55 and the influence lines for the strut stresses created by a unit impact force are plotted against the length of the float. Strength and calculation values are tabulated. Author

*717. Kartveli, A.: Stress Analysis of Flying Boat Hulls. Aviation Engineering, vol. 6, no. 6, June 1932, pp. 9-13, 33.

Determination of external loads; flying, wave loading, and landing conditions in accordance with Department of Commerce requirements.

Eng. Ind., 1932, p. 1166

718. Hathaway, M. E.: Typical Pressure, Stress, and Acceleration Measurements on an XPBS-1 Flying Boat. Bureau Project No. 3506. NACA MR, Bur. Aero., Aug. 26, 1941.

Some of the results of measurements of pressures, stringer stresses, and accelerations obtained during take-offs and landings in smooth water and landings in rough water of a Sikorsky XPBS-1 flying boat are presented in the form of: maximum pressures, stringer stresses, and accelerations plotted against landing speed, trim, and velocity normal to the keel; time-history plots of trim, airspeed, water speed, and accelerations; and plots of the distribution of maximum pressures and stringer stresses over the hull bottom. (See also abstract 711.)

The data substantiates and extends those obtained with the P2Y-3 (abstracts 732 and 733). The impact loads increased with the square of the landing speed and increased rapidly with trim. There appears to be little justification for the present reduction of design loads towards the bow and chines. A deep, sharp bow might permit such reduction in bottom loads at the bow and keep the angular accelerations down to safe values.

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*719. Sydow, J.: Untersuchung der Festigkeit eines Schwimmergestells (Investigation of the Strength of a Float Gear). FB No. 459, Z.W.B.

Take-offs and landings in rough sea are made with a seaplane. The stresses occurring in the float gear are measured with a scratch strain gage and compared with the buckling stresses. Twice the undercarriage was damaged; as was to be expected on a statically indeterminate system, several members failed simultaneously. Only one strut buckled in the middle. In other cases the ball head, the connecting bolts, and the fuselage fitting, or base of the strut were damaged. After several members in the undercarriage were strengthened, the strength was about equal in all parts of the undercarriage, at least as far as could be determined from the few tests made. High stresses in landing and take-off occurred as soon as a sea roughness of 3 was reached. Author

*720. Sydow, J.: Die Wirking einer Feder im Schwimmergestell auf die Stösse beim Starten und Landen (Spring Action in Float Gear and its Effect on Impact during Take-Off and Landing). FB No. 1249/1, Z.W.B.

In order to examine the action of springs built into the float bracing, tests were made during take-off and landing on rough sea with the FW 62 equipped as a single-float aircraft or as a two-float aircraft. Spring tension was changed between tests. The tests demonstrated that only very soft springs with considerable deflections gave satisfactory results. Author

(See also abstracts 608, 727, 732, 733, and 829.)

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(See abstracts 669 and 673.)

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721. Kreps, R. L.: Experimental Investigation of Impact in Landing on Water. NACA TM No. 1046, 1943.

Theoretical computations by Wagner and other authors on the impact phenomenon are correlated and compared with actual test results. To make such a comparison more significant the experimental work was carried out under conditions which adhered as closely as possible to the assumptions of usual impact theory.

Idealized bodies for which the associated mass can be calculated exactly are dropped vertically into the water and the impact forces are measured. The results obtained are in disagreement in several cases with the computed values. This disagreement is shown to be at least partially due to the theoretical assumption that the process is that of an ideal impact which goes on in an infinitesimal period of time. If the equations of motion are changed to allow for momentary immersion of the body, the computed values are considerably improved. This change from an impact process to an immersion process involves the inclusions of the weight of the body, the hydrostatic forces, and the resistance of the water in the equation of motion.

722. Stout, Ernest G.: Landing Analyses for Flying Boats and Seaplanes, – Part II. Aviation, vol. 44, no. 11, Nov. 1945, pp. 140–146.

A photographic method is proposed to replace the expensive and complex method of using accelerometer units in the hull. The translational and angular displacements are determined by descriptive geometry and the curves are differentiated with respect to time to obtain velocities and accelerations.

A method is proposed for determining landing accelerations in a hull from planing and buoyancy data. The trim is assumed to remain constant until maximum deceleration is obtained. The decelerating force at each instant, dynamic plus buoyant lift, is calculated and the drafts resulting from the unbalanced forces are found by integration. The accelerations are determined from the decelerating force and the moving mass.

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723. Richardson, E. G.: Measurements of Impact Forces on Water of a Sphere. Rep. No. H/Arm/Res. 29, British M.A.E.E., June 1945.

A sphere was dropped vertically onto a water surface and time histories of acceleration were obtained by means of a condenser-type accelerometer in the sphere and from motion-picture records (at about 2000 frames per second) of the fall of the sphere. The curves of acceleration as a function of time were converted to curves of acceleration as a function of draft for a more direct comparison with the theory. The experimental results agreed well with von Kármán's theory for impact (see abstract 93) at least up to the instant of maximum acceleration.

724. Mayo, Wilbur L.: Theoretical and Experimental Dynamic Loads for a Prismatic Float Having an Angle of Dead Rise $22\frac{1}{2}^{\circ}$. NACA RB No. L5F15, 1945.

An application of a modified hydrodynamic impact theory is presented. Plots are given from which the maximum load, the time to reach maximum load, and the variation of load with time may be obtained for a prismatic float of $22\frac{1}{2}^{\circ}$ angle of dead rise for different combinations of flight-path angle, trim, weight, velocity, and fluid density. The curves cover the range of trim, flight-path angle, and weight-velocity relationship for conventional airplanes. Test data obtained in the Langley impact basin are presented and are used to establish the validity of the theoretical curves.

(See also abstract 544.)

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725. Anon.: Side Load on Boat Seaplanes. Aircraft Airworthiness Section Rep. No. 3, CAA, 1939.

Although side-load conditions are required for landplanes and for float seaplanes, there are no such requirements for flying boats. In a landing with side drift, a lateral water load is built up on the hull bottom or lower portion of the hull side that imposes a rolling acceleration on the airplane. The loads set up may be critical for bulkheads or wing fittings.

By assuming that the pressure on one side of the keel is the same as in the symmetrical step-landing condition while that on the other side is reduced to one-half the step-landing value and by assuming a dead-rise angle of $22\frac{1}{2}^{\circ}$, it was found that the total vertical load is reduced to three-quarters of the step-landing value, while the side load varies from about 10 to 23 percent of the vertical load required for a symmetrical step landing.

Steady Lateral Forces and Moments – Heeling Moment

(See abstracts 511 and 726.)

Steady Lateral Forces and Moments – Yawing Moment

(See abstracts 756 and 795.)

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726. Hutchinson, J. L.: Trials of Model Shetland Floats on Saro 37. Rep. No. H/Res/177, British M.A.E.E., July 7, 1944.

Trial tests were made of $\frac{1}{2.79}$-scale models of the Shetland auxiliary floats fitted to a Saro 37 airplane. Water handling tests were made under rough-sea conditions with winds up to 28 miles per hour which covered taxying across wind and turning down wind. The maximum safe cross wind was determined and compared with a calculated value. The agreement between the two maximum values tended to corroborate the method of calculation used. (See also Rep. No. H/Res/153 British M.A.E.E.)

Forces and Moments – Pressure Distributions

*727. Sydow, J.: Beanspruchungsmessungen an einem Flugboot bei Start und Landung im Seegang (Strain Measurements on a Flying Boat During Take-Off and Landing on a Rough Sea). FB No. 1402, Z.W.B., June 17, 1941.

The pressure on the bottom of the hull and the stresses in individual parts of a flying boat were measured during take-off and landing on rough sea. The measurement gives magnitude and distribution of the pressure on the bottom of the boat. From these measurements, conclusions can be drawn as to the safety of the whole construction, and the basis for construction specifications.
Author

*728. Sydow, J.: Der Bodendruck beim Starten und Landen von Seeflugzeugen nach Versuch und Rechnung (The Bottom Pressure at Take-Off and Landing of Seaplanes According to Experiment and Calculation). FB No. 1592, Z.W.B, Reprint from Jahrb. 1941 der deutschen Luftfahrtforschung, pp. 1398–1403 with additional figures and tables.

Tests were carried out on several aircraft to determine the magnitude and distribution of the bottom pressure at take-off and landing on the sea.
Author

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729. Baker, G. S., and Keary, E. M.: Experiments with Full-Sized Machines. Second Series. R. & M. No. 683, British ACA, Sept. 1920.

Tests were made with an F.3 and an H.16 flying boat to determine the maximum pressures on the forebody bottom when taxying and landing. The gross weights during the tests were from 10,600 to 11,600 pounds. Landing speeds of 50 to 55 knots were normal for the two flying boats. The pressures were measured by spring-loaded plungers arranged to break an electrical circuit when the force of the water on the plunger exceeded the force of the spring.

The maximum pressures were greater while taxying in rough water than in smooth, and were greater when the flying boat was porpoising than when it was running steadily. Greater pressures were obtained in areas near the free-water surface than in more submerged areas. An appreciable pressure was measured at the bow at low speeds only. Landings at high speeds in rough water produced the greatest pressures, about 8.7 pounds per square inch. These pressures were localized and occurred near the middle of the forebody. During stalled landings the pressures were greatest near the step. It is concluded that an average pressure of about 6.3 pounds per square inch should be acceptable for general structure design, and about 8.2 pounds per square inch for local structure design. The bow rarely experienced pressures greater than 4.0 pounds per square inch.

730. Shanley, F. R.: Hull Water Loading Requirements. Aircraft Airworthiness Section Rep. No. 12, CAA, Sept. 1939.

The continued increase in size and speed of flying boats makes it desirable for specifications used in hull design to properly provide for all types of water loading without requiring any excess weight. Local pressures, used for designing bottom plating and stringers; distributed pressures, used for designing cross frames and keels; and step, bow, and stern landing loads, used for designing the hull structure and other parts of the flying boat are discussed (see abstract 725 for side loading conditions). The maximum local pressure is assumed to vary as the square of the landing speed, and a lengthwise variation of local pressure is suggested. Numerical values of the various design factors are suggested but the final values should be the result of experience, tests, and various practical considerations.

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731. Anon.: P.5 Flying Boat N.86, Impact Tests - (Experiments with Full Size Machines. Third Series). R. & M. No. 926, British ARC, April 1924.

Tests were made to determine the distribution of pressure on the forebody bottom of a P.5 flying boat when taxying and landing. These tests form a continuation of those reported in abstract 729. It was found that the greatest pressures that occurred frequently were about 0.5, 3.1, and 3.7 pounds per square inch on the forward, middle, and aft third of the forebody, respectively. The maximum pressure recorded was 4.65 pounds per square inch. These values are about one-half of those reported in abstract 729, and the difference is attributed to the shape of the planing bottom.

732. Burke, Walter F.: Preliminary Report on Some Bottom Pressures and Strain Measurements on the Hull of a P2Y-3 Flying Boat. NACA MR, Bur. Aero., Oct. 24, 1938.

Tests were made on the P2Y-3 flying boat to determine (1) the distribution of bottom pressures and resulting hull stresses during landings and take-offs under a variety of loading and operating conditions and (2) the accelerations at various locations in the structure, principally at the tail and in the neighborhood of heavy concentrations of load, such as engine nacelles and wing gas tanks. It was desired to obtain an "impact factor" which would signify the ratio of the stresses that occur during landing and take-off to those that exist during steady planing. As the instruments did not give sufficient accuracy, smooth-water landings were used as a basis for comparison. Landings were made on smooth water with two extremes of loading; light load with just sufficient fuel to operate safely (17,310 pounds), and in the maximum overload condition (25,906 pounds). Landings and take-offs were made in approximately the lightly loaded condition in various seas including smooth water, choppy sea, and in the presence of moderate swells. No tests were made in the maximum overload condition in rough water.

The instrumentation is described and a few of the records are described in detail.

733. Hathaway, M. E.: Second Report on Bottom Pressure and Strain Measurements on the Hull of a P2Y-3 Flying Boat. NACA MR, Bur. Aero., April 17, 1940.

The results of tests of the P2Y-3 flying boat described in abstract 732 are presented in summary form. The results show the relationship of maximum pressure, maximum stringer stress, and acceleration to landing speed, trim, and beam loading for various types of take-offs and landings in smooth and rough water.

No exact conclusions were drawn but, in general, it was shown that with a constant trim the maximum pressures and maximum stringer stresses varied as the square of the landing speed. No appreciable reduction in either pressure or stress was evident near the bow or chine. The maximum pressures recorded at any given landing speed appeared to have as an upper limit the dynamic pressure of the water corresponding to that speed plus an increment due to wave motion. For a given landing speed in smooth water, both maximum pressures and maximum stringer stresses depended to a great extent upon the trim of the hull.

*734. Mewes, E.: Theoretische Untersuchung über die Stosskräfte und die Druckverteilung vor der Stufe für zwei Bodenformen von Flugbootprojekten (Theoretical Investigation on the Dynamic Loads and Pressure Distribution in Front of the Step of Two Hull Bottom Shapes). FB No. 192, Z.W.B.

The possible bottom pressures in front of the step were calculated for two seaplane projects. It was intended to replace the equations of the pressure distribution by simpler approximating laws which should permit a faster determination of the pressures and still give approximately the same stresses as the exhaustive pressure-distribution laws according to Wagner. In this procedure it was found that contradictions occur in the theoretical pressure calculation. Consequently, the conclusion must be drawn that the pressure distribution according to the theory hitherto applied are not shown with sufficient exactness in all cases. Author

(See also abstracts 458, 519, 679, 682, 703, 704, 711, 712, 718, 736, 790, and 900.)

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735. Dawson, John R., and Walter, Robert C.: The Effects of Various Parameters on the Load at Which Spray Enters the Propellers of a Flying Boat. NACA TN No. 1056, 1946.

The results of experiments made with a technique for investigating the spray characteristics of flying-boat models are presented. In the method of testing used, the minimum load at which spray strikes powered propellers was determined for a range of speeds and trims. These measured loads were plotted against speed with trim as a parameter, and the resulting curves were found to have minimum points that determined the greatest load that could be carried without spray striking the propellers.

The forebody of a pointed-step flying-boat hull was used for the tests, and the effects of varying trim, propeller position, and amount of power (expressed in terms of disk loadings) were investigated.

Either of the two types of spray that emanate from a forebody (pressure or velocity spray) may limit the gross load of a flying boat, depending on the configuration. Increasing the power reduced the load at which spray entered the propellers. Increasing the trim increased the minimum load at which pressure spray struck the propellers, but the corresponding load for velocity spray varied erratically with trim. The normal, lateral, and longitudinal positions of the propellers tended to be near the positions that would give the smallest value of the minimum load at which spray struck the propellers. For pressure spray this minimum load increased approximately linearly with upward movement of the propeller position.

736. Cram, R. L.: Hull Model Towing Tests. Model 314. BAC Rep. No. D-1604, Oct. 1, 1936. Revised Nov. 7, 1938.

Part I.- Spray photographs of a $\frac{1}{10}$-size model of the Boeing 314 flying boat, taken at Langley tank no. 1 and supplementing those of abstract 647, are presented.

Part II.- After the tests reported in abstract 647 were completed, further tests of the model were made by towing the model from a motor boat at Lake Washington to study the wave and spray formation of the hull and stub wings in turns and other maneuvers.

Photographs of the model at various loads and speeds running in waves of various sizes are presented.

Part III.– The tests of part II were continued by towing the model rolled to one side by an applied rolling moment. The action of various sizes of water rudders and fins at the sternpost were studied. The hull was directionally unstable without a water fin.

Part IV.– Tests of various modifications to the stub wings of the model were made in an effort to eliminate the loss of righting moment found in full-size cross-wind taxi tests of the Boeing 314 at speeds from 9 to 19 miles per hour or to reduce this critical speed range. Flaps at the trailing edges of the stub wings were the best modification. The pressure distribution at the tips of the stub wings was investigated. Photographs of the model in motion are given.

737. Axt, W. C.: Investigation of the Effect of Variation in Length-Beam Ratio and Loading on the Bow Spray Characteristics of Flying-Boat Hulls in Rough Water. Rep. No. 296, SIT, 1945.

The results of a brief investigation made at the Stevens tank to determine the effects of length-beam ratio and hull loading on the bow spray characteristics of flying-boat hulls in rough water are presented. Three models, with length-beam ratios of 6.19, 7.32, and 8.45, were each tested at three loads and three speeds, in the displacement range, at hump speed, and in the planing range, and the spray at the bow was recorded photographically. Waves with a length-height ratio of 20 were used, and the size of the waves was increased with increasing speed. The test results at the lowest speed are taken from abstract 253. It was found that increasing the length-beam ratio or decreasing the beam loading decreased the amount of spray at the bow. Variations in length-beam ratio and beam loading are of considerable importance with regard to bow spray in the displacement range, but at speeds from hump to get-away, bow spray is not a major consideration in the hydrodynamic performance of flying-boat hulls.

738. Anon.: Kingfisher F. N. 678 – Effect of Fitting Spray Deflectors to Float. 4th Part of Report No. H/162, British M.A.E.E., April 11, 1943.

Because in conditions other than calm water, a considerable amount of spray was thrown into the propeller of the Kingfisher during taxying, spray strips were fitted along the chine at the nose of the float. In choppy water, the spray strips effectively prevented heavy spray from entering the propeller but in a rough sea when the nose of the float was buried frequently, no beneficial effect was obtained from the spray strips.

739. Scheider, M. G.: Method of Spray Comparison for Flying Boats. Rep. No. 1782, GLM, April 22, 1943.

A number of hulls were tested in the Stevens Towing Tank and the spray patterns recorded (see abstract 249). The results cover a range of speeds and water loads encountered during the pre-hump taxi run and are applicable to any boat hull similar to the five mentioned.

The data are analyzed to determine the possibility of spray pattern prediction. A nondimensional method is evolved which is satisfactory for this purpose. Examples, showing the application of the method to a number of hulls, are included. A chart shows a method whereby satisfactory propeller clearance may be estimated.

740. Olson, Roland E., and Bell, Joe W.: Spray Characteristics of a Powered Dynamic Model of a Flying Boat Having a Hull with a Length-Beam Ratio of 9.0 - TED No. NACA 2351. NACA MR No. L5I12a, Bur. Aero., 1945.

An investigation of the spray characteristics of a $\frac{1}{10}$-size powered dynamic model of a twin-engine flying boat was made in Langley tank no. 1. The design was generally similar to that of the Boeing XPBB-1 flying boat, but the length-beam ratio of the hull was increased from 6.3 to 9.0 while constant length^2-beam product and height of hull were maintained. The hull frontal area was reduced approximately 23 percent and the volume was reduced approximately 11 percent by this increase in length-beam ratio.

At the same gross load, the spray characteristics of the model with a length-beam ratio of 9.0 compared favorably with those of the model of the XPBB-1 flying boat and no adverse effects on the spray characteristics were introduced by the higher length-beam ratio and smaller hull.

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*741. Miki, T.: Study of Wave Formation and Water Flow Adjacent to Bottom Surface of Seaplane Floats. Jour. Soc. Nav. Arch. Japan, vol. 52, Oct. 1933, pp. 265-282.

Details of two pairs of seaplane floats tested in experimental tank; curves and illustrations given.

Eng. Ind., 1933, p. 1008

(See also abstracts 432, 498, 518, 531, 575, 576, 585, 588, 595, 598, 601, 602, 614, 617, 626, 632, 635, 637, 642, 645, 649, 655, 660, 680, 746, 747, 751, 754, 772, 774, 776 to 781, 784, 788, 791, 791a, 795, 808, 819, 893, and 906.)

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*742. Schulte-Frohlinde: Konstruktive Loesungen der Stabilitaetsfragen bei Flugzeugen. Schiffbau, vol. 34, no. 5, March 1, 1933, pp. 96-100.

Structural solutions of stability problems in aircraft, particularly seaplanes; recent regulations governing design and testing of aircraft with reference to stability; factors governing stability of seaplanes in water; tailless airplanes.

Eng. Ind., 1933, p. 1009

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743. Pierson, J.: Correlation of New York University and Glenn L. Martin Company Porpoising Analysis Methods. Rep. No. 1235, GLM, Jan. 30, 1940.

A comparison was made of the methods for obtaining hydrodynamic stability derivatives derived at New York University (abstract 264)

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and at the Glenn L. Martin Company (abstract 748). Differences between the methods are shown and discussed. Correlation of the two sets of formulas was impossible until extension of the Glenn L. Martin derivation resulted in a set of formulas like the New York University set except for the vertical velocity, w, derivatives. The final agreement between the two methods of analysis indicated the preference for revised New York University formulas which have the w derivatives corrected for apparent draft change.

*744. Albring, W.: Der Einfluss von Flüssigkeitsgrenzen auf die Langestabilitat von Korpern (The Influence of Fluid Boundaries on the Longitudinal Stability of Bodies). UM No. 6407, Z.W.B., July 1944.

Hitherto, only experiments could give the magnitude of the disturbance of the flow about bodies due to the nearness of the surface and due to waves, since theory cannot, as yet, handle the subject. Since, however, such test results are not known, it is intended to show by means of the stability equation how, by means of proper dimensioning of hull shapes and stabilizing surfaces, good maneuverability can be obtained near a surface. Author

745. Pierson, J. D.: A Method for Qualitative Porpoising Analysis by Means of Center of Pressure Variations. Rep. No. 1164, GLM, Oct. 12, 1939.

A method for determining the longitudinal stability of a flying boat is described that is similar to the method described in abstract 748, except, instead of trimming moment, center of pressure is the basic variable. This method gives slightly higher stability limits than that of abstract 748. For a stable hull (low lower trim limit of stability) the moment derivatives and the ratio of angular to linear force derivatives should be small.

746. Burghardt, J.: Model PBM-3 Hydrodynamic Report. Rep. No. 1615, GLM, Sept. 1, 1942.

A summary of the hydrodynamic characteristics and performance on the water of the Martin Model 162-B flying boat, a twin-engined patrol bomber designated by tho U. S. Navy as the PBM-3, is presented. Hydrodynamic design; longitudinal and transverse hydrostatic stability; longitudinal, transverse, and directional stability; take-off performance; and spray characteristics are discussed. Where possible, correlations are established between predicted and flight test performance.

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747. Scheider, M. G., and Burghardt, J.: Model XPB2M-1 Hydrodynamic Report. Rep. No. 1560, GLM, July 1943.

A summary of the hydrodynamic characteristics and performance on the water of the Martin model 170 flying boat, a four-engine patrol bomber designated by the U. S. Navy as the XPB2M-1, is presented. Hydrodynamic design; longitudinal and transverse static stability; longitudinal, transverse, and directional stability; take-off performance; and spray characteristics are discussed. The hull is a modification of the DVL-1a hull. Modifications made to change to the cargo version, the XPB2M-1R, are discussed in appendix. Where possible, correlation is established between predicted and flight test performance.

748. Fila, Ladislaus J.: Porpoising Analysis. Rep. No. 999, GLM, Dec. 30, 1938.

The general stability equations of the symmetric motion of a planing craft are expressed. The hydrodynamic derivatives of these equations are evaluated in a manner similar to that of Perring and Glauert (abstract 267). The results of the analysis agree well with results of tests conducted at the Stevens Institute of Technology on a $\frac{1}{27}$-size model of the XPBM-1.

*749. Perring, W. G. A.: The Porpoising of Seaplanes. Proc. 4th Int. Cong. Appl. Mech., Cambridge, 1934.

The instability of a seaplane on the water is an undesirable feature which the designer attempts to eliminate in the model stage, that is, during tank tests. These tests, however, are open to the grave objections that they are frequently made with the bare hull without the appropriate aerodynamic structure of wings and tailplane, and that the models almost invariably are constructed with excessive mass and inertia.

To elucidate the porpoising problem a mathematical investigation was attempted and the steps of this investigation are outlined. The theoretical work indicated that a variation of the horizontal component of a seaplane's velocity had negligible effect on the stability criteria, and hence the instability of porpoising can be ascribed to the interaction of the vertical and pitching motions. The work also showed the necessity in model tests of using true dynamic models.

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To develop the mathematical work the values of the derivatives contained in the stability determined are required and a method is outlined whereby these derivatives can be experimentally determined.

Finally, the use of dynamic models is discussed and the results of some model tests are considered and compared with the theoretical investigations.

Airc. Eng., Aug. 1934, p. 219

750. Anon.: Report of the Civil Aeronautics Board on the Investigation of an Accident Involving Aircraft of United States Registry NC 41880 in the Bay of Exploits, Botwood, Newfoundland, on October 3, 1942. Docket No. AC-3, June 18, 1943.

The crash of a Vought-Sikorsky 44A flying boat during a take-off at Botwood, Newfoundland was investigated by the Civil Aeronautics Board. As the aircraft came up onto the step, the nose dropped and the airplane began to porpoise. On the second or third porpoise the flying boat loft the water, rose about 10 feet, settled back on the water with a light skip, and took off again at an attitude of about 30°. After reaching an altitude of about 35 feet, the flying boat leveled off, gradually nosed down, and crashed into the water at a steep angle. The probable cause was inadvertent activation of the wing flaps to the full-down position during the take-off, rendering the flying boat excessively nose-heavy and uncontrollable.

751. Raymond, S.: Tank Tests on the Effect of Slipstream on the Water Performance of a Large Four Engined Flying Boat (Shetland I). Rep. No. Aero. 2036, British R.A.E., April 1945.

Tank tests have been made to examine the dependence of the porpoising stability, trim, and spray of a four-engined flying boat on the correct representation of air flow over the hull, wings, and tailplane.

It is shown that the porpoising stability measured when the model is initially severely disturbed in pitch can be (1) much too optimistic when there is bad interference with the air flow over the hull, (2) improved considerably by the presence of slipstream. The severe model disturbance used is a fairly quickly applied nose-down displacement in pitch of 7°. The porpoising stability measured with no initial disturbance shows little dependence on the local air-flow conditions but with an initial disturbance of 3° an intermediate condition of stability is obtained. This intermediate stability range gives the best agreement with flight tests made under fair operational conditions.

Porpoising stability has been measured in the past without slipstream with the models attached at the center of gravity to a large fitting which can interfere considerably with the air flow over the hull. For tests with slipstream represented the model is suspended by the wing tips. With the first rig there is good stability above 40 knots, with the second rig no stability, using a 7° disturbance.

The addition of slipstream to the model with wing-tip suspension restores a narrow stability range for take-off.

The free-to-trim attitudes with elevator central are also shown to depend on the form of suspension, but there is little effect of slipstream. The effect of adding slipstream is of the same order as can be calculated, although more laboriously, from changes of pitching moment. The best agreement with flight tests is obtained with the wing-tip suspension, but model attitudes are still higher just above the hump speed.

The rate of change of trim with elevator deflection measured in the presence of slipstream is in good agreement with flight test results.

The nature of the spray is radically altered by the presence of slipstream, the resulting forms qualitatively agreeing much better with flight tests. In particular, interference between the propellers and bow spray at low speeds is only found model scale in the presence of slipstream.

(See also abstracts 483, 519, 575, 708, 829, 837, 888, and 906.)

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752. Olson, Roland E., and Land, Norman S.: Dynamic Tests of a Model of the Modified XPBM-1 Flying Boat, N.A.C.A. Model 112. NACA MR, Bur. Aero., Sept. 5, 1940.

Tests were made in Langley tank no. 1 to determine the trim limits of stability of a $\frac{1}{8}$-size dynamic model of the Martin XPBM-1 flying boat with the beam increased from 12.75 inches to 15 inches and the forebody length increased by $4\frac{1}{2}$ inches. Modifications to the model included changing the position and depth of the step and changing from a straight transverse step to a curved step. The effects of changing the position of the center of gravity were also investigated. The tests were run at four gross loads ranging from 46,000 to 70,000 pounds, full size. Increasing the gross load raised both the upper and lower trim limits of stability. Changing the position of the step had little effect on the lower limit of stability. Increasing the depth of step raised the upper limits. The model with the curved step had a lower lower limit and a higher upper limit than the model with the straight transverse step. Moving the center of gravity aft and down a small distance lowered the upper limit and seemed to increase the violence of the high-angle porpoising. There was some tendency toward lateral instability at speeds less than hump speed. The tendency increased with increasing gross load.

753. Pierson, J.: Water Stability of the XPBM-1 from Automatic Observer Records, March 1940. Rep. No. 1294, GLM, May 2, 1940.

Flight test data of trim, speed, and elevator deflection were obtained by the Automatic Observer in the form of moving pictures of a special instrument panel during take-offs and landings of the XPBM-1. The data are presented as a function of time. The lower trim limit of stability checks well with that predicted from dynamic model tests and mathematical analysis.

(See also abstracts 754, 780, 794, and 795.)

[redacted]

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754. Parkinson, John B., and Olson, Roland E.: Tank Tests of Revised 1/12-Full-Size Dynamic Model of the XPB2M-1 Seaplane NACA Model 113. NACA MR, Bur. Aero., Sept. 25, 1941.

Tests were made of a $\frac{1}{12}$-size dynamic model of the XPB2M-1 flying boat in Langley tank no. 1 with the water at the 6-foot level, movable elevators, approximately correct scale pitching moment of inertia, and leading-edge slats. The tests were made to determine the effects on the hydrodynamic longitudinal stability of changes in the hull lines not included in the first model, to obtain data over a wider range of gross load than covered in the original tests (abstract 284), and to provide data for comparison with data obtained from an investigation of the stability of the same hull at Stevens Institute of Technology (abstracts 278 and 769a).

The model was towed just above the water at about hump speed and about get-away speed to determine the aerodynamic characteristics. Accelerated take-offs and landings were made to determine the spray and longitudinal stability characteristics with and without artificial ventilation. Motion pictures were taken of the model during take-off and landing to illustrate spray and landing characteristics and the pictures are analyzed. The trim limits of stability were determined for a number of different gross loads. Resistance tests were made with the complete model over the complete speed range and specific fixed-trim and free-to-trim resistance tests were made of the hull alone.

The lower limit of stability rose rapidly at high speeds. With the ventilation ducts open, upper limit porpoising could not be obtained at low planing speeds or high planing speeds; the effect was to shorten the extent of the limit curves somewhat. Both the upper and lower trim limits of stability are raised by increasing the load on the water but the effect on the range of stable trims is very small. By correcting the results to take into account the difference in lift obtained at Stevens, the lower limit agrees well at low speeds but diverges sharply at high speeds indicating a possible difference in the flow characteristics between the two models above a certain critical speed. The hysteresis effect in the upper trim limit was greater in the tests made at Stevens Institute and the upper limit, increasing trim, was higher and extended to lower speeds.

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755. Locke, F. W. S., Jr., and Barklie, Jean A.: Tank Tests on the Resistance and Porpoising Characteristics of Three Flying-Boat Hull Models Equipped With Planing Flaps. NACA ARR No. 4H30, 1944.

The results of exploratory model experiments on the resistance and porpoising characteristics of flying-boat hulls equipped with retractable planing flaps are presented. The experiments were made in the course of an investigation which had the two-fold objective of developing a flap-hull combination which would have:

1. With the flaps extended, hump-resistance characteristics at least equal to those of the selected reference ship, the XPB2M-1 flying boat.

2. With the flap retracted, much better upper-limit porpoising characteristics at planing speeds.

Both of the above objectives have been realized with a planing flap attached to the afterbody, about two beams abaft the main step of hulls which have high upper limits of stability with no flap. Three combinations of hull and afterbody flap, together with possible operating procedures, are suggested as having practical possibilities.

With the first two combinations, the hump resistance is about equal to the corresponding value for the XPB2M-1 flying boat, and the peak of the curve of lower limits of stability is lower. By retracting the flap as soon as planing is established, upper limit porpoising is eliminated.

The above advantages of planing flaps when attached to the afterbody were not obtained when the planing flaps were attached to the forebody. Forebody flaps were found to have harmful effects on the hump resistance. They lowered to a very appreciable extent the lower limit of stability at moderate and high-planing speeds, but had little effect on the position of either the peak of the lower-limit curve, or of the upper-limit curve.

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755a. Locke, F. W. S., Jr.: Progress Report on the Porpoising and Resistance Characteristics of a Flying-Boat Hull Model Equipped with Afterbody Flaps. Rep. No. 246, SIT, Oct. 1943.

This report gives in preliminary form some of the data and results of abstract 755.

(See also abstracts 752, 757, 794, 795, and 910.)

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756. Parkinson, John B., Bell, Joe W., and Olson, Roland E.: Additional Tank Tests of 1/8-Full-Size Dynamic Model of Consolidated PB2Y-3 Flying Boat - NACA Model 116 E-2, Etc. NACA MR, Bur. Aero., May 15, 1942.

Tests were made in Langley tank no. 1 of $\frac{1}{8}$-size models of the hull and tip float of the PB2Y-3 flying boat. The aerodynamic lift and pitching moment were measured at a speed of 45 feet per second with the model supported just clear of the water. The effect of wing area, stabilizer setting, and elevator position on the aerodynamic forces was investigated at three places in the tank where landing tests were to be made. Trim limits of stability, stable range of positions of the center of gravity, landing stability, and yawing moments were determined for the hull and modifications. Lift and draft of the tip float and modifications were determined as a function of speed. The modifications to the hull included spoilers on the forebody just forward of the step, spray strips and sharp chines on the tail extension, changes in depth and plan form of the step, and skegs just aft of the sternpost and on the tail extension. The modifications to the tip float included an increase in the length of the bow and various shapes of the stern. The tests of the hull were made at several loads and the effect of rate of deceleration on the landing stability was noted.

The results of tests of the hull showed that skipping could be eliminated by an increase in depth of step and that depth of step

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and attitude are more important variables than plan form of step or center-of-gravity position. The model had unstable yawing moments at low speeds both with and without powered propellers. The range of speeds over which unstable yawing moments occurred was increased by the addition of spray strips or sharp chines on the tail extension. No significant change occurred in the yawing moments when the depth of step was increased. The yawing moments were greatly reduced by the addition of skegs to the sternpost and the tail extension.

The results of tests of the tip float showed that each of the three models with increased length produced greater dynamic lift than the basic model. The modification which had increased width near the stern produced the greatest dynamic lift. Little change in hydrostatic lift was noted between the modifications.

757. Locke, F. W. S., Jr.: An Analysis of the Skipping Characteristics of Some Full-Size Flying Boats. NACA ARR No. 5J24, 1946.

An analysis is made of the skipping characteristics of some full-size flying boats. The skipping characteristics were obtained from reports of flight tests and from opinions expressed by pilots who had flown the flying boats. A plot relating skipping characteristics, step depth, sternpost angle, and gross load coefficient is presented. Skipping characteristics can be improved by decreasing the gross load coefficient, increasing the step depth, or decreasing the sternpost angle. The effects of sternpost angle and depth of step on the upper trim limits of stability, and ventilation, step plan form, step fairings, rough water, and pilot technique on skipping characteristics are discussed briefly.

*758. Lechner: Beitrag zur Frage des Tauchstampfens von Seeflugzeugen (Contribution to the Problem of the Porpoising of Seaplanes). FB No. 1668, Z.W.B., May 1942.

Porpoising is a coupled pitching and heaving vibration which may occur at take-off and landing as a result of dynamic instability on the water. The significance and effect of this movement are summarized and the theoretical basis is discussed from the background of experience.

The stability limits of a single-float aircraft, type Vought V85, were determined experimentally and analytically. The effects of

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various alterations on the stability limits were computed and compared with results from model and full-sized tests. Author

759. Olson, Roland E., and Land, Norman S.: Complete Tank Tests of a Model of the Boeing XPBB-1, NACA Model 115. NACA MR, Bur. Aero., Oct. 1, 1940.

Tests were made in Langley tank no. 1 to determine the longitudinal stability, lateral stability, and resistance of a $\frac{1}{10}$-size dynamic model of the Boeing XPBB-1 flying boat and several modifications consisting of simultaneous variations of afterbody keel angle and step position. Several planing surfaces and fairings were added to the bottom of the tail extension to prevent water from flowing around the tail turret.

The longitudinal stability was investigated by determining the trim limits of stability of each configuration for several gross loads and positions of the center of gravity and two flap deflections. Increasing the gross load raised both of the trim limits. Varying the position of the center of gravity had a negligible effect on the lower limit. Deflecting the flaps produced the same effect as decreasing the gross load. The modifications to the hull had a negligible effect on the lower limit.

Lateral stability was investigated by towing one configuration of the model at constant speeds or in accelerated motion free in either or both roll and yaw. The model was fitted with tip floats and controllable rudder and elevators for these tests. When fixed at 8° yaw and free to roll, the model rolled away from the yaw except in a range of speeds below hump speed where an oscillation in roll, once started, continued. The model was wrecked while running at high speed free in both yaw and roll.

Specific free-to-trim and general fixed-trim resistance tests were made of two modifications which had the most favorable longitudinal stability characteristics. The modifications with the smaller angle of afterbody keel had the lower hump trim and resistance and the greater resistance at high speed.

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759a. Milliken, W. F.: Preliminary Report – Dynamic Tests on Tank Model – Model XPBB-1. BAC Rep. No. D-2785, Aug. 1940.

This report presents and discusses some of the results obtained in the tests reported in abstract 759.

760. Anon.: Dynamic Model Tests in NACA Tank, Model 314. BAC Rep. No. D-2608, May 1940.

This report presents and discusses the results of the tests reported in abstract 274.

761. Ward, Kenneth E., and Land, Norman S.: Dynamic Tank Tests of a Model of the Consolidated XPB2Y-1 Flying Boat – N. A. C. A. Model 86. NACA MR, CAC, Nov. 3, 1938.

Tests were made in Langley tank no. 1 to investigate the porpoising characteristics of a $\frac{1}{12}$-size dynamic model of the Consolidated XPB2Y-1 flying boat. The original configuration was unstable. Moving the center of gravity aft, or the step forward, removed or lessened the instability.

761a. Land, Norman S.: Dynamic Tank Tests of a Model of the Consolidated XPB2Y-1 Flying Boat – N.A.C.A. Model 86. NACA MR, Bur. Aero., Jan. 5, 1939.

Some of the results of the tests discussed in abstract 761 are presented. The construction of the $\frac{1}{12}$-size dynamic model of the Consolidated XPB2Y-1 flying boat, the testing equipment, and the testing procedure are described.

762. Land, Norman S.: The Effect of Afterbody Length on the Hydrodynamic Stability of a Dynamic Model of a Flying Boat – Langley Tank Model 134. NACA MR No. L5I28a, Bur. Aero., 1945.

A program of model tests has been completed at Langley tank no. 1 which will furnish a qualitative guide as to the relation of length of afterbody and depth of step. The model used for the tests was a $\frac{1}{12}$-size unpowered dynamic model of a hypothetical 160,000-pound airplane. The results showed that an increase in length of afterbody requires an accompanying increase in depth of step to maintain adequate landing stability. Changing the length of afterbody and depth of step in such a manner as to maintain a given landing stability will result in only small changes in take-off stability.

763. Johnston, L., and Tye, W. D.: Effect of Differences of Form on the Porpoising Characteristics of Two Flying Boats. R. & M. No. 1777, British ARC, 1936.

As a result of tank tests, a flying-boat hull, which in service trials displayed disagreeable porpoising characteristics, was extensively modified and a new hull form evolved that was a complete success. The large number of modifications made it difficult to determine exactly what features caused the improvement.

A $\frac{1}{12}$-size dynamic model of the stable form and several modifications were tested to determine the effect of each modification on the longitudinal stability. The modifications included a replacement of the V-step by a straight transverse step located at the median of the V-step, the transverse step moved 1 foot aft of the median of the V-step, a decrease in angle of dead rise and width of the afterbody stations, a vertical displacement of the afterbody stations to give a concave keel with a hook at the second step, and the concave keel with the hook removed.

Each of the modifications except moving the transverse step aft and removing the hook at the second step lowered the upper trim limit of stability. Both trim limits were raised by moving the transverse step aft and the upper trim limit was raised slightly by removing the hook at the second step. The lower trim limit of stability was lowered by replacing the V-step with a straight transverse step at the median of the V-step. The effect of other modifications on the lower limit was expected to be negligible and, therefore, was only briefly investigated. The trim track of the new stable form of the hull was about midway between the trim limits, while the trim track of the original form was very close to the upper trim limit.

764. Abel, G. C.: Full Scale and Model Porpoising Tests on the "Seal." Rep. No. F/Res/112, British M.A.E.E., Jan. 10, 1938.

Full-scale longitudinal stability tests have been made on a Fairey Seal twin-float seaplane over a wide range of trims at speeds between 30 and 55 knots and the results have been compared with model measurements. The model as tested was slightly heavy in moment of inertia and weight but the ratio of moment of inertia to weight was almost correct. The model lower trim limit of stability was 4° higher than the full-scale lower limit at 30 knots but the two curves approached each other as the speed increased until good agreement was obtained at 50 knots. The model upper trim limit of stability was consistently higher than the full-scale upper limit by $1\frac{1}{2}^{\circ}$.

765. Ebert, John W., Jr., and Garrison, Charlie C.: Hydrodynamic Tests of a Navy PBM-3 Flying Boat with the NACA Events Recorder. NACA MR, Bur. Aero., Sept. 2, 1943.

Hydrodynamic tests were made of a Martin PBM-3 flying boat with the NACA events recorder installed. The tests were made in smooth water at gross loads of 40,000, 45,000, and 53,000 pounds and in waves $3\frac{1}{2}$ to 4 feet high and about 50 feet long at a gross load of 46,500 pounds. The tests were made in smooth water to determine the trim limits of stability, the landing stability, resistance, and spray characteristics and in rough water to determine the general take-off and landing performance.

The results of the tests were compared with the results obtained during tank tests of a $\frac{1}{8}$-size model (abstracts 602 and 752). Good agreement was found in the lower trim limit of stability. The differences in the upper trim limit were attributed to scale effect on the aerodynamic lift of the model wing. The resistance data agreed well, especially at high speed where the full-scale measurements were more reliable.

During take-offs in smooth water, there was a strong tondency for the flying boat to yaw to the left, and there was a sudden increase in trim just after the flying boat left the water. The flying boat showed no dangerous skipping characteristics during the tests.

In the rough water tests the accelerometer in the bow recorded an acceleration of 6g and the accelerometer at the center of gravity recorded several accelerations of 4g. The flying boat, however, suffered very little structural damage.

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766. Stout, Ernest G.: Landing Analyses for Flying Boats and Seaplanes.– Part III. Aviation, vol. 44, no. 12, Dec. 1945, pp. 163–166.

The general physical aspects of landing instability or skipping, some of the variables involved, and a method of determining the landing stability of a flying-boat design are discussed.

All forms of instability associated with high trims are functions of the afterbody. The jet-pump action of the wake from the forebody flowing below the afterbody induces a region of low pressure on the afterbody from tho step to the point of impact of the roach. This low pressure is partially nullified by air flowing in from the sides of the step, and additional nullification can be obtained by increasing the depth of the step or by adding ventilation ducts in the afterbody near the step.

Information on the skipping characteristics of a flying boat and the effects of various modifications are readily obtained from landing tests of a dynamic model in a towing tank. The effects on take-off stability of modifications made to improve landing stability should also be investigated.

From the results of a number of tests both of models and full-size flying boats, it has been concluded that depth should be not less than 8 percent of the beam for satisfactory skipping characteristics without the use of additional ventilation, a V-step is superior to a straight transverse step from the standpoint of skipping, and step ventilation vented near the afterbody keel is effective in eliminating skipping.

*767. Full, G.: Messungen zur Frage der Nacht- und Gas-landung an Flug-boot BV 222 V4 (Measurements Concerning the Question of Night and Power Landing of the Flying Boat BV222 V4). UM No. 1001, Z.W.B., May 19, 1943.

One cannot make power landings in the customary manner with the flying boat BV-222 without pulling. From the experience gained another simple procedure was derived for which some measurements and considerations are given. Author

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768. Parkinson, John B.: Phototheodolite Records of Four Water Landings of an OA-9 Amphibian. NACA MR, Army Air Corps, Dec. 23, 1941.

Four water landings of a Grumman OA-9 amphibian were observed with a phototheodolite. All of the landings were satisfactory from the point of view of operation. In landings when the main step entered the water first and the afterbody was at a small negative angle with respect to the water surface, the airplane trimmed up abruptly and left the water as soon as flow was established over the bottom of the hull. The motion was more violent in a landing with greater vertical velocity. The landings were much smoother when the landing trim was higher so that both steps touched the water at about the same time and the afterbody was at a small positive angle with respect to the water surface. The instability observed during the landings was reproduced satisfactorily with a scale model in Langley tank no. 1.

769. Anon.: Porpoising Investigation on 1/30-Scale Model of XPB2M-1 Seaplane. Rep. No. 145, SIT, April 5, 1941.

This report presents some of the results given in abstract 307.

769a. Locke, F. W. S., Jr.: Porpoising Investigation on 1/30-Scale Model of XPB2M-1 Seaplane. Rep. No. 155, SIT, June 14, 1941.

This report presents some of the results given in abstract 307, and supersedes abstract 769.

770. Garner, H. M.: Porpoising Tests on a Model of a Flying Boat Hull. R. & M. No. 1492, British ARC, 1932.

Because porpoising or longitudinal instability on the water had been experienced by a number of flying boats, a general investigation to determine the effect on stability of changing certain fundamental quantities was undertaken. A $\frac{1}{24}$-size model of a Saunders R.4/27 flying boat was tested to determine the effect on longitudinal stability of, (1) changing the thrust line and center of gravity, (2) fitting wings and tail, (3) applying pitching moments, and (4) preventing the vertical movement of the model.

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The model was found to be unstable for certain positions of the thrust line and center of gravity and for certain applied moments. The effect of wings and tail was to increase the stability of the model appreciably. No instability was found when the vertical movement of the model was prevented. A theoretical analysis of the motion of a towed model shows that, in the absence of damping of rotational motion, instability is most likely to arise from a small number of derivatives associated with the vertical motion.

771. Shaw, R. A., and Evans, G. J.: Porpoising Tests on the "G" Class Flying Boat. Rep. No. H/Res/141, British M.A.E.E., March 4, 1941.

During a normal landing of the Golden Horn at a weight of 77,000 pounds, violent porpoising resulted in an accident to the port wing. A general investigation of the stability of the "G" class flying boat was therefore made. Records of speed and trim were obtained during steady runs over the full range of stick position at weights of 65,000, 70,000, and 72,000 pounds. Records of speed, trim, and acceleration were obtained during landings at 72,000 pounds gross weight and during take-offs at weights up to 77,500 pounds.

No porpoising was found in normal take-offs nor in fast landings at low trims. Instability was found in landings and steady runs at high trims and therefore slow landings are not recommended.

Wind, load, and position of the center of gravity appeared to have little effect on the water performance.

There were marked disagreements in stability between the model and full-scale flying boat. The full-scale stability limits were lower and the stability range was wider than the model tests predicted.

772. Woodward, David R., and Zeck, Howard: Spray Characteristics and Take-Off and Landing Stability of Several Modifications of a 1/8-Size Model of the PBN-1 Flying Boat — NACA Model 192. NACA MR No. L5C30, Bur. Aero., 1945.

Tests were made in Langley tank no. 1 of several modifications to a $\frac{1}{8}$-size model of the PBN-1 flying boat to determine the effect of these changes on the spray characteristics and the take-off and landing stability. The modifications included the addition of spray strips to the bow and an increase in depth of step and angle of afterbody keel.

The spray over the bow at low speeds was reduced by the addition of spray strips and, to a lesser extent, by an increase in depth of step or angle of afterbody keel. The range of speeds over which spray entered the propellers was reduced by the addition of spray strips. An increase in angle of afterbody keel had little effect on the propeller spray.

The basic model skipped at all trims above 6°. This skipping was eliminated by an increase in depth of step from 3.8 to 7 percent beam. An increase in angle of afterbody keel from 6.25° to 7.75° reduced the landing stability. The location of the main step was satisfactory for stable take-offs with neutral elevators at forward positions of the center of gravity and with elevators deflected -10° at after positions of the center of gravity. An increase in depth of step or angle of afterbody keel did not appreciably affect the forward limit for stable positions of the center of gravity. With the elevator deflected -10°, the after limit for stable positions of the center of gravity was moved aft when the depth of step was increased.

*773. Sottorf, W., and Lange, F.: Systematische Untersuchungen über den tauchstampffrein Stabilitätsbereich des DVL-Einheitsschwimmers (Systematic Investigations of the Stability Range where there is no Porpoising of the DVL Single Float). FB No. 1547, Z.W.B.

The results of systematic investigations of the position of the porpoising zones of the DVL single float are given. Investigations were made of a flat planing surface and several surfaces with dead rise. The surfaces were straight in longitudinal direction. These investigations as well as the investigation of the bow of the single float give material for comparison which permits determination of the effect of the bow, dead rise, and longitudinal curvature on the position of the stable region. The effect of rear transverse steps was also investigated. Author

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774\. Olson, Roland E., Haar, Marvin I., and Bradford, John A.: Take-Off and Landing Stability and Spray Characteristics of a 1/12-Full-Size Model of the JRM-1 Flying Boat - NACA Model 164J. NACA MR, Bur. Aero., May 1, 1944.

Tests were made in Langley tank no. 2 to determine the take-off and landing stability and spray characteristics of a $\frac{1}{12}$-size powered dynamic model of the Martin JRM-1 flying boat. The spray characteristics at the design gross load of 82.5 pounds (145,000 pounds, full size) were considered to be satisfactory, but the spray which entered the propellers at a gross load of 91.0 pounds (160,000 pounds, full size) was excessive. Porpoising occurred on nearly every take-off with positions of the center of gravity ranging from 26 to 40 percent mean aerodynamic chord and with elevator deflections from 0° to -25° (full up). With full-up elevators, violent lower-limit porpoising occurred at positions of the center of gravity forward of 27 percent mean aerodynamic chord. To obtain a stable take off with the center of gravity at 24 percent mean aerodynamic chord and an elevator deflection of -15°, the step of the model should be moved forward about 1.5 inches. The critical effect of elevator deflection on the take-off stability is more marked than in most other models and is believed to be caused more by the aerodynamic than by the hydrodynamic characteristics of the JRM-1 model. Landing instability occurred at trims greater than 4°. The tendency to skip on landing was not eliminated by increasing the rate of deceleration during landing although the duration of the violent motion was shortened. Moving the center of gravity forward decreased the violence of the instability slightly but did not eliminate it. Increasing the gross load increased the violence of the instability slightly.

775\. Parkinson, John B., and Benson, James M.: Tank Tests of a 1/8-Full-Size Dynamic Model of the Consolidated PB2Y-3 Flying Boat - NACA Model 116. NACA MR, Bur. Aero., Dec. 13, 1940.

Tests were made in Langley tank no. 1 of the hydrodynamic longitudinal stability and aerodynamic forces of a $\frac{1}{8}$-size model of the Consolidated PB2Y-3 flying boat. The hull, the pitching moment of inertia, and the aerodynamic characteristics of the wings and tail surfaces were approximately similar to the full-scale flying boat. Tests were made with a pointed step, sponsons, and several depths of transverse step.

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The method of measuring the aerodynamic forces is presented and the technique of defining experimentally the limits of stable positions of the center of gravity and limits of stable trims is described.

Increasing the depth of step from 3.56 percent to 5.55 percent beam increased the range of stable positions of the center of gravity but increasing the depth of step to 6.85 percent beam did not increase the stable range further. A 10-percent increase in the beam of the forebody obtained by adding sponsons resulted in a marked reduction in the range of stable positions of the center of gravity.

A number of photographs of the flow of water in the region of the tail are included.

776. Olson, Roland E., and Land, Norman S.: Tank Tests of a 1/8-Full-Size Dynamic Model of the Consolidated PB2Y-3 Flying Boat – N.A.C.A. Model 116. NACA MR, Bur. Aero., March 18, 1941.

Tests were made in Langley tank no. 1 to determine the effect of gross load and step position on the spray and longitudinal-stability characteristics of a $\frac{1}{8}$-size dynamic model of the Consolidated PB2Y-3 flying boat. The limiting value of gross load was determined by spray rather than by stability characteristics. Excessive spray hit the propellers at gross loads greater than 76,000 pounds, full size. The stable range of the center-of-gravity positions decreased with increasing gross load, except in the region between gross loads of 56,000 and 66,000 pounds, full size, where the trend was abruptly reversed. Moving the step aft moved the stable range of center-of-gravity positions aft.

777. Olson, Roland E., and Havens, Robert F.: Tank Tests of a 1/8-Size Dynamic Model of a Modified PBY Flying Boat – NACA Model 132. I – Tests without Power. NACA MR, Bur. Aero., April 5, 1944.

Tests of a dynamic model of a modified PBY flying boat were made with propellers idling to determine the spray characteristics and with the propellers removed to determine the longitudinal stability during take-off and the behavior on landing. Results of these tests are compared to similar data obtained for a model of the PBY flying boat.

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Changes in the design of the PBY, which were included in the present model, were an increase in the length of the forebody and the afterbody, a V-type step of greater depth, twin vertical tail surfaces, and the substitution of a spherical tail turret for the "waist blisters." Several further changes were made in the plan form and depth of step and in the lines of the tail extension to improve the landing stability.

The range of stable positions of the center of gravity was about 14 percent of the mean aerodynamic chord greater than that of the model of the PBY, and the step was located more favorably for take-offs at forward positions of the center of gravity. The spray characteristics of the bow were satisfactory at a gross load corresponding to 40,000 pounds, full size, and were superior to those of the PBY. The tail turret was free of spray and water at all of the loads and speeds used in the tests.

The trim limits of stability were virtually unaffected by changes in the plan form of the step or by the horizontal location of the center of gravity. An increase in the depth of a transverse step from 6.5 to 8 percent beam raised the upper trim limits and improved the landing stability but decreased the range of stable locations of the center of gravity about 3 percent mean aerodynamic chord.

778. Havens, Robert F., and Goldenbaum, David M.: Tank Tests of a 1/8-Size Dynamic Model of a Modified PBY Flying Boat - NACA Model 132. II - Tests with Power. NACA MR No. L5K02a, Bur. Aero., 1945.

Tests of a $\frac{1}{8}$-size dynamic model of a modified PBY flying boat were made to determine the effects of powered propellers on the spray characteristics and the take-off and landing stability.

With power, the spray entered the propellers at gross loads greater than 53.8 pounds (27,800 lb, full size). Without power, spray was clear of the propeller disks at values of the gross load up to 67.8 pounds (35,000 lb, full size) and only light spray entered the propeller disks at a gross load of 77.4 pounds (40,000 lb, full-size). Less spray struck the wing and tail with power than without power.

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The powered propellers reduced the range of stable positions of the center of gravity by 11 percent mean aerodynamic chord when neutral elevators were used to define the forward limit and elevators deflected -25° were used to define the after limit.

The upper trim limits of stability occurred at lower speeds and trims with power than without power. This change is similar to that obtained with a decrease in load on the water.

At forward positions of the center of gravity the model was generally stable on landing with or without power. Skipping that occurred during landings with the center of gravity aft of 36 percent mean aerodynamic chord was reduced when landings were made with power. This difference in landing stability was small and may be associated with the decrease in landing speed that is obtained with power.

779. Bell, Joe W., and Havens, Robert F.: Tank Tests of a 1/8-Size Dynamic Model of the PB2Y-3 Airplane with Increased Power - NACA Model 131. NACA MR, Bur. Aero., June 9, 1943.

The Consolidated Aircraft Corporation proposed to replace the 1200-horsepower engines of the PB2Y-3 flying boat with 1800-horsepower engines, and to increase the operating gross load from 70,000 to 76,000 pounds. Tests of a $\frac{1}{8}$-size powered dynamic model of the PB2Y-3 were, therefore, made in Langley tank no. 1 to investigate the stability and spray characteristics at both the present and proposed conditions of gross load and engine power. The effects of acceleration on the porpoising and spray characteristics of the model were investigated. The aerodynamic characteristics of the model with several settings and configurations of the aerodynamic surfaces and different amounts of power were determined.

Powered propellers increased the lift, slope of the lift curve, and elevator effectiveness, and decreased the static longitudinal stability. The effect of gross loads on the stable range of center-of-gravity position was small for the gross loads tested (70,000 to 76,000 pounds, full size). Increasing the power and gross load had little effect on the after center-of-gravity limit of stability but moved the forward limit aft about 3 percent mean aerodynamic chord. Deflecting the flaps from 0° to 40° decreased the range of stable center-of-gravity positions about 2.5 percent mean aerodynamic chord and moved the range aft 13 percent mean aerodynamic chord. A greater change in stability characteristics resulted from changing the flap deflection from 0° to 20° than from 20° to 40°. Increasing the acceleration did not change the speed range in which porpoising occurred, had little effect on the frequency of an average porpoising cycle, decreased the amplitude of porpoising, and had little effect on the formation and distribution of spray. A large amount of spray hit the propellers at the gross loads tested.

780. Land, Norman S., and Posner, Jack: Tank Tests of a 1/11-Size Dynamic Model of the Bureau of Aeronautics Design No. 22ADR, Class VPB Airplane – Langley Tank Model 206 – TED No. NACA 2361. NACA MR No. L5H06, Bur. Aero., 1945.

Tests were made in Langley tank no. 1 to determine the take-off and landing stability and spray characteristics of a $\frac{1}{11}$-size powered dynamic model of the Bureau of Aeronautics design number 22ADR flying boat. The behavior of the model in rough water was briefly investigated. The model was modified by changing from a 45° V-step to a 30° V-step with the same position at the keel.

To obtain stalling attitudes in the air with a forward center-of-gravity position and full power, it was necessary to change the stabilizer incidence from the design value of -4.5° to -9.5°.

At the design gross weight (105,000 pounds, full size) no spray entered the propellers and only light spray hit the flaps. Two lower trim limits of stability were observed at moderate and high planing speeds. The model would run steadily at trims between the two lower limits after damping had been applied, but a slight disturbance would start the porpoising motion again. Changing the plan form of the step from 45° V to 30° V raised the lower of the two lower limits. The range of stable positions of the center of gravity was satisfactory. Changing from the 45° V-step to the 30° V-step moved the forward center-of-gravity limit aft. Landings in smooth water were stable except at a stalled attitude where light skipping was observed. No violent behavior was noted during taxi-runs, take-offs, and landings in wave 2 feet high and 82.5 feet long, full size. In waves 5.5 feet high and 110 feet long, full size, the model skipped very violently after landing and a moderate amount of water entered the propellers during take-offs and taxi-runs.

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781. Olson, Roland E., and Haar, Marvin I.: Tank Tests of a $\frac{1}{12}$-Size Powered Dynamic Model of the JRM-1 Flying Boat with the Hull Modified for Increased Gross Loads – Langley Tank Model 180. NACA MR No. L5K05, Bur. Aero., 1945.

The changes in the hull of the JRM-1 flying boat which were believed desirable for normal operation at a gross load of 165,000 pounds (3000-horsepower engines) were incorporated in a $\frac{1}{12}$-size dynamic model. These changes included an increase in forebody length of 5.63 feet, a decrease in afterbody length of 7.16 feet, an increase in beam of 1.50 feet, a change in plan form of the step from transverse to 30°-V, and a forward movement of the step. The forebody and afterbody planing surfaces were added to an elliptical streamline body and the tail of the streamline body was warped up to form a horizontal deckline. The depth of the hull, and the proportions and relative locations of the wing and tail corresponded to those of the JRM-1. Tank tests of the model (designated as Langley tank model 180) were made to determine the spray characteristics, resistance, and take-off and landing stability.

The spray characteristics of model 180 were considered satisfactory at a gross load corresponding to 165,000 pounds and acceptable for limited operations at a gross load of 185,000 pounds. The spray striking the flaps was slightly less than that of the model of the the JRM-1. The roach from under the afterbody struck the horizontal tail at the root, but the addition of breaker strips on the tail extension prevented this wetting. Inboard spray strips eliminated the spray from the propellers up to a load of 200,000 pounds and eliminated spray from the flaps up to a load of 185,000 pounds. With a depth of step of 9 percent beam at the centroid, stable landings were made at all trims and at forward and after positions of the center of gravity. The take-off time at a gross load of 165,000 pounds was estimated to be 54 seconds and the distance 4300 feet. With constant deflection of the elevators of −20°, take-offs were stable at positions of the center of gravity from 24 to 37 percent mean aerodynamic chord. The location of the main step was considered satisfactory.

These tests indicated that the spray characteristics and take-off and landing stability of model 180 were more satisfactory than those of the model of the production JRM-1 at an overload corresponding to 165,000 pounds.

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782. Olson, Roland E., and Haar, Marvin I.: Tank Tests of a Powered Dynamic Model of a Flying Boat Having an Afterbody Length-Beam Ratio of 4.7 – Langley Tank Model 203C-1 – TED No. NACA 2351, NACA MR No. L5I28, Bur. Aero., 1945.

Tank tests of a $\frac{1}{10}$-size model of a hypothetical flying boat having an afterbody length-beam ratio of 4.7 and a forebody length-beam ratio of 5.2 were made in Langley tank no. 1 to determine the take-off and landing stability and the resistance characteristics.

The range of stable trims was less than that of models with conventional afterbody length-beam ratios, but the range of stable positions for the center of gravity was approximately the same as that of most models. The landing stability with the depth of step used in the tests was satisfactory. The hump trim and resistance were lower than those for models with conventional afterbody length-beam ratios.

783. Ward, Kenneth E., Dawson, John R., and Land, Norman S.: Tank Tests of Two Models of the Consolidated "X" Flying Boat – N.A.C.A. Models 87 (Dynamic Model) and 85. NACA MR, CAC, Nov. 3, 1938.

Tests were made in Langley tank no. 1 to investigate the longitudinal stability and resistance characteristics of a $\frac{1}{12}$-size dynamic model of the Consolidated "X" [model 31] flying boat and various modifications. The stability tests were made by towing the model with a constant acceleration and noting the trim and behavior of the model at various speeds. The model was unstable with the center of gravity in a forward position. Increased stability was obtained with a rearward movement of the center of gravity or with a forward movement of the step. Modifications which consisted of adding planing surfaces at the sternpost reduced the amount of the roach which hit the tail extension. General resistance tests of the original configuration and of some of the modifications, and specific free-to-trim resistance tests of a $\frac{1}{8}$-size model of an earlier version which had a smaller beam and a different bow form were made.

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784. Raymond, S., and Tomaszewski, K. M.: Tank Tests on the Porpoising Stability and Spray Characteristics of a Single Engined Twin Float Seaplane (Auster V). Rep. No. Aero. 2088, British R.A.E., Nov. 1945.

Tank tests were made of a powered dynamic model of the Auster V float seaplane to investigate porpoising and spray characteristics during take-off and landing.

The seaplane is unstable with the stick neutral both in take-off and landing. With the stick back, there is a wide range of stable trims for take-off and landing if one-third engine power is used; with engine off, the landing run is unstable. There is no upper limit of stability although the floats have long wide afterbodies and shallow steps.

Spray is heavy in choppy water and there is some interference between the bow spray and the propeller. The tailplane and rear fuselage are severely wetted throughout the hump-speed region.

*785. Sottorf, W.: Tauchstampfen im Modellversuch (Porpoising in Model Tests). FB No. 1385, Z.W.B.

Porpoising tests were made with a Plexiglas model consisting of floats, wing, and tail assembly. For average angles of attack, the model and the full-scale airplane are both stable and in good agreement. Alteration of the moment of inertia, position of the center of gravity, and replacement of aerodynamic forces on the wing and control surfaces by reduction of weights or moments have no influence. Changes of load and afterbody keel angle have, however, a large effect. Author

*786. Lechner, H.: Tauchstampfversuche am Flugboot BV 222 (Porpoising Test on the Flying Boat BV 222). Rep. No. Hf 206/6, Inst. für Seeflugw. der DVL, July 1942.

Porpoising tests were made on the BV 222-V2 at three gross weights, and the results are compared with corresponding model tests. The influence of wind on the stability limits was also investigated. Author

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*787. Lechner: Tauchstampfversuche an einem Zweischwimmerflugzeug (Porpoising Experiments on a Twin-Float Aircraft). FB No. 1904, Z.W.B., Feb. 10, 1944.

Porpoising experiments were carried out on a twin-float aircraft of the type Ar 196 with three different weights and positions of the center of gravity with and without landing flaps deflected to determine the limits of dynamic stability on the water. The results are compared with tests of models. The influence of the propeller slipstream is studied. Author

788. Ebert, John W., Jr.: Taxi Tests of the Boeing XPBB-1 Flying Boat Made with the NACA Events Recorder. NACA MR, Bur. Aero., Feb. 23, 1943.

Time-history records of propeller rotational speed, torque, trim, airspeed, water speed, and elevator and rudder deflection were obtained with the NACA events recorder during take-offs and landings of the Boeing XPBB-1 flying boat. The tests were made at several combinations of gross weight, flap deflection, and take-off and landing trims for the purpose of obtaining the trim limits of stability, the take-off and landing stability, and the resistance, for comparison with similar data obtained from tests of a $\frac{1}{10}$-size unpowered dynamic model (abstract 759). The use of the data obtained with the events recorder for determining the stability and resistance characteristics and the take-off and landing times and distances is discussed. It was found that the trim limits of stability obtained during take-off and landing runs were not as clearly defined as those obtained by slowly changing trim during runs at constant speeds.

The XPBB-1 showed no signs of skipping. At low speeds it tended to yaw to the left, and the bow spray was sucked into the lower part of the propeller disks. The trim limits of stability and resistance of the full-size flying boat were compared with those of the $\frac{1}{10}$-size model. The lower limit of the full-size flying boat agreed closely with that of the model. The resistance of the full-size flying boat was greater than that of the model, and was greater during landing than during take-off.

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789. Ebert, John W., Jr.: Taxi Tests of the Navy XP4Y-1 Flying Boat with the NACA Events Recorder to Determine the Location of the Stable Range of the Center of Gravity. NACA MR, Bur. Aero., May 24, 1944.

Tests of a Consolidated XP4Y-1 flying boat were made to determine the center-of-gravity limits of stability at gross loads of 45,000 and 50,000 pounds. The data was obtained with the NACA events recorder. It was found that, with flap deflections of not more than 20°, the stable range of positions of the center of gravity was from 24 to 36 percent mean aerodynamic chord at 45,000 pounds gross load and from 26.8 to 36 percent mean aerodynamic chord at 50,000 pounds gross load. The forward center-of-gravity limit was approximately the same as that determined by tank tests of a $\frac{1}{8}$-size dynamic model of the XP4Y-1 (abstract 258), and the porpoising motion of the full-size flying boat was more violent than that of the model. Deflecting the flaps moved the limits aft. The limits were further forward and the stable range of center-of-gravity positions was wider without power (as during a landing) than with power. The horizontal tail was struck by water at low speed. The hump trim occurred at a lower speed during landing than during the take-off.

790. Parkinson, John B., and Olson, Roland E.: Tests of a 1/5-Full-Size Dynamically Similar Model of the Army OA-9 Amphibian in the NACA Tank - NACA Model 117. NACA MR, Army Air Corps, Jan. 9, 1941.

Tests were made in Langley tank no. 1 of a $\frac{1}{5}$-size dynamic model of the Grumman OA-9 amphibian and various modifications to analyze the uncontrollable tendency of the OA-9 to porpoise and to make changes that would eliminate the porpoising. Tests to determine the trim limits of stability and landing stability were made. Modifications to the model included increasing the step depth, ventilating the step, fitting swallow-tail and notched steps, moving the step aft, and increasing the forebody keel angle by 2.1°. Experience and previous tests on the full-size amphibian (abstract 768) showed that instability occurred during landings and that no difficulty was experienced during take-off. The results of the tests showed that the cause of the tendency of the OA-9 to porpoise was a combination of a shallow step and a lower trim limit of stability

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which rises with speed above the stalling speed. The behavior of the model was greatly improved by increasing the step depth, ventilating the step near the center line of the afterbody, or fitting a 30° swallow-tail step.

Observations of the pressure just aft of the step were made using a multimanometer. It was found that a small negative pressure exists aft of the step. The negative pressure increased with the increase in speed and was greater during porpoising and landing at high trims than at low trims. The negative pressure on the afterbody is considered to be an important cause of instability at high speeds and trims.

791. Olson, Roland E., and Land, Norman S.: Tests of a 1/8-Full-Size Dynamically Similar Model of the Consolidated PBY Flying Boat — NACA Model 124. NACA MR, Bur. Aero., April 3, 1941.

Tank tests were made of a $\frac{1}{8}$-size dynamically similar model of the Consolidated PBY flying boat to determine the longitudinal stability characteristics while on the water. Provision was made in the model for 20°, 30°, and 45° V-steps in addition to the basic transverse step. The V-steps were located so that the mean depth of step was equal to the depth of the transverse step at the same station.

The variation in plan form of step had in general only a small effect on the stability. The amplitudes of porpoising were slightly lower with the 20° V-step but were higher with the 45° V-step. A breaker step on the tail extension reduced the flow around the tail and had a negligible effect on the stability. Lengthening the afterbody 28.9 percent and removing the chine flare on the afterbody increased the stability but required an aft movement of the breaker step for effective control of the spray on the tail. The amplitude of porpoising decreased with increasing acceleration.

791a. Stout, E. G.: Report on the PBY 1/8 Scale Dynamic Tank Tests at the N.A.C.A. Towing Basin. Rep. No. ZH-28-005, CAC, 1941.

The results of tests (abstract 791) of the longitudinal stability and spray characteristics of a $\frac{1}{8}$-size dynamic model of the Consolidated PBY flying boat made at Langley tank no. 1 are discussed and summarized. Construction details of the model are presented.

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792. Olson, Roland E.: Tests of a 1/8-Full-Size Dynamically Similar Model of the Consolidated PBY Flying Boat – N.A.C.A. Model 124D-2. NACA MR, Bur. Aero., July 14, 1941.

Additional tests were made of a $\frac{1}{8}$-size dynamic model of the Consolidated PBY flying boat (abstract 791) with the 30° V-step moved aft 1.33 inches. The results of the tests showed that the forward limit of stable positions of the center of gravity was moved aft by an amount approximately equal to the change in position of the step. The after limit was moved forward by an indeterminate amount.

793. Olson, Roland E.: Tests of a 1/8-Full-Size Dynamically Similar Model of the Consolidated PBY Flying Boat with a 20° Vee Step – N.A.C.A. Model 124D-3. NACA MR, Bur. Aero., Aug. 25, 1941.

Tests were made in Langley tank no. 1 of a $\frac{1}{8}$-size dynamic model of the Consolidated PBY flying boat with a 20° V step which had the same position at the chine as the 30° V step of abstract 791. Changing from the 30° to the 20° V step in this manner effectively moved the step forward and caused a corresponding forward movement of the forward center-of-gravity limit of stability.

794. Land, Norman S., and Zeck, Howard: Tests of a 1/8-Full-Size Dynamic Model of the XP4Y-1 Airplane with Scale Power – N.A.C.A. model 143. NACA MR, Bur. Aero., March 11, 1943.

Tank tests were made of a $\frac{1}{8}$-size self-propelled dynamic model of the XP4Y-1 flying boat. The model was towed just above the water to determine the aerodynamic characteristics. Constant speed and accelerated tests were made of the model in the water to determine the trim limits of stability, the stable range of positions of the center of gravity, and the landing stability. The model was towed under the main carriage because a recent air-flow survey indicated that the airspeed under the main carriage was about 5 percent above the carriage speed. This is a more normal maneuver than the 10 percent lower airspeed encountered when the model is towed under the auxiliary carriage.

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It was concluded that small changes in propeller speed, near full thrust, do not cause any marked change in the lift and trimming moment coefficients. The stable range of positions of the center of gravity was narrowed from 10.4 percent to 7.5 percent of the mean aerodynamic chord when the thrust was increased from 50 percent to 100 percent of scale take-off thrust. The effect of flap deflection on the stable range of positions of the center of gravity is noted.

795. Bell, Joe W., Olson, Roland E., and Goldenbaum, David M.: Tests of a 1/10-Size Dynamically Similar Model of the Consolidated XPB3Y-1 Flying Boat in NACA Tank No. 1 — NACA Model 147. NACA MR, Bur. Aero., June 14, 1943.

Tests were made in Langley tank no. 1 of a $\frac{1}{10}$-size self-propelled dynamic model of the Consolidated XPB3Y-1 flying boat. The tests of the model and modifications provided information on the aerodynamic characteristics, stable range of positions of the center of gravity, trim limits of stability, spray characteristics, landing stability, and directional stability at low speeds. Changes in form investigated included variations of the depth of step, location of the step, ventilation of the step, form of the bow, form of the afterbody, and angle of afterbody keel.

It was found that the model was unstable aerodynamically when towed above the water. This instability caused difficulty in making landings and may have affected the stability characteristics while on the water. The effect of a small change in the vertical location of the center of gravity without a corresponding change in the location of the pivot axis of the model was found to be relatively small and to be subject to computation. By moving the step forward a distance equal to 4.35 percent mean aerodynamic chord and by increasing the mean depth of step from 4.8 percent beam to 6.4 percent beam, the forward center-of-gravity limit was moved forward 4 percent mean aerodynamic chord and the aft limit was moved forward 1 percent mean aerodynamic chord. This modification reduced the tendency to skip during landing. The center-of-gravity limits were moved forward 1 percent mean aerodynamic chord by moving the wing aft 1 percent mean aerodynamic chord. Skipping was eliminated by the use of artificial ventilation but the center-of-gravity limits were unaffected. A decrease in the angle of afterbody keel from 7° to 5° narrowed the stable range of center-of-gravity limits

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and reduced the upper trim limits but did not affect the landing characteristics. The spray in the propellers and flaps was not improved by the use of the lower bow. In general, the center-of-gravity limits were moved forward and the trim limits of stability were lowered by increasing the deflection of the flaps. The investigation of the yawing moments with the basic afterbody showed directional instability at speeds from about 25 to 30 knots (full size). The magnitude of the unstable yawing moments was reduced by use of an afterbody with cusp plan form near the second step.

*796. Lechner: Untersuchung des Tauchstampfverhaltens einer Ju-52-See (Investigation of the Porpoising of a Ju-52-See). UM No. 1340, Z.W.B., July 15, 1944.

A Ju-52-See equipped with a float of 11,000 liters displacement was investigated. The measurements were made for two weights of the airplane with landing flap at 25° deflection. In a number of take-offs the pitching was determined and compared with model tests. The influence of the wind on stability limits was computed. Author

797. McCaig, I. W.: Water Stability Tests on Saro 37 Fitted with Shetland Hull Bottom, Wing-Tip Floats, and Tail. Rep. No. H/Res/180, British M.A.E.E., Oct. 12, 1944.

Take-off and landing tests were made to determine the trim limits of stability, trim tracks, and elevator effectiveness of a Saro 37 fitted with a $\frac{1}{2.75}$-size model of the Short Shetland hull bottom, wing-tip floats, and tail. The tests were made at various combinations of gross weight, center-of-gravity position, and flap deflection. Some of the results of the tests are compared with those of previous tests of the same seaplane fitted with the Saro 37 tail.

Satisfactory stability was obtained at a gross load of 120,000 pounds (full size) with neutral or up elevator at normal and aft center-of-gravity positions. At a gross load of 130,000 pounds (full size) the upper and lower trim limits of stability coincided in the vicinity of hump speed, and the seaplane tended to yaw to starboard at speeds less than hump speed. Bounce porpoising [skipping] occurred during some slow landings at normal and aft center-of-gravity positions. Moving the center of gravity forward lowered the upper trim limit and the trim track, and vice

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versa. The change from the Saro 37 tail to the Shetland tail had little or no effect on the trim limits of stability but the Shetland tail gave a higher hump trim and was more effective in changing trim at speeds near get-away.

(See also abstracts 498, 584, 600, 754, 909, and 910.)

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*798. Croseck, H.: Das Steuern der Seeflugzeuge auf dem Wasser. W.R.H., vol. 13, no. 19, Oct. 1, 1932, pp. 283–286.

Steering of seaplanes on water; study of characteristic movements; drifting on water; steering on straight course; turning; based on conclusions, certain factors for design of seaplanes are established and presented.

Eng. Ind., 1932, p. 1166

(See also abstracts 759 and 759a.)

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*799. Diemen, F. Z.: Flying Boats in a Seaway. Z.F.M., vol. XVIII, Oct. 14, 1927, p. 448.

The relation between wind and waves, and the stability of flying boats with auxiliary stabilizing units near the hull or as inherently stable hulls is discussed. There are two principal cases, when the velocity of the boat through the water is small and when the velocity is large with respect to the wave velocity.

The properties of the flying boat during take-off in a seaway, and the relation between the motion of wave and hull, with determination of the stresses impressed on the boat are discussed.

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The boat form is discussed, finally, with examples of Dornier Metallboote construction, illustrating the relative merits of keeled and flat-bottom construction. Jour. R.A.S., Sept. 1928, p. 826

800. Emery, E. G., Jr.: Hydrodynamic Stability Study. BAC Rep. No. D-2220, May 1939.

The results of hydrodynamic tests of a $\frac{1}{10}$-size model of the hull and stub wing stabilizers of the Boeing 314 flying boat are presented in the form of four progress reports. These reports deal with various modifications to the stub wings that were designed to improve the transverse stability.

Progress report no. 1.– Because it was believed that by depressing the bow wave the transverse stability would be improved, the chine was extended downward and two different radii of flare were investigated. The model was towed at three angles of incidence $\left(7\frac{3}{4}^{\circ}, 7^{\circ}, \text{and } 6^{\circ}\right)$ of the stub wings but no improvement in stability was found in the critical range.

Progress report no. 2.– Spray strips of two different widths extending outward horizontally from the side of the hull were investigated. The spray strips were ineffectual in improving the transverse stability.

Flaps, hinged at the step of the stub wings, were tested at deflections of 0°, 10°, 20°, 30°, and 40° with the leeward flap and then both flaps deflected alternatively. The improvement in the transverse stability was of sufficient importance to warrant further investigation.

Progress report no. 3.– The flaps tested previously were extended in span so that the area was increased 27.4 percent. The larger flaps gave slightly better transverse stability at speeds in excess of 11 miles per hour.

Progress report no. 4.– The dihedral angle of the stub wings was reduced from $4\frac{1}{2}^{\circ}$ to $1\frac{1}{2}^{\circ}$ and the model was tested with the stub wing flaps deflected 0°, 10°, 20°, 30°, and 40°. The transverse

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stability was improved appreciably and there was no tendency for the stub wings to "dig in."

801. Bush, R. G.: Lateral Water Stability Model 314 Dynamic Model. BAC Rep. No. D-2870, Oct. 1940.

Hydrodynamic tests were made of a 0.09-size dynamic model of the Boeing 314 flying boat to improve the lateral stability in a manner that would minimize structural changes and additional design. The model was towed beside a 26-foot Chris-Craft motor boat on Lake Washington. The modifications investigated include auxiliary wing-tip floats in conjunction with the stub-wing stabilizers, retractable wing-tip flaps in conjunction with the stub wings, and a complete redesign of the stub wings.

The wing-tip flaps, apparently, would be satisfactory if the wing tips were permitted to touch the water and if the seaplane were in motion when critical upsetting moments occurred.

*802. Sottorf, W.: Schleppversuche mit einem Seitenschwimmer des Zentralschwimmerflugzeuges Vought-Corsair (Towing Experiments on an Outboard Float of a Single Float Vought-Corsair Seaplane). FB No. 446, Z.W.B.

The capsizing of a single float Vought Corsair seaplane was the reason for determining the magnitude and direction of the hydrodynamic vertical forces on an outboard float at various rolling speeds. The measured forces reach a maximum of 5 percent of the static buoyancy of the float. Therefore, in the present case the capsizing of the aircraft must be attributed solely to the wind-force moment. The result confirms that rolling conditions may arise, during which the stabilizing force of the outboard floats may disappear. It is therefore advisable to avoid curved bottom surfaces on outboard floats and sponsons. Author

*803. Full: Stabilität und Steuerbarkeit des Flugbootes BV 222 beim Rollen auf dem Wasser (Stability and Maneuverability of the Flying Boat BV 222 for Rolling on the Water). Rep. No. H 56/2, Inst. für Seeflugw. der DVL, March 2, 1943.

The stability of a seaplane on the water was formerly investigated for steady conditions only. The influence of motion and of angle of yaw are of decisive importance for rolling on the water so that model measurements for these conditions become necessary.

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The calculations of the equilibrium condition that appears while rolling at an arbitrary angle with respect to the wind and at an arbitrary velocity areperformed. Since the bases of the calculations were not exactly applicable and somewhat incomplete, the accuracy is claimed to be only fair. The margin of stability is in reality probably somewhat larger than calculated here. But as far as tendency is concerned, the behavior of the airplane agrees well with the results of the calculation. Author

(See also abstracts 505, 736, 746, and 747.)

Lateral Stability Under Way — Directional Stability

*804. Spaak, G.: The Maneuvrability of a Seaplane on Water. Ing. Vet. Akad. Handl. No. 105, 1930.

A standard Avro airplane, type 504K, fitted with floats was used for this investigation. The maneuverability tests were made with stiff floats and air rudder, stiff floats and braking rudder, flexible floats and moment gage, and flexible floats alone. The flexible floats gave the best results. [See also "Aeronautical Research in Sweden," by Ångström, Jour. R.A.S., Oct. 1929, pp. 897-914.]

Eng. Ind., 1930, p. 1575

*805. Pabst: Modelversuche zur Eraiftlung der Kurs-Stabilität beim Starten und Treiben (Model Studies to Determine Directional Stability in Take-Off and Drifting). FB No. 101, Z.W.B.

It was observed that a twin-engine seaplane tended to assume a position parallel to the waves while drifting. In order to investigate this problem, a procedure was developed for model studies in the towing tank. The double pontoons with various modifications were then studied. Author

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806. Pierson, J.: Model XPB2M-1 Towing Basin Tests to Improve Directional Stability Below Hump Speed. Eng. Rep. No. 1647, GLM, July 20, 1942.

In conjunction with yawing tests on the PBM-3 model at Stevens Institute of Technology (abstract 334) the XPB2M-1 hull model ($\frac{1}{30}$-scale SIT model 404) was also tested. The results of these model yaw tests at pre-hump speeds and subsequent flight reports of taxi runs of the actual ship indicated an extended region of directional instability on the water. Several modifications of the model were made and tested to improve this undesirable characteristic. The best solution tested was a side step on the afterbody extending from the chine to above the running waterline about one-fourth of the way from second to main step.

Although this side step does not make the model entirely stable throughout the speed range, sufficient improvement in the stability is obtained to enable the yawing to be controlled.

807. Anon.: Report of the Civil Aeronautics Board of the Investigation of an Accident Involving Civil Aircraft of the United States NC 15376 which Occurred in San Juan Harbor, Puerto Rico, on October 3, 1941. Docket No. SA-50, File No. 5106-41, Jan. 16, 1942.

The crash of a Sikorsky S-42B flying boat during a night landing in San Juan Harbor, Puerto Rico was investigated by the Civil Aeronautics Board. It was found that the captain landed the flying boat in an unduly nose-low attitude with a slight drift to port. Almost immediately after contact the aircraft swerved violently to the right and broke into several major sections. The water was smooth and there was a bright moon almost directly overhead, tending to lessen depth perception and determination of sideways motion.

808. Milliken, W. F., with supplementary remarks by R. Bush: Report of Dynamic Yaw Tests, Model XPBB-1. BAC Rep. No. D-2838, Aug. 1940.

Exploratory tests of directional stability of a $\frac{1}{10}$-size dynamic model of the Boeing XPBB-1 flying boat were made in Langley tank no. 1 (see abstract 759). Test conditions were: 8° yaw, 0° roll and free to roll; free to yaw $\pm 8^{\circ}$, free to roll and 0° roll. The model appeared to be stable and controllable in yaw at speeds where it was planing entirely on the forebody. When a yawing motion started it was sometimes accompanied by a pitching oscillation. The model was damaged during the high-speed portion of an accelerated run.

The supplementary remarks discuss water flow about the model and describe the accident which resulted in the destruction of the model. Directional instability at low speeds is attributed to the roach which wets the stern and tail extension.

*809. Full, G.: Versuche über das Steuern von Seeflugzeugen auf dem Wasser (Experiments on the Steering of Seaplanes on Water). UM No. 613, Z.W.B., Feb. 16, 1940.

After a short review of the equilibrium of an aircraft yawing on the water, the magnitudes which are characteristics of a condition of equilibrium are given and their determination is tried on two airplane models. The measurements are intended to give information only about the order of magnitude of the results. A more accurate method of measuring is developed, which shall be used in further experimentation. Author

(See also abstracts 518, 623, 736, 746, 747, and 788.)

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810. Webster, W. W., and Clark, W. D.: Flying Boats for Transoceanic Service. Jour. Aero. Sci., vol. 1, no. 2, April 1934, pp. 55-66.

An analysis is made of the computed aerodynamic performances and weights of component parts of groups of hypothetical flying boats, half of which are biplanes and half monoplanes, the other primary variables being engine power and stalling speed. All boats in each group are geometrically similar. A summary comparison is made on the basis of:

$$\text{Composite performance} = \frac{\text{Pay load} \times \text{Average economical speed} \times \text{Range}}{\text{Gross weight} \times 1000}$$

A monoplane has greater speed than a biplane but has less range, load carrying efficiency, and composite performance except when the wing loading is comparatively high. Maximum speed, range, and load carrying efficiency increase with increasing gross weight. Although there is some decrease in speed as a result of overloading a given design, the range and composite performance are greatly increased.

811. Wood, John H., and Pepoon, Philip W.: Free-Spinning-Tunnel Tests of 1/16-Scale Models of the Curtiss-Wright XSC-1 Seaplane and Landplane - TED No. NACA 2311. NACA MR No. L5A09, Bur. Aero., 1945.

Tests were made in the Langley 20-foot free-spinning tunnel of $\frac{1}{16}$-size models of the Curtiss-Wright XSC-1 seaplane and landplane to determine the spinning characteristics. The effects of control settings and movements upon the erect and inverted spin and recovery characteristics of each model were determined in the normal loading with flaps and slats retracted. The effects of opening the slots fully or partially, equally or unequally, were also determined. Tests were made with both slots fully open and with flaps down. Effects of moderate mass variations were determined for the seaplane model. Tests to determine the rudder-pedal force for each model as well as tests to determine the relative

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effectiveness of tail and wing-tip parachutes as a spin-recovery device were also included.

The landplane exhibited poorer spinning characteristics than the seaplane model. When the elevator was neutral or down on the landplane model, aileron-against settings retarded recoveries and when the elevator was full-up, aileron-with settings retarded recoveries whereas on the seaplane there was little effect of aileron setting.

*812. Tomotika, Susumu, and Imai, Isao: The Interference Effect of the Surface of the Sea on the Lift of a Seaplane. Rep. No. 146, Aer. Res. Inst., Tokio Imperial Univ., Feb. 1937.

The appreciable interference effect on the lift of a seaplane produced by flying near the surface of the sea, and which according to experiments carried out at Felixstowe may produce a 10 percent increase in the maximum lift cannot be satisfactorily explained by the ordinary vortex theory. In this paper a mathematical analysis is made of the problem of calculating the lift of a flat plate placed in a two-dimensional continuous stream of fluid which is bounded by a free surface on the lower side of the plate, assuming various values for the angle of attack of the plate and for the distance of the plate from the free surface. It is shown that for practically important angles of attack, such as 10° or 15°, the lift is increased by a few percent due to the presence of the free surface when the distance of the plate from it is of the same order of magnitude as the breadth of the plate. The surface of the sea being considered as a free surface, by assuming the water at rest and neglecting gravity, the theoretical results are applied to the case of a seaplane taxying over the sea surface, and it is shown that for an angle of attack of about 15° the maximum lift may be expected to be increased by about 6 percent when the distance of the wing from the surface is of the order of the breadth of the wing.

Jour. RAS, June 1937, p. 494.

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813. Nelson, William J., and Ebert, John W., Jr.: An Investigation of the Air Flow Around a Martin PBM-3 Flying Boat by Means of Tufts. NACA MR, Bur. Aero., April 16, 1943.

Observations by means of tufts were made of the air flow around a Martin PBM-3 flying boat to aid in the determination of possible methods of reducing the air drag. The behavior of the tufts on the hull and tip floats was recorded at various airspeeds by still and motion pictures taken from an accompanying airplane; tufts on the wing, nacelles, radar fairing, and gun turrets were observed but not photographed.

The tests showed that:

1. The air flow over the hull was generally parallel to the direction of flight.

2. As a result of the cross flow over the sharp forebody chine, flow separation occurred above the chine which caused the tufts in this region to stand away from the surface. The violence of the separation was greatest at low airspeeds.

3. A flow separation similar to that over the hull occurred above the chine on the tip float. Flow separation also occurred behind the step on the tip float at all flight speeds.

4. Flow separation occurred on the bottom of the hull for approximately 10 feet behind the main step. The length of the region of separation was greater at the high-speed condition. The flow was also disturbed behind the vertical steps on the sides of the afterbody.

5. The flow was turbulent over the engine nacelles, ahead of the windshield, around the juncture of the radar fairing and the hull, behind the top turret, and behind the junctures of the tip floats and the tip-float struts.

814. Rennie, J. D.: The Problem of the Long Range Flying Boat. Jour. R.A.S., vol. XXXII, no. 208, April 1928, pp. 264-295.

The effects of various aerodynamic design parameters on the water and air performances of a flying boat are investigated and discussed; the results are presented in tabular and graphical form.

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Flying boats may be divided approximately into two classes — fair weather boats and general service boats. Some requirements for the seaworthiness of general service boats are mentioned. It is shown that an increase in get-away speed or power loading increases the time and distance required for take-off, and that a head wind during take-off increases the air drag but reduces the total resistance. Increasing the aspect ratio of the wings or decreasing the get-away speed increases the maximum range and decreases the cruising speed. Decreasing the parasite drag increases both cruising speed and range. Decreasing the specific fuel consumption of the engines increases the range and has no effect on the cruising speed. A fuel system adaptable to various methods of refueling is described.

815. Phelan, John J.: Spin Tests of 1/14-Scale Models of the XSO3C-1 Landplane and Seaplane. NACA MR, Bur. Aero., Jan. 20, 1940.

Tests were made in the Langley 15-foot free-spinning wind tunnel of a $\frac{1}{14}$-size model of the Curtiss XSO3C-1 landplane and seaplane to determine the effects of loading changes; open and closed cockpit canopies; rudder, elevator, aileron, and flap deflections; and slots on the spinning characteristics. Subsequent tests were made to determine the effects of tail modifications on the landplane and seaplane and the effect of a uniform increase in gross weight on the seaplane.

In general, the seaplane recovered from spins more rapidly than the corresponding landplane.

816. Donlan, Charles J.: Spin Tests of 1/16-Scale Models of the N3N-3 Landplane and Seaplane. NACA MR, Bur. Aero., Jan. 12, 1940.

Tests were made of a $\frac{1}{16}$-size model of the N3N-3 landplane and float seaplane in the Langley free-spinning wind tunnel to determine the effects of loading changes and control dispositions and the effect of cowled and uncowled engines on the spinning characteristics both of the landplane and seaplane types. A series of tests were also made with various tail modifications.

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In the normal-loading condition the landplane spins were generally easier to hold than the seaplane spins. The landplane tended to give slightly flatter spins with consequent longer recoveries than the seaplane. The effects of control disposition, variations in mass, and center-of-gravity positions on the spinning characteristics of the two models were similar. A rigid comparison of the two models cannot be made at this time since the landplane model was tested at a slightly higher equivalent altitude. (The effect of an increase in altitude is to flatten the spin somewhat and to retard recovery.) This may partially account for the inferior recovery characteristics exhibited by the landplane model.

817. McHugh, James G.: Tests in the NACA 19-Foot Pressure Tunnel of a Tapered Wing with Spanwise Spoiler Wires Attached to its Upper Surface. NACA MR, Bur. Aero., April 12, 1940.

The practice of mooring out large airplanes has necessitated the use of some form of spoiler to destroy the lift that might be experienced on the wings of such airplanes in high winds. Although "spoiler boards" have been used successfully, tests were made to determine the spoiling action of a line along the upper surface of the wing about 0.05 chord back from the leading edge. Tests were made at three values of Reynolds number with wires which had diameters of 0.00568 and 0.01137 mean aerodynamic chord.

The wires hastened the stall and increased the drag but neither wire had any appreciable effect on the slope of the lift curve up to angles of attack of about 8°. The lift coefficient at stall was not consistently affected by Reynolds number. Flaps that can be deflected upward would be more effective as well as practical in reducing the lift.

(See also abstracts 471, 487, 518, 795, 826, and 831.)

Propulsive Arrangements

(See abstracts 468, 601, 735, and 826.)

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818. Liddell, Robert B.: The Aerodynamic Tests of Three Edo Floats for the SB2U-3, OS2U-2, and XSB2C-2 Seaplanes - NACA Models 106-K, 107-K, and 125-AH. NACA MR, Bur. Aero., March 27, 1942.

Aerodynamic tests were made in the Langley 7- by 10-foot wind tunnel of $\frac{1}{4}$-size models of Edo floats for the SB2U-3, OS2U-2, and XSB2C-2 seaplanes (see abstracts 634 and 655). Lift, drag, and pitching moment were measured at various angles of pitch (-10° to 16°, in 2° increments) at zero yaw, and lateral force, drag, and yawing moment were measured at various angles of yaw (-5° to 20°, in 5° increments) at 0° and 10° angle of attack. The data are presented in the form of coefficients based on the volumes of the floats. The model of the float for the XSB2C-2 had a lower drag coefficient than the other two models at angles of attack from -2° to 7°, based on the deck line. Minimum drag for all the models occurred at 0° angle of attack.

819. Cowley, W. L., and Others: Collected Reports on British High Speed Aircraft for the 1927 Schneider Trophy Contest. (Introduction by W. L. Cowley). R. & M. No. 1300, British ARC, 1931.

Forty-two reports describing the extensive research carried out in connection with the 1927 Schneider Trophy contest are presented in full. For the purpose of classification, they are divided into the following four groups: research; specifications, design, and construction; inspection and testing; and operational. The seaplanes that were designed for the contest were twin-float seaplanes. The Supermarine S.5 was a monoplane powered by a water-cooled engine, the Gloster IV was a biplane with a water-cooled engine, and the Short Crusader was a monoplane with an air-cooled radial engine.

<u>Research</u>.- Wind-tunnel tests were made at the National Physical Laboratory of $\frac{1}{4}$-size models of the three seaplanes and many of their

constituent parts. Tests were also made to determine the effect of interference between the parts, and a few other problems were investigated. The two seaplanes with the water-cooled engines and with radiators spread over the surfaces of the wings, fuselages, and floats were found to be superior to the Crusader. The air drag of the Crusader was decreased considerably by cowling the cylinders of the engine. Step fairings decreased the air drag of the floats of the Gloster IV. Methods of comparing the drag of the various floats are discussed. The tunnel test appears to be consistent with the full-size tests. (See also abstract 354.)

Aerodynamic tests of models of the floats and fuselage of the Gloster IV and of a model of the Crusader were made at the Royal Aircraft Establishment. An investigation was made of aerodynamic directional instability. The effect on air drag of the protruding rivet heads on a seaplane float was investigated by tunnel tests of a $\frac{1}{4}$-size and a full-size float. The heat dissipation and air drag characteristics of corrugated and uncorrugated surface radiators and honeycomb radiators were compared.

Specific free-to-trim resistance tests of $\frac{1}{8}$-size models of two pairs of floats for the S.5 were made in the William Froude National Tank. The speed limitations of the towing carriage allowed tests to be made only at speeds less than one-half get-away speed (about 80 knots, full size). The models differed in track, position of the center of gravity, and wing incidence. The spray of the twin floats was considered to be composed of the inboard and outboard bow blisters thrown up and out from the forebody chines, the central fan (roach) caused by the meeting of the inboard bow blisters, and the rear fans thrown up abaft each float. The height of each portion of the spray was measured at various speeds.

Full-size tests to determine the static thrust and the thrust under take-off conditions of various propellers for the racing seaplanes were made at the Marine Aircraft Experimental Establishment, and the design of high-speed propellers is discussed. The effects on maximum permissible engine speed of a reduction in the mass of the reciprocating and rotating parts is discussed.

Specifications, design, and construction.– The Air Ministry specifications for the Supermarine S.5 are given. The specifications for the other seaplanes are similar. The design and construction of the three seaplanes, the Supermarine S.5, the Gloster IV and the Short Crusader, are discussed. The results of tank tests of various modifications to the floats of the S.5 are summarized. (See also abstract 204.) The Napier Lion Series VIIB in-line water-cooled engine, used in the S.5 and the Gloster IV, and the British Mercury radial air-cooled engine, used in the Crusader, are described.

Inspection and testing.- Strength tests of the fuselage of the the S.5 and of the material used in the fuselage of the Crusader were made at the Royal Aircraft Establishment. The hydrostatic longitudinal and lateral stability of the Gloster IV floats were investigated at the Marine Aircraft Experimental Establishment.

Operational.- The angle of attack and landing speed of the S.5 were measured and it was found that the angle of attack during landing was not high enough to take advantage of the high maximum lift coefficient of the airfoil section used. It was considered that another airfoil section having a lower minimum drag and maximum lift would be more suitable. "Cornering" or turning around pylons at high speed was analyzed. The best mean speed around the Schneider Trophy course was computed to be about 3 percent less than the maximum speed in the straight flight; this value was in agreement with that obtained in flight tests. The test flights of the seaplanes are discussed and a short account of the race at Venice, Italy, is given.

820. Garner, H. M., and Others: Collected Reports on British High Speed Aircraft for the 1931 Schneider Trophy Contest. (Introduction by H. M. Garner.) R. & M. No. 1575, British ARC, 1934.

Teh reports describing the research done in connection with the Schneider Trophy contest of 1931 are presented. The design and construction of the Supermarine S.6B, a low wing, wire braced, monoplane, twin-float seaplane are discussed. The conflicting requirements of take-off, landing, and air drag of the floats posed a difficult design problem. The development of the Rolls-Royce 1931 "R" engine and the design and construction of the propellers are reviewed. The S.6B and S.6A (used for training purposes) were modifications of the S.6, which won the contest in 1929.

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Wind-tunnel investigations of a $\frac{1}{4}$-size model of the S.6B were made at the National Physical Laboratory. The investigations consisted of: tests of various floats in an effort to decrease the air drag; tests of the air flow inside the wings for additional cooling of the wing radiators; tests of various propellers; tests of the complete model with and without an operating propeller; and tests of the directional stability of the model without floats in the presence of a ground board simulating the sea during take-off. A drag coefficient based on volume$^{2/3}$ was found to provide a basis for comparison of the air drag of various floats.

The turning of high-speed aircraft around pylons was investigated by tests of the racing seaplanes. Tests of maximum speed, take-off time, and static thrust of the seaplanes fitted with propellers of varying pitch-diameter ratios were made. The flying and water handling characteristics of the seaplanes and the medical aspects of high-speed flying are discussed. A description of the contest, and the establishment of a world's record maximum speed of 407.5 miles per hour, which took place near Portsmouth, England, is given.

821. Belsley, Stephen E., and Jackson, Roy R.: The Effect of Amphibious Floats on the Power-Off Stability and Control Characteristics of the Douglas C-47 Airplane. NACA MR, Army Air Forces, Jan. 18, 1943.

Tests were made in the Ames 7- by 10-foot wind tunnel to determine the effects of amphibious floats on the power-off stability and control characteristics of a $\frac{1}{11}$-size model of the Douglas C-47 airplane. Longitudinal stability and control characteristics were investigated for three flap positions.

At any angle of attack, the floats reduced the lift coefficient by a negligible amount. At a fixed position of the center of gravity, the floats reduced the static longitudinal stability by reducing the slope of the curve of the pitching-moment coefficient plotted against lift coefficient by about 0.02, which was equivalent to shifting the neutral point 2 percent mean aerodynamic chord. The full-load stability with floats was, however, greater than that without floats because the substitution of the floats for the landing gear moved the center of gravity forward 3 percent mean aerodynamic

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chord. The negative pitching moment (taken about the stability axes) due to the floats was independent of the angle of yaw. The floats reduced the slope of the curve of the yawing-moment coefficient plotted against angle of yaw (static directional stability) by 0.0004. Three of four ventral and dorsal fins tested to compensate for this loss in directional stability proved satisfactory. The floats did not change the control characteristics of either the elevator or rudder. Substituting the floats for the retracted main landing wheels and removing the tail wheel increased the parasite drag coefficient by 0.0095 at an angle of attack corresponding to high-speed flight. Extending the wheels of the floats increased the parasite drag coefficient by 0.0070.

822. Hanson, Frederick H., Jr.: The Effect of a Wing-Tip-Mounted Fuel Tank on the Aerodynamic Characteristics of a High-Speed Bomber Wing. NACA ACR No. 5H06, 1945.

Tests were made to determine the effect of a wing-tip-mounted auxiliary fuel tank on the aerodynamic characteristics of a high-speed bomber wing. Fuel tanks consisting of streamline bodies of revolution corresponding to NACA fuselage form 111 and modified versions of fuselage forms 111 and 332 were tested. Fuselage form 111 was tested at fineness ratios of 3.5 and 5 and at volumes, to $\frac{1}{10}$-scale, of 300 and 600 gallons. The modified version of fuselage form 332 was also tested at volumes corresponding to 300 and 600 gallons. All tanks were tested mounted on the tip of a semispan wing with the center line of the tank approximately one-half of the tank diameter below the wing-tip chord. One tank of NACA fuselage form 111, having a fineness ratio of 5 and a volume corresponding to 300 gallons, was also mounted in a central location on the wing tip and in an underslung position beneath the wing inboard from the tip.

It was found that the wing-tip-mounted tanks caused an average increase of 3.75 percent in lift-curve slope. This increase is equivalent to an increase of 27.5 percent in the effective aspect ratio based on the geometrical aspect ratio of 9. At a lift coefficient of 0.15, a wing-tip-mounted tank had one-third the drag of a tank mounted inboard from the tip and underslung beneath the lower surface of the wing. At lift coefficients above 0.6, the drag of the wing with the tip-mounted tank became equal to or less than the measured drag of the wing without a tank because of the decrease in induced drag.

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The modified version of form 332 had a critical Mach number of 0.72 which was equal to the critical Mach number of the wing at a lift coefficient of 0.20.

823. Crouch, A. S.: Full-Scale Lift and Drag Curves of a Standard Seaplane. R. & M. No. 1448, British ARC, 1931.

The lift and drag of a seaplane were measured during glides with the propeller stopped and with the propeller operating at zero thrust over a range of angles of attack from 4° to 14.5°. The drag of the fixed propeller was practically constant up to about 10° angle of attack.

824. Cushing, R. K., and Coombes, L. P.: Full Scale Measurement of Lift and Drag of Large Seaplanes - Experiments on Blackburn "Iris." R. & M. No. 1354, British ARC, 1929.

The lift and drag of a Blackburn Iris flying boat were measured during glides with the engines fully throttled and with the propellers operating at such a speed as to produce zero thrust. The method of determining when the propellers were operating at zero thrust is described. There was a difference in lift and a large difference in drag between the fully throttled and zero thrust conditions. The drag of the flying boat with zero thrust agreed well with the results of model tests.

825. Crouch, A. S.: Full Scale Measurements of Lift and Drag of Southampton Boat Seaplane. R. & M. No. 1391, British ARC, 1931.

The lift and drag of a Supermarine Southampton flying boat were measured during gliding tests without power at angles of attack ranging from 2° to 10° and the data are presented. A few glides were also made with the engines fully throttled. The maximum lift coefficient was not attained because of inadequate control at angles of attack greater than 10°.

826. Wilson, Herbert A., Jr. and Lehr, R. R.: Full-Scale Wind-Tunnel Tests of the 1/5-Scale Model of the Revised XPB2M-1 Flying Boat. NACA MR, Bur. Aero., April 15, 1940.

Tests were made in the Langley full-scale tunnel of a $\frac{1}{5}$-size model of the revised Martin XPB2M-1 flying boat to determine

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power-off and power-on aerodynamic characteristics, propulsive characteristics, control effectiveness, and to obtain data on flap loads, fuel-dump valve outlet locations, and air flow over the wings and tail. The tests allowed the determination of the increments in drag due to wing-hull fairing, tail turret, main-step fairing, and rear-step-turret fairing, antenna mast and loop, tip floats, bomb racks, gun turrets, rotation of the rear-step turret, and the conning hood. Some tests were made to show the change in aerodynamic characteristics that would accompany a replacement of the nacelles by extension shafts such as might be used with a submerged engine installation. An estimate is made of the performance for three flight conditions and six model conditions. The results are plotted and a number of photographs of the model are included.

*827. Devkin, M. M.: Lateral Stability of a Seaplane on the Water in a Side Wind. The Screening of the Tail Surfaces of a Flying Boat by the Hull and the Wing. Rep. No. 166, CAHI.

The changes of rolling moments and force of side wind acting on a seaplane in the case of a simple roll, given a constant degree of roll and a constant angle of drift 90°, are investigated in the first part of the report.

To find the coefficient of rolling moment C_{m_x} and the coefficient of side force C_z, five models of seaplanes were tested on a moment apparatus in wind tunnel T-1 with and without the "Sea" screen. The tests were made by the laboratory of the Experimental Aerodynamic Department of CAHI. The experiments for C_{m_x} were made with the following positions of the model in relation to the screen: (1) submersion to the water line; (2) touching the screen; (3) at a distance of 50 millimeters from the screen; (4) without screen; the experiments for C_z were made only for the first and fourth positions.

Formulas are obtained to calculate for each model with reference to the center of gravity the average values of the coefficient of rolling moment C_{m_x} and the derivative $dC_{m_x}/d\theta^{\circ}$ representing the intensity of its increasing, as well as the changes of these values generated by the influence of the screen in its given position with relation to the model; the numerical values of these changes, common to all the models, are also established.

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Formulas are obtained to calculate for each model the value of the coefficient of side force for a model in the presence of the screen and without it, also the correcting quantity for the influence of the screen on the coefficient of side force.

With knowledge of the rolling moment and side force for a seaplane model, calculated in relation to the center of gravity, it will be easy to calculate the rolling moment of a seaplane in relation to any center of rotation.

The effect of the aerodynamic shadow thrown by the flying boat on the aerodynamic characteristics of the tail surfaces is investigated in the second part.

The tail surfaces of two types of flying boats were tested for their C_x and C_y values. The tests were made using isolated tail surface, tail surface in the presence of the hull and wing, tail surface in the presence of the wing, and tail surface in the presence of the hull at four positions of the tail with relation to the thrust line.

The effect of the flying boat on the aerodynamic characteristics of the tail surfaces is resolved into components. The part which each component has in the total effect of the flying boat is determined. The maximum as well as the average effect which each factor has on the tail surfaces is evaluated. Empirical formulas are developed which permit calculation of the total effect of the flying boat on the C_x and C_y values of the tail surfaces and thus to trace the C_x and C_y curves of the tail surfaces in actual conditions. A theoretical analysis is made of the structure of the aerodynamic shadow thrown by the wing on the tail, giving results closely corresponding to the experimental conclusion.

Airc. Eng., Nov. 1934, p. 308

828. Tomotika, Susumu, and Imai, Isao: Notes on the Lift and Moment of a Plane Aerofoil which Touches the Ground with its Trailing Edge. Aero. Res. Inst., Tokyo Imperial Univ., Rep. No. 154, July 1937.

Special equations for the ideal two-dimensional air lift and moment of a plane airfoil which touches the ground with its trailing edge that were developed by Dätwyler are checked by using general

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equations for the lift and moment of a surface in the presence of a boundary that had been developed previously by Tomotika. The calculations yielded the following set of equations:

$$C_a = \frac{\pi}{\sin(\pi\alpha)}\left(\frac{\alpha}{1-\alpha}\right)^{1-2\alpha}$$

and

$$C_m = \left(\frac{\alpha}{1-\alpha}\right)^{1-2\alpha}\left[\pi\cot(\pi\alpha) - \log\left(\frac{1-\alpha}{\alpha}\right) - \frac{1-2\alpha}{2\alpha(1-\alpha)}\right]$$

where

$$C_a = \frac{L}{\frac{\rho U^2}{2}(2a)}$$

$$C_m = \frac{M}{\frac{\rho U^2}{2}(2a)^2}$$

L lift

M moment about leading edge

ρ density of air

U velocity

α angle of attack/π

$2a$ length of plate

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829. Garner, H. Mason: Recent Full-Scale and Model Research on Seaplanes. The Aeroplane, vol. LV, no. 1434, Nov. 16, 1938, pp. 618-619.

Wind-tunnel tests on a family of shapes showed that the air drag of a conventional flying-boat hull with a transverse second step was 50 percent greater than that of a symmetrical streamline body of the same fineness ratio. Second-step fairings were found to give satisfactory hydrodynamic characteristics and permit a reduction of about 9 percent in air drag. Main-step fairings reduce the drag by over 10 percent but unless retracted may give unsatisfactory resistance characteristics. The possibility of using air jets in place of discontinuities in the planing bottom is suggested. Tip floats were found to be better aerodynamically than stub wings. Longitudinal stability is mentioned and a few general rules relating geometrical shape to position of trim limits of stability are given. Impact tests are briefly noted in which von Kármán's impact formula (abstract 93) was substantiated. Mention is made of a wave recorder. [Précis of paper read at a meeting of the Lilienthal Gesellschaft in Berlin. See also Jahrb. 1938 der deutschen Luftfahrtforschung (supp. vol.), pp. 357-373.]

*830. Kohler, M.: Sechskomponenten-Messungen an einem Modell des Flugbootes "Dornier-Wal" uber einer den Wasserspiegel darstellenden Platte (Six-Component Tests on a Model of a Flying Boat "Dornier-Wal" over a Plate Representing the Water Surface). FB No. 716, Z.W.B.

The results of six-component measurements on a model of the flying boat "Dornier Wal" are given. The tests were made in the wind tunnel over a plate representing the water surface at angles of yaw from 0° to 360° and at various trims and angles of keel. Several tests were made to determine the effect of rudder and ailerons. The results are discussed and compared with the results of similar tests on a model of a biplane-floatplane (abstract 341).
Author

831. Irving, H. B., and Batson, A. S.: Spinning Experiments and Calculations on a Model of the Fairey IIIF Seaplane with Special Reference to the Effect of Floats, Tailplane Modifications, Differential and Floating Ailerons and "Interceptors." R. & M. No. 1356, British ARC, 1930.

Tests of a model of the Fairey IIIF seaplane were made in the 7-foot wind tunnel of the National Physical Laboratory to provide information on the spinning properties of a typical twin-float seaplane with special reference to the effects of the floats on those aerodynamic characteristics of most importance in spinning. The effects of differential and floating ailerons, spoilers, and various modifications to the horizontal stabilizer on spinning were also investigated. The tests were made on a rolling balance to determine the rolling and yawing moments due to rolling about the wind axes, and on a six-component balance to determine the rolling and yawing moments due to roll and sideslip. The rolling moment due to rolling of the floats was positive for all angles of pitch tested (27.5°, 42.4°, and 60.9°). The yawing moment due to rolling of the floats was negative at 42.4° angle of pitch and positive at 60.9° angle of pitch. Large positive pitching moments due to the floats were observed at high angles of pitch. Interference of the floats on the horizontal stabilizer was responsible for about one-third of this pitching moment. Spinning calculations based on the test results showed that removing the floats increased the margin of safety in spinning, although the seaplane with the floats should recover from a spin without difficulty.

832. McKee, John W., and Maloney, James A.: Wind-Tunnel Tests of a 1/6-Scale Model of the XSC-1 Airplane. I - Longitudinal Stability and Control. NACA MR, Bur. Aero., Feb. 23, 1944.

Pitch tests were made in the Langley 7- by 10-foot wind tunnel of a $\frac{1}{6}$-size model of the XSC-1 float seaplane to determine the longitudinal stability and control characteristics and the effects of various model modifications made to improve the longitudinal stability. The results indicated that the model was statically longitudinally stable, stick fixed and stick free, for the clean condition with and without power. The original model in the dirty condition became unstable at high lift coefficients when power was applied. Tests of the separated main float in the presence of the rest of the model indicated that, at low angles of attack, the applications of power caused the float to contribute only a slightly more unstable moment. At high angles of attack, however, the float contributed a large destabilizing moment. By retracting the inboard sections of the slat the stability was improved at the expense of a reduction of $C_{L_{max}}$, propeller windmilling, of about 0.5 but without an appreciable reduction of $C_{L_{max}}$ with power. The addition of large end plates and more area to the horizontal tail greatly improved the static longitudinal stability, dirty condition, power on. Other modifications, including small end plates and additional horizontal-tail area without an increase in tail span, gave very little improvement in stability.

833. Bioletti, C.: Wind-Tunnel Tests of a 1/12-Scale Model of the XPBS-1 Flying Boat. NACA MR, Bur. Aero., April 14, 1936.

Tests were made in the NACA 20-foot propeller-research tunnel of a $\frac{1}{12}$-size model of the Sikorsky XPBS-1 flying boat. Measurements of lift, drag, pitching moment, and yawing moment were made. The model was tested with two stabilizers of different size and with various modifications to the hull and fillets.

834. Rossi, Peter F., and Riebe, John M.: Wind-Tunnel Tests of a $\frac{1}{16}$-Scale Model of the Martin PBM-3 Airplane without Power. NACA MR, Bur. Aero., Sept. 12, 1944.

Tests were made in the Langley 7- by 10-foot tunnel of a $\frac{1}{16}$-size model of the Martin PBM-3 flying boat, without power, (1) to determine the aerodynamic effects of changing the incidence of the standard PBM-3 wing, nacelles, and tip floats, (2) to study the stalling characteristics of the standard PBM-3 wing and a new twisted wing by means of tufts for the flap-up condition, and (3) to determine the aerodynamic characteristics of the PBM-5 tail unit on the PBM-3 model. In addition, pressure surveys were made to determine the angularity of the air flow at the mouth of the nacelles of the model and the pressures in the nacelles proper.

The results are plotted and a number of photographs and sketches are included.

(See also abstracts 437, 510, 624, 625, 706, 754, 756, 779, 780, and 794.)

OPERATION
General

*835. Smith, Frederick, H.: Hints on Seaplane Operation. Aero Digest, vol. 36, no. 5, May 1940, pp. 40, 41, and 79.

Recommendations are given in regard to equipment and accessories; precautions before take-off; and maneuvering during take-off, after take-off, and in landing. It is recommended that the seaplane stay near the water and avoid river-valley flying.

Jour. Aero. Sci., July 1940, p. 414

*836. Anon.: Hoisting and Lowering Seaplanes from a Ship. Illustr. Flugwoche, vol. XI, no. 8/9, 1929, p. 159.

A descriptive article with four photographs, showing a flexible slipway lowered from the deck of a ship and trailing in the sea.

Jour. R.A.S., March 1930, p. 290

837. Ebel, William K.: Operating Characteristics of Large Flying Boats. SAE Jour., vol. 43, no. 2, Aug. 1938, pp. 7-12.

The operating conditions obtained during flight, take-off, and landing of large seaplanes are compared with those of landplanes. The controllability and maneuverability at very low water speeds, handling and docking, spray characteristics, and porpoising characteristics of large seaplanes are discussed. The trend toward increased beam loadings and the lack of knowledge about porpoising are pointed out. It is considered that wing flaps having high lift and low drag improve take-off performance and ease of landing more than do high-drag flaps. Flight characteristics, aerodynamic control, and the division of duties between the members of the operating crew are discussed. Flying scale models of proposed seaplanes are regarded as being valuable in the development of the proposed seaplanes. Conventional model tests in wind tunnels and towing basins provide basic design information, and the flying models [intermediate in size between the full-size airplane and the conventional models] supplement this information by serving as prototypes to develop the refinements of the full-size seaplanes. Seaworthiness is discussed with reference to the forced landing of the NC-3 and its subsequent 205-mile journey sailing in the open sea in rough water.

OPERATION
General

*838. Schildhauer, C. H.: Operating Problems of Flying Boats. SAE Preprint for meeting, Oct. 15 to 17, 1936.

Problems encountered in the Pacific Division of the Pan American Airways System are discussed with comments on a typical flight along the airway from Alameda to Manila.

Jour. Aero. Sci., Jan. 1937, p. 128.

839. Coombes, L. P.: Tests of Anchors for Use on Flying Boats. R. & M. No. 1449, British ARC, 1931.

An investigation was made at the Marine Aircraft Experimental Establishment to determine the conditions under which anchors operate, to develop apparatus and technique for testing anchors, to investigate the possibility of testing scale models of anchors, and to improve the efficiency of seaplane anchors.

The holding force of an anchor is dependent on the shape of the anchor and the size of the flukes, and varies only slightly with the weight of the anchor. Stockless anchors have smaller holding forces than anchors with stocks, and generally tend to be unstable. The holding force of an anchor decreases rapidly as the angle of the cable to the horizontal increases, and becomes very small at angles greater than 20°. Increasing the weight of the anchor cable is of little value in increasing the holding force of an anchor under steady conditions, but may be of value when there is considerable "snatch" in the cable. The holding force of an anchor may be predicted satisfactorily from tests of a scale model if the size of the particles in the model sea-bed is approximately to the same scale as the model anchor.

[See also Engineering, vol. 141, no. 3673, June 5, 1936, pp. 625-627. Inst. Nav. Arch., paper no. 11 for meeting Apr. 3, 1936.]

(See also abstracts 414, 426, 433, 439, and 471.)

[redacted]

OPERATION
Piloting

*840. Moebus, L. A.: Aircraft Seamanship. Aero Digest, vol. 16, no. 4, April 1930, pp. 68-70.

Handling of various types of seaplanes in take-off and landing is described and illustrated by sketches; conditions of wind and water require special maneuvers.

Eng. Ind., 1930, p. 1573

841. Maycock, R. B.: Airmanship at Sea. Jour. RAS, vol. XXVIII, no. 163, July 1924, pp. 450-462. Discussion, pp. 462-474.

The handling and maintenance of seaplanes on the water are discussed. It is considered that seaplanes would be more useful if they were not dependent on bases ashore, but were moored on the water and operated from large mobile floating docks. Buoys and moorings and the use of drogues and water rudders in maneuvering at low speeds on the water is discussed. In addition to knowledge of the operation of aircraft in the air, seaplane pilots should have a practical knowledge of seamanship.

*842. Pacher, W.: Alighting of Flying Boats on Rough Sea or in the Dark. Flugsport, vol. 26, no. 3, Feb. 7, 1934, pp. 51-54, and vol. 26, no. 4, Feb. 21, 1934, p. 73.

A brief descriptive account is given of familiar problems regarding the landing of flying boats on rough sea or in the dark.

A sketch of a device for landing in the dark shows a rope passing through a loop attached to a shock absorber and trailing behind. On contact with the surface an impulse is communicated through the shock absorber to the pilot and indicates a previously determined height above the surface.

Jour. R.A.S., Feb. 1935, p. 154.

*843. Ragosin, N.: Consejos prácticos a los pilotos de hidraviones. Revista de Aeronautica, vol. 1, nos. 3, 4, and 5, June 1932, pp. 110-115, July 1932, pp. 161-164, Aug. 1932, pp. 204-207.

Practical hints for seaplane pilots with particular regard to precautions in landing, take-off, and taxying; geographical and meteorological considerations.

Eng. Ind., 1932, p. 1166

OPERATION
Piloting

*844. Brice, David: Flying a Boat. Aeronautics, Dec. 1944, pp. 47-50.

It is noted that when a flying boat is on the water it is virtually a marine vessel and therefore subject to natural and man-made laws of the sea. The operation of the flying boat under these conditions is discussed. Sections of the article refer to moorings, taxying, take-off, landing, and mooring procedure after landing.

Aero. Eng. Rev., Feb. 1945, p. 84

*845. Adamoli, Giuseppi: Flying Boat and Hydroaeroplane for Sea Flying. Flying, June 1918.

Limitations of the double-float seaplane for rough-water landing, training flying, boat pilots, taking off, landing, and so forth.

Eng. Ind., 1918, p. 209

*846. Anon.: The Flying Boat in a Seaway. Luftwacht, Sept. 1929, pp. 406-409.

A descriptive account of methods of using sea anchors to minimize stresses in a sea.

Jour. R.A.S., Jan. 1930, p. 141

*847. Anon.: Glassy Landings. Scientific American, vol. 160, no. 1, Jan. 1939, p. 32.

Judging height accurately when alighting on perfectly calm water is practically impossible. Within the last year, about 50 pilots and passengers have lost their lives in various parts of the world because of "glassy landings." Under glassy conditions, the pilot should not guess at height and follow the conventional maneuver of gliding down and then flattening out a few feet from the surface. He may flatten out too late, and nose into the water with possible disastrous consequences. What he should carry out is a "power stall." At about 50 feet from the surface of the water, he should open up the throttle a trifle and pull the nose slightly above the horizon. The airplane will then lose altitude slowly in almost stalled attitude. The subsequent contact with the

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water will be harmless, although to land in a power stall on the much harder ground might not be so judicious.

Jour. R.A.S., Feb. 1939, p. 111

*848. Smith, Fred: The Handling of Flying Boats on the Water. Aero Digest, vol. 40, no. 6, June 1942, pp. 73-74 and 220.

Flying boats have individual peculiarities when handled on water, though these are not important if there is plenty of space in which to maneuver. Taxying on the step is not recommended by veteran pilots as lateral control is limited and the danger of striking objects in the water is increased. Mooring methods are discussed and advice is given on checking anchorage positions.

Aero. Eng. Rev., July 1942, p. 37

*849. Post, George B.: Handling the Seaplane. Flying, Nov. 1945, pp. 44, 45, 92, 94; Dec. 1945, pp. 30, 31, 78, 81, 82, 86, 90, 92.

Several fundamental characteristics that form the basis for the wide differences between handling a landplane and a seaplane are described. The effect of a high wind force and centrifugal force when taxying a seaplane is discussed. Detailed advice is given as to special points that must be observed by the pilot of a seaplane on the take-off run, when landing, while taxying in normal weather, and in maneuvering on the water during storm conditions. Special piloting methods that differentiate the handling of a plane with floats from that of a plane with wheels are noted.

Aero. Eng. Rev., Dec. 1945, p. 67 and Jan. 1946, p. 63

850. Stout, Ernest G.: Landing Analyses for Flying Boats and Seaplanes - Part I. Aviation, vol. 44, no. 10, Oct. 1945, pp. 137-141.

The landing of seaplanes in rough water is treated. The trochoidal theory of waves is reviewed and the size of the waves in relation to the seaplane is described. Landing technique is discussed and the necessity for considering the speed and direction of the waves as well as the speed of the wind is pointed out. In all but the heaviest seas, a take off parallel to the wave crests is not considered to be as satisfactory as a take off directly into the wind, at least during the latter portion of the run.

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*851. Baetz, K.: Light Seaplane Pointers. Western Flying, March 1940, pp. 14-16, 24.

Recommendations are given with regard to taxying into the wind, downwind, crosswind, turning into the wind, turning downwind, sailing, take-off, and landing.

Jour. Aero. Sci., May 1940, p. 314

852. Brimm, D. J., Jr.: Seaplane Handling. The Technique of Water Flying. Aviation, vol. 36, no. 1, Jan. 1937, pp. 31-33; vol. 36, no. 2, Feb. 1937, pp. 28, 29, 72; vol. 36, no. 3, March 1937, pp. 30, 31, 70.

The art of seaplane seamanship is discussed in detail. The effect of the speed and direction of the wind and the speed and attitude of the seaplane upon the water handling characteristics are shown. The methods of embarking and disembarking from a seaplane ramp, a float, a dock or pier, and a beach are described. The difference in performance between the landplane type and the seaplane type is shown and the piloting technique for take-off and landing in glassy water and rough water is described. Auxiliary devices for added convenience and safety are mentioned and head mooring and handling equipment are discussed.

853. Goodwin, E. S.: Seaplanes. Taking Off and Alighting. R. & M. No. 784, British ACA, December 1921.

The pilot technique used in taking off and landing marine aircraft is discussed briefly with notes on the position of the pilot with respect to visibility and spray. Low-powered seaplanes often experience difficulty in rising on to the step and planing, especially in calm water. This can be overcome by holding the elevators up and quickly lowering them, thereby decreasing the trim. This may be repeated as often as necessary. Sticking of a twin-float seaplane may be overcome by yawing the seaplane a few degrees from side to side with the rudder. For night landings at sea a stick, which projects down and is hinged at the bow of the flying boat and which is connected to the elevators, is helpful in flattening out the glide near the water.

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*854. Soennichsen, Th. E.: Die Seemannschaft in der Luftwaffe (Sailorship in the Air Force), E. S. Mittler & Son, (Berlin), 1938.

This booklet is a manual intended for the instruction of personnel serving with the naval wing of the German Air Force. It refers to everything connected with the handling and navigation of water craft in the service, including the special high-speed motor-boat classes required for seaplane stations. The manual is comprehensive, instructive, full of practical experience, and up to date. The towing and general handling of seaplanes on the water is included, as well as regulations, signals, first-aid advice, and so forth. A dictionary of special nautical terms is added. All definitions given are precise and yet easy for novices to understand.

Jour. R.A.S., Sept. 1938, p. 862.

*855. Post, George B.: Water Handling of Seaplanes and Flying Boats. Aero Digest, vol. 14, no. 5, May 1929, pp. 51-53, 258.

Handling of seaplanes in water is discussed; definitions of weather-cock, step, planing, rock, and porpoise; advisable to taxi seaplane as slowly as possible consistent with maintaining adequate rudder control; suggestions for handling of downwind course and strong sidewind course; precautions in take-off; technique of bringing seaplane to float.

Eng. Ind., 1929, p. 1647

*856. Hawkins, Charles J.: Wings Afloat. Air News, July 1945, pp. 25-28, 56, 58.

Differences in the handling characteristics of seaplanes and landplanes are indicated. The specialized techniques required for operation of a seaplane during the taxying, take-off, and landing stages are described briefly.

Aero. Eng. Rev., Sept. 1945, p. 73

(See also abstracts 433, 601, 757, 820, 835, 872, and 888.)

857. Pack, Harry S., Jr.: Air Terminals for Transatlantic Services. Aero Digest, vol. 31, no. 5, Nov. 1937, pp. 46, 48, 50, 102.

The maintenance developed by Pan American Airways for its large transoceanic flying boats is discussed, and the terminals and facilities at Port Washington, Long Island, and Baltimore are described. The precise technique developed for safe and efficient handling of the flying boats on land or when not operating under their own power is outlined.

858. King, F. W.: Assisting Take-Off and Alighting. Flight, vol. XXXVIII, no. 1645, July 4, 1940, pp. 7, 8.

A hydroplane launching gear for stepless flying boats is described. The aircraft is mounted for launching on a float-supported structure similar to that of a twin-float seaplane. Extra thrust is provided by several aircraft engines and airscrews mounted on the floats. The air flow induced by the propellers which are placed just behind the wings of the aircraft increases wing lift and thereby reduces take-off time. Aircraft could be mounted for launching without external assistance. The floats of the launching gear provide convenient tankage for refueling and eliminate the need for a separate tender. Servicing operation could conveniently be performed from the floats.

859. Anon.: Australia's Inland Flying-Boat Base. Flight, vol. XLVI, no. 1868, Oct. 12, 1944, pp. 396a-396f.

Lake Boga, in Victoria, Australia, has been used since 1942 as a flying-boat repair depot. The lake is almost perfectly circular in shape, about 2 miles in diameter, and about 14 feet deep. Slipways, hangars, workshops, powerhouses, and fuel stores were built and main rail and road facilities were made available.

860. Cooke, Donald D.: Bases for Seaplanes. Aero Digest, vol. 32, no. 4, April 1938, pp. 24-28.

Bases for light seaplanes are discussed in detail. Particular equipment used at several known bases is described and the costs involved are given. Special emphasis is placed on facilities for twin-float seaplanes.

*861. Anon.: Concrete Floating Drydocks Suggested for Docking, Servicing Flying Boats. American Aviation, June 15, 1945, p. 74.

An ingenious floating drydock built of concrete is suggested which would hold a seaplane securely while it was being repaired. The structure would contain a cradle on which the craft would rest during its stay in drydock. Sketches are given suggesting the form and general construction.

Tech. Data Digest Sept. 1945, p. 13

862. Anon.: Directory of Seaplane Bases and Anchorages. Bull. No. 11A, CAA, May 15, 1941.

The directory lists all seaplane bases, anchorages, and approved water areas, both civil and government owned, on record with the CAA. A base is a protected water area having complete servicing facilities; an anchorage has limited facilities; and an approved water area has no facilities.

863. Cooke, Donald D.: Floatplane Bases Cut Expenses and Time. Aviation, vol. 44, no. 12, Dec. 1945, pp. 178-182.

Expansion in the use of water-based aircraft, especially in nonscheduled flying, is anticipated because:

1. The provision of a water-flying base does not involve the heavy investments that are required for a landplane base.

2. Suitable water-flying areas already exist at or near the heart of every community and industrial or recreational area.

3. Interest in water flying was increasing steadily before the war [World War II].

4. Water flying has attributes of fun and personal satisfaction that are unique in aviation.

Types of installation for hauling water aircraft out of the water, various types of beaching gear for use with ramps, facilities for loading and discharging passengers, and water conditions affecting installations are discussed in detail.

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864. Anon.: Flying-Boat Moorings. Flight, vol. XLVII, no. 1897, May 3, 1945, pp. 474-475.

A method of docking flying boats, devised by Saunders-Roe, Ltd., is described. Opposite the covered hangar-dock into which the flying boat is to be hauled there is a breakwater, parallel to the front of the hangar and facing it. Between the breakwater and the back wall of the hangar there is an endless cable, the upper run of which is supported on or near the water surface by small buoys. Stops are spaced about 10 feet apart along the cable. A special hook on the bow of the flying boat engages the cable, which is used for hauling the flying boat in and out of the hangar. A line from the breakwater to the stern of the flying boat is used to control the heading of the flying boat.

*865. Anon.: Handling of Seaplanes in Airports. Illustr. Flugwoche, vol. XI, No. 8/9. 1929, p. 179.

A description with 14 photographs and sketches of the handling of seaplanes and flying boats by means of trolleys, slipways, cranes, and floating docks.

Jour. R.A.S., Mar. 1930, p. 290

866. Doherty, Edward, Jr.: Hydroports for the Private Flyer. Flying, Oct. 1945, pp. 46-47, 108, 110.

Waterports for small float seaplanes and amphibians are discussed as a possibility for economical operation and convenience to private plane owners. The large number of waterways available is shown to offer numerous advantages with few disadvantages. The approximate cost of construction of water ports of different sizes is quoted and reference to some available engineering drawings is made.

*867. Mitchell, R. J.: Notes on the Ground Operation of Flying Boats. The Aircraft Engineer, supp. to Flight, vol. 18, no. 2, Mar. 25, 1926, pp. 178h-178j.

Methods employed in launching, bringing ashore, and handling flying boats on ground.

Eng. Ind., 1926, p. 332

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*868. Anon.: Portsmouth's Plan for an International Airport at Langstone Harbour. The Aeroplane, vol. LXIX, no. 1801, Nov. 30, 1945, pp. 642, 643.

Details are given of a suggested plan to construct combination landing facilities for landplanes and flying boats at Langstone Harbour, Portsmouth, England. The scheme has been prepared for three stages of development, the first of which encompasses the enlargement of the existing airport to accomodate Dakota-type aircraft, the dredging of an adjacent mooring basin, and the provision of three water runways over 1 mile in length and with a low water depth of 10 feet. Temporary landing slips and terminal buildings would be erected close to the main road and electric railway to London. In the second stage of development, the three water runways would be nearly doubled in length and a new land base created on reclaimed land. The erection of barriers across the two sea inlets is provided to insure a constant water level throughout the harbor, with a minimum low water depth of 15 feet in three runways and 12 feet in the mooring basin and taxi channels. In the third stage the water runways would be widened and extended by further dredging, and "fill" would be provided to extend the reclaimed area in order to provide for a duplicate set of parallel runways for the landplanes. If necessary, a water runway 18,000 feet long would be dredged in the direction of the prevailing wind.

Aero. Eng. Rev., Feb. 1946, p. 47

*869. Anon.: Radio Controlled Seadrome Lights Make Landing "Fields" of Harbours and Lakes. Commercial Aviation, Nov. 1940, pp. 44, 50.

Fluorescent lights mounted on floating rubber doughnuts and controlled by short-wave radio are shown and described. Developed for use as marker beacons for seaplane or flying-boat landing lanes, the new lights make possible night-landing facilities for practically every seaplane base.

Jour. Aero. Sci., Aero. Eng. Rev. sect, Jan. 1941, p. 26

870. Pennow, W. A.: The Seadrome Lighting System. Aviation, vol. 41, no. 3, March 1942, pp. 144, 145, and 203.

An explanation is given of the Westinghouse seadrome contact and boundary lights which provide direct fluorescent lighting, making night operations possible at marine bases. Details are given on the structure of the lights, the theory of operations, and their application.

*871. Anon.: Seaplane Fueling. Aviation Maintenance, Oct. 1945, pp. 52-53.

Drawings and descriptive data are given of the gasoline barge and pump installation used by Pan American Airways for refueling large "Clipper-type" aircraft. The particular barge illustrated is designed for a capacity of 2000 gallons of gasoline but is is suggested that the same design could be adapted to either larger or smaller quantities of gasoline. Chief advantages claimed for the barge are that it eliminates problems connected with towing seaplanes to stationary fueling facilities and relieves congestion at a base where many aircraft have to be refueled simultaneously.

Aero. Eng. Rev., Dec. 1945, p. 57

872. Anon.: Seaplanes. Air Facts, vol. 4, no. 8, Aug. 1, 1941, pp. 8-17.

Descriptions are given of some of the numerous light-seaplane bases in and around New York City and a number of photographs are included. Seaplane handling at the bases is described and the technique of piloting light seaplanes in rough and glassy water is briefly reviewed.

(See also abstracts 403e, 408, 414, 429, 432, 441, 481, 841, and 876.)

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873. Anon.: Breakers and Surf - Principles in Forecasting.
H. O. No. 234, Hydrographic Office, United States Navy Department, Nov. 1944.

Breakers and surf are treated in three parts:

1. Theoretical and empirical knowledge of waves in shallow water

2. Forecasting procedure

3. Verification of forecasts from aerial photographs

Wave velocity, wave length, wave refraction, wave height, wave steepness, and the character of the breaking wave are described and discussed in great detail. A number of equations are given and the results are shown graphically. Several examples are given of predictions of wave formations around different topographical shapes and the predictions are verified by aerial photographs.

(See also Sverdrup, H. U., and Munk, W. H.: Empirical and Theoretical Relations between Wind, Sea, and Swell. Trans. American Geophysical Union, vol. 27, no. VI, Dec. 1946, pp. 823-827; and Sverdrup, H. U., and Munk, W. H.: Theoretical and Empirical Relations in Forecasting Breakers and Surf. Trans. American Geophysical Union, vol. 27, no. VI, Dec. 1946, pp. 828-836.)

*874. Ehring: Eindeutige Kennzeichnung des gemessenen Seegangs aufgrund der Häufigkeitsverteilung von Wellenhohe, Wellenlange und Steilheit (Clear-Cut Classification of Measured Sea Roughness as to Wave Frequency, Length, and Steepness). FB No. 1293, Z.W.B., Oct. 25, 1940.

It is suggested to represent the measured sea roughness by frequency distribution curves of wave height, wave frequency, and wave steepness. The numerical evaluation and comparison of the sea roughness is made by the use of coefficients that can be read from the frequency curves. Author

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*875. Brauer, H.: Messungen und Beobachtungen des Seegang beim Feuerschiff Fehmarnbelt (Measurements and Observations of the Sea Roughness at the Light-Ship Fehmarnbelt). UM No. 579, Z.W.B.

The results of the measurements and observations made from the light-ship Fehmarmbelt (Baltic Sea) are given and compared with each other. Based on the results of these measurements the frequency curves of first and second kind for the wave-heights and of the wave-lengths are given for four-week periods in October and November 1936. For the years 1937 and 1938 only observations are used for the determination of the frequencies of the wave heights and of the sea roughnesses. Finally, the connection between wave height and sea roughness is established. Author

*876. Anon.: Smoothing Out Waves of the Sea (Soviet Institute of Water Transport). Jour. Soc. Nav. Arch. and Mar. Eng., vol. 48, no. 3, Aug. 1936, p. 447.

A series of parallel pipes carrying compressed air are submerged to a depth of some 30 feet beneath the surface of the water. Each pipe, 4 inchos in diameter, is perforated with small holes several inches apart. When a wave passes over the apparatus, the jets of compressed air released through the perforations are stated to smooth the water surface.

With the use of strong "columns" of compressed air it is contended that a large wave could be completely levelled.

Tests with a "wave-breaker" in the harbor of Sebastopol (Black Sea) are reported to have shown that waves 3 or 4 feet in height could be reduced in force and height by 40 percent. The wave crests were entirely smoothed out.

An application to flying-boat harbors is contemplated.

Jour. R.A.S., Jan. 1937, p. 17

877. Hidaka, Koji: Study of Ocean Waves by Stereophotography. Jour. Oceanogr., vol. XI, nos. 1-4, March 1939, pp. 693 - 704.

Using methods of stereophotography a number of photographs of ocean waves were taken. Data were obtained from these photographs

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and wave contours were plotted. Waves as high as 4 meters (about 13 feet) were observed. The author discusses in detail the photographical methods used.

(See also abstract 850.)

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*878. Barrillon, E.: The Work of the Permanent Commission for Aeronautical Studies in Connection with Tests on Seaplane Hulls. La Technique Aéronautique, no. 64, Feb. 15, 1927.

Before the creation of the Permanent Commission for Aeronautical Research (Commission Permanente d'Etudes Aéronautiques), isolated tests of seaplane hulls were occasionally carried out, but led to no definite conclusions because the forms of the hull studied have no relation one to another and because it is not certain that model tests at constant speed are sufficient for estimating the qualities of a hull.

When the Commission recognized the desirability for carrying out systematic tank tests on hulls, various modifications to existing apparatus were made and the scope of the research extended. The necessity for tests on full-scale models and for the establishment of a standard of comparison between full-scale and reduced-scale models was recognized and tests on full-scale models were begun with a series of Romano seaplanes. Such tests are not yet completed, but neither time nor money will be spared to obtain good results.

Model tests are also in course of execution and the reason for the delay in obtaining results in connection with the problems of take-off and alighting will disappear when the new S. T. Aé. Laboratory at Marignone is completed.

Jour. R.A.S., Feb. 1928, p. 149

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*879. Pabst, W.: Apparatus for Measuring Waves. Z.F.M., vol. 24, no. 21, Nov. 4, 1933, pp. 598-600, and vol. 24, no. 22, Nov. 28, 1933, pp. 613-619.

A moored buoy, in the shape of a flat double cone, carries a water pressure registering apparatus at the end of a vertical cable, the length of which is adjustable to half the wave length or more. The equations of motion for a two-dimensional wave in uniform depth are quoted from Lamb. The expression for the pressure as a function of the depth is periodic with the wave, and is integrated to give the effective pressure at any point and in particular at the registering apparatus. Corrections are required for the finite depth of suspension and for the inertia of the whole apparatus under periodic wave forces.

Examples of errors are shown graphically for particular assumptions, and families of curves give corrections for any combinations of wave length, cable length, and depth of water. Examples of records are reproduced and the corresponding data are given in a table. A chart shows Lübeck Bight in which the measurements were made.

[See also Z.V.D.I., vol. 77, July 8, 1933, p. 755.]

Jour. R.A.S., Oct. 1934, p. 850

*880. Cremona, Cesare: Il Carroponte Dinamometrico della Vasca Idrodinamica di Guidonia. Atti di Guidonia, No. 1, 1939.

Photographs and comprehensive diagrams show the bridge-type towing carriage of the Guidonia towing basin. The apparatus, weighing only 6000 kilograms (13,200 lb), uses 100 horsepower at its maximum speed of 20 meters per second (66 ft/sec). Quick starting is given by an electromechanical device, which also gives a varying range of speeds. Pneumatic tires have been preferred to metal or solid rubber, but emergency metal wheels come into operation in case of a tire-burst or puncture. The car can be entered from either side and is surrounded by an external catwalk to facilitate observation while in motion.

The car, which is streamlined with a noncorrosive light aluminum-alloy cowling, is driven by four continuous current motors coupled electrically and mechanically in pairs. Each motor develops 25 horsepower at 48 rpm, but can be made to give 62.5 horsepower at 320 rpm for 10 seconds. Braking is electric. Illumination and signalling devices are provided. A rheostat device, operated by an observer in the car, by which acceleration and speed can be varied, is described in detail, and a diagram of the complete electric circuit is also given.

The cabin contains a dynamometric balance and an indicator showing the distance traveled; also a three-component accelerograph.

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Graphs show the results of tests made with the motors running in series and in parallel. The total distance traveled by the carriage was 440 meters (1445 ft), of which 140 (440 ft) were used for the initial acceleration and 100 (330 ft) for braking, giving a useful length of 200 meters (655 ft).

Airc. Eng., Jan. 1940, p. 19

881. Fuller, Dell: Data and Specifications 1/10 Scale Radio Free Flight Model. Rep. No. ZH-024, CVAC, May 1945.

A compilation of all data and specifications pertinent to a $\frac{1}{10}$-scale radio-controlled free-flight research model of a hypothetical flying boat of 180,000 pounds gross weight has been prepared. The model discussed is but one of a family of hulls to be built and tested for the purpose of determining the correlated effects of length-beam ratio and depth and position of step on the general hydrodynamic characteristics. In order to make direct comparisons of the results within the family, the various hulls are to be suspended beneath the same wing and tail combination.

882. Brooke, H. E.: Development of a Radio Controlled Free Flight Dynamic Model. Rep. No. ZH-020, CVAC, May 1944.

The development of a radio-controlled free-flight dynamically similar model of a flying boat is discussed. The model and control equipment are described and illustrated by photographs and colored sketches.

883. Stout, Ernest G.: Development of Precision Radio-Controlled Dynamically Similar Flying Models. Jour. Aero. Sci., vol. 13, no. 7, July 1946, pp. 335-345.

Great progress has been made in recent years toward improving the reliability, speed, and accuracy of the various experimental test procedures available to the aircraft designer. This paper describes the development of such a procedure whereby flying scale models, which are dynamically similar scale duplicates of the full-scale prototypes, may be accurately flight-tested through the use of positioning, multichannel radio remote control. This development allows the designer to determine accurately many dynamic characteristics of a new design which would not ordinarily be available until the actual airplane is flight-tested. This procedure is particularly well adapted to the determination of dynamic stability during the take-off and landing of flying boats and was developed primarily for this purpose. It is directly applicable, however, to many other dynamic problems of both landplanes and seaplanes.

The design and construction of the self-propelled free-flight models and the remote-control equipment are considered, as well as a general discussion of the instrumentation, analysis, and testing procedure. It is concluded that:

1. Full-scale hydrodynamic stability can be accurately predicted by scale, free-body, dynamically similar models through the use of multichannel radio remote control.

2. The special Consolidated Vultee radio transmitter and receivers, designed for the proportional control of seven simultaneous channels, have proved entirely feasible and reliable.

3. The special two-cylinder, two-cycle gasoline engines have excellent speed control characteristics and have proved satisfactory and dependable under the most severe conditions of salt water and continuous high-power operation.

4. The method of instrumentation and analysis for free bodies has proved to be simple, rapid, accurate, and extremely versatile in its operation.

These conclusions are substantiated by extensive operation and the results of full-scale correlation.

(See also abstracts 722, 899, and 906.)

*884. Lange, F.: Dynamische ähnliche Schwimmwerksmodelle aus Plexiglas (Dynamically Similar Float Models of Plexiglas). UM No. 608, Z.W.B.

Plexiglas is being turned to as building material for dynamically similar float models instead of the usual balsa wood, which cannot resist a long test in water. Plexiglas is impervious to water and is easily worked in smallest wall thicknesses (of 0.5 mm (0.02 in.) upwards) on forming apparatus. The high mechanical demands on the dynamically similar model, little weight, and small moment of inertia

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with sufficient strength, are being filled by the use of Plexiglas. The principal advantage of Plexiglas is its transparency, by which the water flow on the bottom of a float can be observed. Besides this, there is the smoothness of the material to be considered, which surpasses a first-class paint. Plexiglas is thus a material which can be applied with manifold success in model research. The report concludes with a discussion of a test of a float model. Author

885. Truscott, Starr: The Enlarged N.A.C.A. Tank, and Some of its Work. NACA TM No. 918, 1939.

Design considerations and novel features of the original NACA tank (abstract 50) are discussed briefly. To increase the amount of work that would be done in a given time and to be able to tow larger models at higher speeds, the length of the tank was increased from 1920 feet to 2880 feet and the four wheels of the carriage were replaced by eight independently driven wheels arranged in four groups of two. The maximum speed of the revised carriage is 80 miles per hour. The revised carriage, its power and control equipment and towing gear, and the method of taking and recording data are described. It is considered that the relative merit with regard to resistance of forms for hulls can be determined only by considering each form as part of a specific complete seaplane and making take-off computations for each. An illustrative example of the use of tank and wind-tunnel data for the computation of take-off performance is given.

*886. Cremona, Cesare: The Experimental Tank at the Guidonia Hydrodynamical Laboratory. R. T. P. Trans. No. 1048, British Min. Airc. Prod. (from Atti di Guidonia, No. 6, April 30, 1939).

The comparative dimensions of existing towing basins are shown in tabular form. The Guidonia tank is 436.70 meters (1430 ft) long, 6.50 meters (21 ft) wide, and 3.75 meters (12 ft) deep, and has a carriage speed of 40 meters per second (131 ft/sec), whereas the Langley Field tank, although 600 meters (1970 ft) long, has a carriage speed of only 27.5 meters per second (90 ft/sec).

Special "Thermolux" glass and insulating materials give a constant temperature and avoid the necessity of heating the building. The basin itself consists of 11 sections and two specially constructed end sections. Subterranean passages allow for inspection and are used for the electric and water conduits, while photographic

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and optical observations can be made through portholes in the terminal sections. The terminal galleries (each holding 24 cubic meters of water) can be rapidly emptied when access is necessary for setting up models.

A boat-shaped sluice, working on the hydraulic ballast principle, is used to divide the basin into two portions when desired. Each separate half can be partially or totally emptied. Both towing carriages can thus be used simultaneously without mutual interference due to wave motion.

The volume of water is 10,800 cubic meters (380,000 ft^3), its surface 2840 square meters (30,600 ft^2). It comes from the Acqua Marcia reservoir on Monte Celio, which also supplies all public services in the district. With the limited quantity available for use, the basin can be filled in 25 days. Supplementary water is pumped from a sunk well. Both installations are controlled from a central cabin, about 180 cubic meters (6400 ft^3) being added daily for cleansing purposes; its equivalent being discharged through the terminal galleries. Four main outlets, working on the portcullis principle, enable the basin to be emptied in 24 hours.

A special feature of the tank is its wave suppressors, which have reduced the time taken by the water to calm down after a test run from 30 minutes to 1 minute. Diagrams show the various devices tried out, and their damping effect. The most satisfactory, which has been adopted, is an artificial beach consisting of sloping shelves projecting downwards into the water along each side and at the ends.

Airc. Eng., April 1940, p. 115

*887. Miki, T.: Experimental Tank of Aichitokei-Denki and Co., Ltd. Jour. Soc. Nav. Arch. Japan, vol. 51, April 1933, pp. 61-75.

Tank 60 meters (183 ft) long, 2 meters (6 ft) wide, and 1.5 meters (4.6 ft) deep for model towing experiments of seaplane floats and flying-boat hulls; driving motors coupled directly on fore and rear-wheel axels, each motor developing 10 horsepower; description of towing carriage.

Eng. Ind., 1933, p. 1008

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888. Truscott, Starr, and Ebert, John W., Jr.: First Tests of the NACA Events Recorder – Take-Offs and Landings of a Consolidated PBY-5 Flying Boat. NACA MR, Bur. Aero., May 7, 1942.

Some take-off and landing tests were made of a Consolidated PBY-5 flying boat with the NACA events recorder installed. The tests were made at gross loads of 24,000 and 28,000 pounds for several different conditions of take-off. Time histories of airspeed, water speed, trim, elevator angle, and rudder angle were recorded. The events recorder is described in detail. The results of the tests were plotted and compared with results taken during tests of a $\frac{1}{8}$-size model in Langley tank no. 1.

*889. Anon.: The Froude Tank of the Hydrodynamical Laboratory of the Italian Ministry of Aeronautics. L'Aerotechnica, vol. 12, no. 4, April 1932, pp. 447-472.

The dimensions of the Froude Tank of the Hydrodynamical Laboratory of the Italian Ministry of Aeronautics are given in sketches and the more important items of equipment in sketches and photographs. The total length is 176 meters (578 ft), depth 2.3 meters (7.5 ft), width 3 meters (10 ft). The maximum velocity of the traveling carriage is 10 meters per second (32.8 ft/sec).

There are two small subsidiary tanks with continuous flow, maintained by a circulation pump absorbing 25 horsepower. Typical curves of air and water resistance of a hull are reproduced and a combined diagram of characteristics is constructed in nondimensional coordinates.

Jour. R.A.S., June 1935, p. 514

*890. Albring, W., and Luetgebrune, Hannover: Der grosse Pariser Rundlaufwasserkanal (The Large Circular Towing Basin at Paris). Tech. Ber., vol. 10, no. 10, Oct. 1943, pp. 303-311.

A description of the construction of the large circular towing basin at Paris is given and weaknesses of the test arrangement are pointed out which had to be eliminated by the Institut für Aeromechanik und Flugtechnik to make possible force measurements. Turbulence measurements give the range of the critical Reynolds number. Finally a basic observation on the suspension of model bodies towed in water is given. Author

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*891. Povitzky, A. S.: Investigation on Landing Impact of Seaplanes. Trans. Sci. Tech. Soc. Shipbld. and Engrg. (Russia), vol. 2, 1936.

Particulars are given of the methods adopted by the Hydro-Experimental Department of the CAHI when carrying out experiments on seaplanes. Interesting results were obtained from the tests by means of microrecording instruments at present used by this department, which include a dynamic tensiometer for synchronous measurement of deflection, an accelograph for overload measurements, and a stress recorder for measuring the pressure on the hull. Illustrations are given of the various instruments employed in carrying out the experiments. The most interesting instrument is the accelograph which has a range of acceleration from 130 units per second (1 variant) to 250 to 300 units per second (2 variants); this high acceleration permits the overload stresses produced by outside forces as well as the vibration to be recorded with great accuracy. Overload graphs are given of a seaplane when landing. (See Eng. Abstracts, vol. 1, no. 2, sect. 3, March 1938, p. 14.)

Jour. R.A.S., June 1938, p. 565

*892. Vogel: Messung der benetzten Bodenfläche bei Starts und Landungen von Seeflugzeugen (Measurement of the Wetted Surface during Take-Off and Landing of Seaplanes). FB No. 1787, Z.W.B., April 1943.

The wetted surface of a Blohm and Voss BV 138A flying boat was measured during take-off and landing in the Baltic Sea (Bay of Lübeck). During these experiments a simple contact instrument was developed, which gave satisfactory results at its first use. Author

*893. Bénard, H.: New Laboratory Equipment for the Study of Fluid Wakes. L'Aéronautique, no. 147, Aug. 1931, pp. 291-293.

A descriptive account is given of the optical and cinematograph installation at the Sorbonne Laboratory for the study of the wake left behind an object moving in a fluid with a free surface. Examples of film records are reproduced, and the determination of the poles of eddies is discussed.

Jour. R.A.S., April 1932, p. 361

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*894. Fried, Walter: The No. 3 Tank for Model Seaplane Tests. Rep. No. 289, Bur. Aero., Oct. 1945.

The No. 3 experimental towing tank at Stevens Institute of Technology for model seaplane tests is described. The tank is 12 feet wide and 6 feet deep and provides additional facilities for testing models of seaplane hulls at speeds up to 60 feet per second. A new two-story building houses both the tank and offices, shop, photographic department, and miscellaneous utilities. The facilities were constructed under the sponsorship of the Bureau of Aeronautics; the building and equipment are the property of the Government; and the land is owned and leased to the Government by Stevens Institute. Salient terms of the Bureau's contract covering the No. 3 tank are included in the report.

Aero. Eng. Rev., Feb. 1946, p. 75.

895. Anon.: Note on Future Requirements for the Tank Testing of Flying Boat Models and for Model "Ditching" Tests. TN No. Aero 1257, British R.A.E., Aug. 1943.

Flying boats and landplanes are briefly compared on an operational basis. It is believed that large flying boats could operate over the oceans with about the same freedom as shipping while large landplanes would be restricted to flying between terminal airports. Limitations in the R.A.E. tank of maximum speed, length of tank, size and scale of model, and air flow around the towing carriage were discussed. A tank adequate to deal with the next stages of flying-boat development should be at least 1500 to 2100 feet long, 15 feet wide, and have a maximum speed of 60 feet per second. Some disadvantages of large models are listed. A tank suitable for model ditching tests would be 100 or 150 feet long, 20 feet wide, and 4 feet deep, and be equipped with flood lighting for movie photography. Wave making apparatus might be provided.

896. Hamilton, J. A.: A Note on the Use of Free Flight Models to Investigate the Water Handling of New Seaplane Designs. Rep. No. F/Res/195, British M.A.E.E., Nov. 16, 1945.

Tests were made of a $\frac{1}{4.5}$-size model of a projected jet-propelled seaplane fighter to investigate the possibility of using radio-controlled models to determine the water handling qualities

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of new seaplane designs. The tests have been concerned, mainly, with the elimination of various defects and weaknesses in the radio and model design, with the improvement in rocket design, and with the development of a suitable piloting technique. It is concluded that many of the difficulties encountered could be overcome by the use of a larger model.

897. Binnie, A. M.: A Possible Form of High-Speed Water Channel. R. & M. No. 1857, British ARC, May 12, 1938.

Disadvantages of the customary [Froude] type of towing basin are the length of the tank and the necessity of accommodating measuring instruments and observers on the towing carriage. A form of towing basin is suggested in which the model is at rest in a stream of water moving with uniform velocity. A Venturi flume, consisting of a convergent-divergent constriction in a horizontal channel, is used to produce the high-speed stream of water. It is shown theoretically and experimentally that, under certain conditions the water downstream of the constriction is of uniform depth and possesses a uniform speed which exceeds the critical velocity of $\sqrt{gd}$, where g is the acceleration due to gravity and d is the depth.

898. Llewelyn-Davies, D. I. T. P.: Proposals for a High Speed Towing Tank for Testing Models of Large Seaplanes. TN No. Aero 1744, British R.A.E., Jan. 1946.

The minimum tank characteristics required for testing large flying boats of 150,000 pounds to 500,000 pounds loaded weight are a length of 2200 feet, a width of 20 feet, and a depth of 6 feet. This length allows a speed of 70 feet per second to be maintained for 20 seconds. Control both of the steady speed and of the rate of acceleration is recommended - the controls to be on the carriage. Two carriages should be used, one for dynamic model tests and the other for force measurements. On both carriages means should be provided for regulating the air flow past the models. Suitable side and end beaches and a wave maker should be provided.

899. Stout, Ernest G.: Radio-Controlled Dynamic Model Augments Hydrodynamic Research. Aviation, vol. 45, no. 2, Feb. 1946, pp. 171-173.

The use of dynamic models as an important tool for predetermining the performance characteristics of projected aircraft design is emphasized. The development of the motors and control equipment for a $\frac{1}{8}$-size free-flight model of the Consolidated model 31 flying boat is discussed. The two throttles, elevator, rudder, ailerons, flaps, and ignition are remotely controllable and several safety features have been incorporated into the design. The aerodynamic forces on the model are measured on a six-component balance which is rigged to a trusswork fastened to the front of a station wagon. Comparison with wind-tunnel results showed very good agreement of lift, moment, and elevator effectiveness.

*900. Behrens, W.: Tests on a New D.V.L. Recorder for the Water Pressure on the Hull of a Seaplane. Luftwissen, vol. 4, no. 7, July 1937, pp. 220-221.

In the new model the diaphragm is machined out of a solid piece and screwed into position instead of being soldered as before. In this way it can be assured that the diaphragm is flush with the bottom of the hull where the pressure is to be recorded. The actual record is by the scratch method as before. The natural period of the new diaphragm is 1500 seconds in air and 1000 seconds in water [apparently should be $\frac{1}{1500}$ sec in air and $\frac{1}{1000}$ sec in water].

Details of 27 landings on smooth water with a flat-bottomed boat are given. The pressures were recorded 50 centimeters (19.7 in.) in front of the step and the maxima varied between 1.2 and 3.9 kilograms per centimeter^2 (17.1 and 55.5 lb/sq in.).

These pressures are considerably higher than those previously recorded. Part of this increase is probably due to the fact that the area of the new diaphragm is smaller than that of the old model — 20 centimeters^2 (3.1 in.^{2}) against 30 centimeters^2 (4.65 in.^{2}). According to the theory of Wagner the peaks of the impact blows are localized over a small area of the hull so that the actual size of the diaphragm used affects the results.

Jour. R.A.S., Oct. 1937, p. 966

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*901. Pabst, W.: Über eine Modellversuchseinrichtung zur Untersuchung der Dynamik von Start und Landung von Seeflugzeugen (New Model Test Equipment for the Investigation of the Dynamics of Take-Off and Landing of Seaplanes). FB No. 252, Z.W.B.

New equipment developed by the seaplane department of the HSVA is described. The equipment is used for the investigation of the landing impact and the porpoising of seaplanes. The equipment is designed to supplement full-scale tests by model tests, because the latter present greater scope for development. Author

*902. Reichart, H.: Über Kavitationsanlagen für kleine Kavitationzahlen (Concerning Cavitation Installations for Small Cavitation Numbers). UM No. 6620, Z.W.B., Feb. 12, 1945.

This report is concerned with the fundamentals of design and operation at low cavitation numbers. The new Göttingen free-flow wind tunnel is described in which tests were carried out at very low cavitation numbers. Author

*903. Boccius: Untersuchungen über die zweckmässigste From eines Wellenerzeugers (Investigation on the Best Form of a Wave-Making Machine). FB No. 389, Z.W.B.

To determine the conditions in rough sea for towing tests on floats and planing surfaces, a wave-making machine has to be provided to create even wave conditions for the whole length of the tank. The tests were carried on mostly with machines of the plunger type. Disturbing cross waves were found at certain frequencies. To damp these near their point of origin, small-meshed screens were proposed. Particular attention has to be paid to the fact that any quantity of water behind the plunger may prove detrimental in that excitation of it by the plunger cannot be wholly avoided. Author

*904. Anon.: Wave-Making Apparatus for Test Tanks. Z.V.D.I., vol. LXXI, Aug. 13, 1927, p. 1168.

The Hamburg Shipbuilding Laboratory has acquired a wave-making apparatus which allows model tests in rough water as well as in smooth water. The essential part of the apparatus is a metal body rounded off at the bottom forward so that waves are produced only in front of the apparatus when the body is raised and lowered in the tank. The motion provided by an electric motor is imparted to the body through three vertical supports sliding within brackets via trains of gearing and two systems of levers and links. The height of the waves can be varied at will up to 30 centimeters with a length of 5 meters. The frequency of the waves can also be varied.

If the moment of inertia of the model is carefully adjusted by means of trimming weights, so that it corresponds exactly according to the law of similarity to the moment of inertia of the full-scale constructions, tests can be carried out to determine whether coincidence exists between the natural period and any of the periods of the waves. The information gained in this way will enable the designer to avoid coincidence by a suitable distribution of the weights.

Jour. R.A.S., Sept. 1928, p. 828.

(See also abstracts 482, 513, 518, 519, 657, 661, 699, 709, 710, 729, 751, 761a, 906, 907, 911, and 914.)

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905. Garner, H. M., and Coombes, L. P.: The Determination of the Water Resistance of Seaplanes. R. & M. No. 1289. British ARC, Oct. 1929.

The accuracies of two general methods for determining the water resistance of seaplanes are investigated. Direct measurement of the forces on a hull may be made by towing a hull beneath a seaplane fuselage and by measuring the forces between the two bodies. Indirect measurements of the resistance of a hull may be made by measuring the forward acceleration and by estimating the thrust and air drag.

The direct method is likely to prove the most accurate if a satisfactory mechanism can be designed. With the indirect method, some important errors can arise from different sources, and a high order of accuracy must be maintained in certain recording instruments. A thrustmeter is essential for use with the indirect method.

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906. Stout, E. G.: Development of Testing Procedure and Correlation Studies on a 1/8-Scale Radio Controlled Dynamic Model of the XP4Y-1 Airplane. Rep. No. ZH-025, CVAC, May 1945.

During March, April, and May 1945, tests were conducted on a free-flight, $\frac{1}{8}$-size, dynamically similar model of the XP4Y-1 airplane. The tests were conducted in San Diego Bay, California, through the use of multichannel radio remote control. The model was powered by 2 two-cylinder, two-cycle gasoline engines and the controls were operated by positioning electric servos. A system of instrumentation and analysis was developed that involved only a good 35-millimeter motion-picture camera mounted on a tripod and a specially designed film analyzer. The runs could be analyzed rapidly with an accuracy of ± 0.25 foot per second for speed readings and $\pm 0.25^{\circ}$ for trim. Stability and spray characteristics of the radio-controlled model were correlated with similar tests conducted on both the full-scale airplane, which was equipped with an NACA events recorder, and a similar $\frac{1}{8}$-scale dynamic model tested in Langley tank no. 1.

*907. Behrens, W.: Ein Verfahren zur Messung der beaufschlagten Schwimmerfläche (A Method of Measurement of the Wetted Surface of a Float). UM No. 605, Z.W.B.

In order to use data on landing impact for the prediction of impact forces, it is necessary to determine several needed values experimentally. Up to now the theory has always assumed a constant "hitting length" during the immersion at landing. In this case there would be a pressure wave parallel to the keel line, and running from the keel to the water line. Actually the wave also runs forward from the step, and hence there will be a resultant oblique pressure wave depending on the shape of the bottom of the float. The magnitude of the impact depends mainly on this wave, and on the magnitude of the wetted surface which lies behind it. In the present paper a method is described for the measurement of the wetted surface of the float. Author

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*908. Mitchell, R. J., and Clifton, A. N.: Experiments in Model Tank as Basis for Design of Floats and Flying Boats. Cinquième Congrès International de la Navigation Aérienne. (5th International Congress of Aviation), vol. 1, Sept. 1-6, 1930, pp. 606-633.

What precautions must be taken to ensure that model results may be applicable to full scale. (In English.)

Eng. Ind., 1931, p. 1265

909. Gott, J. P.: Further Note on the Tank Testing of Dynamic Models of Flying Boats with Special Reference to the Model of the G-boat. TN No. Aero 962 (Tank), British R.A.E., June 1942.

The information presented in abstract 400 is extended and the status of tank testing dynamic models to determine their longitudinal stability characteristics is reviewed. It is generally concluded that tank tests on dynamic models give reliable indication of full-scale behavior provided they are interpreted with due regard to existing experience with model and full-scale behavior. Detailed comparison between model and full-scale behavior requires great care to insure that the model and full-scale conditions are exactly, and not only approximately, comparable. Methods of disturbing both the model and full-size seaplane are discussed and the need for a good definition of porpoising is pointed out.

910. Gott, J. P.: Note on the Comparison of British and American Methods of Tank Testing Dynamic Models of Flying Boats. TN No. Aero 1197, British R.A.E., May 1943.

The methods used by the British and the Americans in the tank testing of flying-boat models for longitudinal stability have been compared and critical comments have been made. The trim limits of stability and the limits of stable positions of the center of gravity have been discussed with special emphasis placed on the upper limit, increasing trim as defined by the NACA. It is believed that the NACA procedures for determining longitudinal stability are too specialized and that similar results are obtained more directly by using the RAE testing method.

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*911. Sikorsky, I.: Novel Method of Studying Flying Boat Hull Models. SAE - advance paper, for mtg. April 15-16, 1931.

Test procedure and equipment utilizing speed boat capable of speed up to 35 miles per hour for towing different models.

Eng. Ind., 1931, p. 1266

912. Sottorf, W.: Take-Off and Landing in Model Experiment. R.T.P. Trans. No. 966, British Min. Airc. Prod. (from W.R.H. Vol. 20, No. 9, Jan. 5, 1939, pp. 113-118).

After some introductory notes dealing with the problem of mechanical similitude, a description is given of the method employed in tank tests of the take-off and landing of dynamically similar flying models. A number of photographs are given of water landing tests carried out on several landplanes and seaplanes, together with graphical diagrams of the results obtained.

913. Coombes, L. P.: The Testing of Seaplanes and Flying Boats. Jour. R.A.S., vol. XXXIV, no. 230, Feb. 1930, pp. 190-209.

The methods used at the Marine Aircraft Experimental Establishment for the determination of gross weight and position of the center of gravity, and of the hydrodynamic and aerodynamic performance of full-size seaplanes and flying boats are described.

Take-off time is determined by an observer with a stopwatch. Take-off distance is determined either by taking bearings on the aircraft from two shore stations or by taking aerial photographs of the wake produced by the seaplane while taking off. The effects of wind, gross weight, and thrust on take-off performance are discussed. Methods for determining water resistance (see also abstract 905), stability at rest, and maneuverability at low water speeds are described.

Tests of aerodynamic performance include determination of maximum speed and rate of climb at various altitudes, fuel consumption, and lift and drag. The reduction of aerodynamic performance data to standard conditions and the presentation of the results are discussed.

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914. Allen, J. E.: Water Tests of Seaplanes Using Free Models. Rep. No. H/Res/183, British M.A.E.E., Nov. 1, 1944.

Some preliminary experiments have been made in which models of a proposed jet-propelled seaplane fighter were catapulted in free flight on to still water. Motion-picture records of the landings were made and the results analyzed to give the trim limits of stability and curves of trim plotted against speed. The spray and general handling characteristics were observed visually. The stability characteristics of the models were similar to those of other models and of full-size flying boats.

The testing technique and methods of obtaining trim, angle of yaw, and speed from the motion-picture records are described. The testing of free models is relatively cheap, requires little auxiliary equipment, and can be done with little modification to existing tank models.

Take-off tests of the models propelled by a slow-burning cordite rocket were also made, but the results are not given in the report.

(See also abstracts 422, 439, 482, 513, 518, 661, 668, 680, 722, 749, 751, 761a, 766, 775, 788, 891, and 896.)

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