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UNCLASSIFIED REPORTS PUBLISHED BY
THE AEROBALLISTICS AREA
1 October 1945 - 31 December 1962

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UNITED STATES NAVAL ORDNANCE LABORATORY, WHITE OAK, MARYLAND

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U. S. NAVAL ORDNANCE LABORATORY UNCLASSIFIED REPORTS PUBLISHED BY THE AEROBALLISTICS AREA 1 October 1945 - 31 December 1962

Prepared by:
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ABSTRACT: A list of all Naval Ordnance Laboratory Unclassified reports published by the Aeroballistics Area during the period 1 October 1945 through 31 December 1962 is presented.

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U. S. NAVAL ORDNANCE LABORATORY UNCLASSIFIED
REPORTS PUBLISHED BY THE AEROBALLISTICS AREA
1 October 1945 - 31 December 1962

This report contains titles and abstracts of all Unclassified NOL Memoranda, NavOrd, NavWeps and Technical Reports published by the Aeroballistics Area during the period 1 October 1945 through 31 December 1962. The reports are listed alphabetically by author under the year they were published. Authors are cross-referenced when there is more than one.

R. E. ODENING
Captain, USN
Commander

R. E. Wilson
R. E. WILSON
By direction

U. S. NAVAL ORDNANCE LABORATORY UNCLASSIFIED REPORTS PUBLISHED BY THE AEROBALLISTICS AREA

CONTENTS

U. S. NAVAL ORDNANCE LABORATORY
UNCLASSIFIED REPORTS PUBLISHED BY THE AEROBALLISTICS AREA
1 October 1945 - 31 December 1962

I. List of Unclassified NOLMemoranda Published During the Period 1 October 1945 - 30 June 1949

Anderson, R. A., "Resolving Power of Eastman Type III High-Speed Camera," NOLM 9050

Abstract: Measurements of the resolving power of the Eastman High-Speed Camera were made by photographing resolving-power charts in the Hydrodynamics Sub-division's model tanks with continuous lighting. Similar tests were made with multiflash lighting and these showed an increase in resolving power of 30 to 50 percent.

Bowles, R. E. and Lobb, R. K., "The Design of a Counter-Rotating Fan for the NOL Subsonic Jet Study Tunnel," NOLM 9992

Abstract: This memorandum presents a relatively simple design procedure which was used to design a counter-rotating fan system for a small low-turbulence subsonic jet tunnel at NOL for use in connection with turbulence and boundary-layer studies.

Cheydleur, B. F., "Tables for Analysis of Underwater Explosions by the Shadowgraph Method," NOLM 9523

Abstract: To determine the density of its gradient behind a strong underwater shock wave, a method of interpolating from special tables constructed on the basis of a series of assumed density distributions is described.

Crown, J. C., "Flow of a Gas Characterized by the Beattie-Bridgeman Equation of State," NOLM 9619

Abstract: In this report, the usual aerothermodynamic relations for flow in a quasi-unidimensional channel have been rederived

using the Beattie-Bridgeman equation of state in place of the perfect-gas law and allowing for the component of specific heat due to the vibrational mode of freedom (for polyatomic gases). Graphs permitting rapid numerical evaluation of the resulting formulae are presented.

Crown, J. C. and Munk, M. M. "The Head Shock Wave," NOLM 9773

Abstract: See Munk, M. M. and Crown, J, C.

Eddy, R. P., "On the Finite Difference Solution of the Heat Equation," NOLM 10,232

Abstract: A number of problems in which the Naval Ordnance Laboratory is interested pertaining, for instance, to the flow of heat, and propagation of waves, fluid mechanics, etc., require the solution of partial differential equations. In some cases either the equation itself or the boundary conditions are so complicated that a solution in terms of known functions is not obtainable and finite difference methods must be resorted to.

DeMeritte, F. J., Fagin, S., and Rogers, M., "Proposed Method for the Design of Ramjet Spike Diffusers," NOLM 9858

Abstract: Previous work on the aerodynamic design of ramjet diffusers has been confined primarily to the application of the theoretical laws without considering scaling phenomena, effects of heat addition, etc. This report broadens the theoretical concepts by attempting to streamline the basic flow solutions by graphical and other means, by considering scaling phenomena, as well as by indicating a possible solution for the effect of heat addition on the ramjet diffuser performance.

Fagin, S., DeMeritte, F. J., and Rogers, M., "Proposed Method for the Design of Ramjet Spike Diffusers," NOLM 9858

Abstract: See DeMeritte, F. J., Fagin, S., and Rogers, M.

Frenkiel, F. N., "The Theory of Measurement of the Characteristics of Turbulence with a Hot Wire of Non-Negligible Length," NOLM 9658

Abstract: In the first two sections the general problems concerning the measurement of turbulence with a hot-wire anemometer are

briefly explaned. The approximation and assumptions which are made in connection with the use of the hot wire are indicated.

The third section considers the measurement of the longitudinal intensity of turbulence with a wire perpendicular to the direction of the mean velocity in a flow of homogeneous turbulence. The thermal lag of the wire is considered to be perfectly well compensated by the amplifier.

Frenkiel, F. N., "Comparison Between Some Theoretical and Experimental Results of the Decay of Turbulence," NOLM 9777

Abstract: The principal purpose of the comparison is to consider a particular case of self-preservation of the correlation function. Other self-preservation should also be considered and it should not be forgotten that self-preservation of the correlation functions is not a necessary condition of the wind tunnel.

Halbmillion, V. and McGraw, H., "A Method of Determining the Pressure Distribution on the Ogival Nose of Measurement Based on an Extension of Taylor-Maccoll Calculations," NOLM 9816

Abstract: This memorandum presents a set of curves enabling a rapid determination of the pressure distribution along the nose of an ogival missile (as a function of the distance in calibers counted from the nose to the tip) for any Mach number up to 10 and for any ogive with a caliber number of 6 to 24. These curves have been determined from results of calculations based on an extension of the Taylor-Maccoll method.

Hall, N. A., "Ramjet Performance Method," NOLM 9962

Abstract: A general procedure for obtaining the performance of supersonic ramjets of arbitrary configuration is set forth. The analytical development emphasizes the aerodynamic aspects of the propulsive action. This is developed in a manner such that thrust and mass flow can be specifically obtained without any reference to the type of fuel to be used or the efficiency of the combustion process.

Hall, N. A., "Performance of Supersonic Ramjet Shock Diffusers," NOLM 9986

Abstract: The performance of oblique shock, supersonic, ramjet diffusers, as characterized by the ram recovery efficiency, is surveyed and certain general results are summarized for various configurations. Particular emphasis is given to the two-shock diffusers. Extrapolations are indicated for three- and four-shock configurations.

Heybey, W. H., "Nozzle Design and Correction for Two-Dimensional Supersonic Flow," NOLM 9132

Abstract: This report gives the application of the method of characteristics to the design and correction of wind-tunnel nozzles. The role of the boundary layer in correcting a nozzle is also discussed.

Heybey, W. H., "Method of Computing Pressure Distribution in Linearized Supersonic Flow," NOLM 9249

Abstract: The general two-dimensional linear hyperbolic partial differential equation of second order is solved under boundary conditions that include, as a special case, the conditions under which the equations of the perturbation potential must be solved if a slender airfoil or projectile is placed in uniform supersonic flow. Expressions for the perturbation components of the velocity along the body's contour are obtained. The cases of the airfoil, the cone, and the general body of revolution are discussed. In the latter case, actual computation of pressure distribution is less complicated than the procedure suggested by the source-sink-method.

Heybey, W. H., "The Prandtl-Busemann Method for Plane Supersonic Flow," NOLM 9250

Abstract: This report outlines the method suggested by Prandtl and Busemann for treating plane, supersonic, isentropic, steady flow. The origin of the method in the mathematical theory of characteristics is shown. The properties of the characteristic equations are stated, from which practical means for applying the method can be developed. The handling of initial and boundary conditions is explained. Finally, a variation of the Prandtl-Busemann method is described briefly, wherein the usual graphical

method is replaced by a computational scheme. No special problem has been discussed here. A report to follow will apply the method to the design of nozzles for two-dimensional supersonic flow in wind tunnels.

Heybey, W. H., "Two Types of Ramjet Flow with Pressure Losses in the Diffuser," NOLM 9748

Abstract: This paper is one of the series discussing the estimation of the performance of ramjet-propelled missiles. An earlier report, NOLM 9454, describes the calculation of the thrust of the ramjet in which the only losses at the entry are those arising with a normal shock. The present memorandum discusses the modifications in flow state and thrust brought about by additional losses within the diffuser. Since there is no way of determining those losses theoretically, simple assumptions as to their dependency on Mach number are made. It is hoped that the results thus gained offer a qualitative description of how actual losses work upon the flow.

Hyman, M., "Deflection of Light Rays in Passing Through Conical Shock-wave Patterns," NOLM 9303

Abstract: This report investigates distortion in shadowgraphs of shock wave patterns in air.

Hyman, M., "Concerning Analytic Solutions of Beltrami-Weinstein Equation," NOLM 9892

Abstract: This paper discusses analytic solutions of a certain partial differential equation which has a singular coefficient and contains a parameter p. This general equation occurs in many different fields of ordnance interest, including two-dimensional and axially symmetric incompressible flow, electrostatics, torsion of shafts, and compressible flow near the speed of sound.

Kaplan, S., "Tables of Functions for Oblique Water-Entry Analysis," NOLM 9834

Abstract: In connection with the problem of the formation of a cavity behind a fast-moving solid body in a liquid, G. Bixkhoff of Harvard University has obtained two sets of simultaneous implicit trigonometric equations. There is presented here a table of solutions of these equations and details of the iterative technique used.

Kaplan, S., "A Note on Richardson's Solution of the Heat Equation by Finite Difference Techniques," NOLM 9915

Abstract: Among the various techniques available for the solution of partial differential equations dealing with heat transfer, supersonic flows, and other problems of physics, one technique that is frequently used on IBM or other high-speed computers is the method involving finite differences. A classical discussion of this method is given in a paper by L. F. Richardson. In the present memorandum, an analysis is given of one of his fundamental equations for the solution of the heat-conduction problem. It is shown that this procedure is unstable, notwithstanding the fact that his formula possesses a smaller initial error than the one presented in (15). It is shown that at an early stage the solutions obtained by Richardson's formula begin to oscillate, and at X = 0.4, t = 0.001, the values diverge beyond the boundary.

Kramer, R. L. and McMillen, J. H., "A Description of a Method for Shooting 1/8-inch Steel Spheres at Velocities above 7,000 ft/sec," NOLM 9188

Abstract: A detailed description is given of a method for shooting 1/8-inch steel spheres at velocities above 7,000 feet per second. Spark shadowgraphs of these fast spheres are also reproduced in this report.

Kurzweg, H. H., "The Pressure at the Base of Bodies at Supersonic Speeds," NOLM 9609

Abstract: The designer of supersonic missiles needs accurate values of the aerodynamic forces and their distribution over the entire surface of the missile. Bodies with flat bases or blunt tails have a base drag which can be quite considerable at high speeds, thus playing an important part in the energy balance.

Our present knowledge of base pressures, particularly at high Mach numbers, is scanty. This report deals with this problem. The available data are discussed, the main test methods are subjected to critical study, and suggestions are made for future wind-tunnel measurements.

Kurzweg, H. H., "The Use of Grating Nozzles and Diffusers," NOLM 9848

Abstract: The improvement of supersonic wind tunnels must include the development of better nozzles and diffusers, respectively, in order to produce better flow conditions and to increase the efficiency of the tunnel; viz., to reduce the required power. Furthermore, construction considerations can lead to improvements even though compromises have to be made with the two previously mentioned major wind-tunnel components. Grating nozzles and diffusers make for extremely short supersonic wind tunnels, a fact which is important for future wind tunnels of large cross section. It is relatively simple to design these nozzles and diffusers to permit the changing of the Mach number continuously during operation. Furthermore, they may be useful in providing extremely short ramjet diffusers with variable throats.

In this memorandum the design and test results of a grating nozzle for Mach number 2.86 is described, the flow field is investigated, and the pressure recovery of a tunnel with such a grating nozzle and diffuser is estimated. This nozzle was constructed and tested in Kochel in 1945. The over-all efficiency of such tunnels will be at least equal to that of the conventional type. The turbulence will be higher but it has had no effect on the measurements carried out thus far.

Lewis, D. C., "Metric Properties of Differential Equations," NOLM 9616

Abstract: This paper discusses the dependence of solutions of a system of first order ordinary differential equations on the initial conditions. The results are applicable in finding limits of dispersion in problems of exterior ballistics.

Lobb, R. K. and Bowles, R. E., "The Design of a Counter-Rotating Fan for the NOL Subsonic Jet Study Tunnel," NOLM 9992

Abstract: See Bowles, R. E. and Lobb, R. K.

Mahan, A. I., "Schlieren Windows for Wind Tunnels," NOLM 9021

Abstract: This report contains the results of shadowgraph tests on pitch polished, felt polished and laminated glass plates and discusses the applicability of these various plates to schlieren techniques when used in wind tunnels.

Martin, M. H., "A Geometrical Approach to Prandtl-Meyer Flows," NOLM 9465

Abstract: Simple geometric proofs are used to derive many well-known properties of the Prandtl-Meyer flows.

Martin, M. H., "A New Approach to Problems in Two-Dimensional Flow," NOLM 9869

Abstract: As an application of the general theory, Prandtl-Meyer flows are discussed and the relation of the theory to the method followed by Kiebel in his study of rotational flows is pointed out.

May, A., "Calculation of Drag Coefficients from Distance-Time Data," NOLM 8694

Abstract: Several methods of calculating drag coefficients are discussed. Those methods appear best which involved plotting a graph whose slope is proportional to the drag coefficient. In particular the method in which reciprocal velocities are plotted against time is preferred. Certain limitations and corrections are discussed.

May, A., "Suitability of Certain Measurements on the Water-Entry Cavity," NOLM 9720

Abstract: In the study of the scaling laws applicable to water-entry phenomena, it is necessary to adopt certain entrance-cavity details and events as criteria. The purpose of this Memorandum is to evaluate such details as regards suitability. In addition, suggestions are made as to the best methods of measuring and of defining such quantities and events.

McGraw, H., "Some Thermodynamic Data for Heat-Transfer Calculations," NOLM 9631

Abstract: This memorandum is a compilation of some frequently used data for heat-transfer calculations. The values given have been selected after a comparison of several different sources.

McGraw, H. and Halbmillion, V., "A Method of Determining the Pressure Distribution on the Ogival Nose of Measurement Based on an Extension of Taylor-Maccoll Calculations," NOLM 9816

Abstract: See Halbmillion, V. and McGraw, H.

McMillen, J. H., "The Size, Shape, and Pressure of Attached Cavities for Spheres at Vertical Entry," NOLM 8735

Abstract: The pressures in the cavities produced by small spheres shot vertically downward into water were calculated from measurements made by means of high-speed motion pictures. The sphere diameters ranged from 1/4 inch to 1-1/2 inch; pressures in tank, from 1/32 atmosphere to one atmosphere; and velocities, from 13 to 71 feet per second.

McMillen, J. H. and Kramer, R. L., A Description of a Method for Shooting 1/8-inch Steel Spheres at Velocities above 7,000 ft/sec," NOLM 9188

Abstract: See Kramer, R. L. and McMillen, J. H.

Munk, M. M. and Prim, R. C., 3rd, "On the Canonical Form of the Equations of Steady Motion of a Perfect Gas," NOLM 9169

Abstract: The equations for general steady motion of a perfect gas are expressed in terms of a reduced number of basic dependent variables. The fundamental characteristic and shock relations are also expressed in terms of these reduced variables.

Munk, M. M. and Prim, R. C., 3rd, "Surface-Pressure Gradient and Shock-Front Curvature at the edge of a Plane Ogive with Attached Shock Front," NOLM 9259

Abstract: The flow of air at high Mach numbers past a sufficiently sharp plane ogive is characterized by the presence of a curved shock front attached to the edge of the ogive. This paper presents and carries out a simple method for computing the exact surface pressure gradient and shock front curvature at the edge of the ogive.

Munk, M. M., "On Some Hodograph Problems," NOLM 9265

Abstract: The second multiplier function in the Fourier series employed in the hodograph method is required (a) not to coincide with the first multiplier function for any parameter occurring and (b) not to assume the value zero at the singularity. General purpose multiplier functions must comply with requirements (a) and (b) for all values of the parameter through the entire subsonic region. That singles out the solutions which become zero at the sonic point. It is shown that certain other solutions proposed by previous writers do not comply with (a) and (b).

Munk, M. M. and Prim, R. C., 3rd, "On the Multiplicity of Steady Gas Flows Having the Same Streamline Pattern," NOLM 9271

Abstract: It is shown that the study of the theoretical motions of a perfect gas may be limited to a study of a special class of such motions of the same gas without loss of generality. These theoretical motions are not necessarily irrotational nor free of shock waves.

Munk, M. M., "On Supersonic Flow Patterns," NOLM 9359

Abstract: For a definite Mach number, all Mach lines in a steady plane two-dimensional potential flow of a perfect gas with expansion exponent γ have more curvature. The use and significance of this relation are discussed, and the hypothetical expansion law consistent with straight Mach lines is deduced.

Munk, M. M., "The Reversal Theorem of Linearized Supersonic Airfoil Theory," NOLM 9624

Abstract: If any supersonically moving airfoil or combination of airfoils is reversed, neither its total drag nor its total lift slope will be changed within the bounds of linearized theory. By reversal is meant a turning of the airfoil by 180°, so that the leading side becomes the trailing side and vice versa.

Munk, M. M. and Crown, J. C., "The Head Shock Wave," NOLM 9773

Abstract: A uniform stream of perfect air impinging with supersonic velocity upon a semi-infinite body of finally constant width may give rise to only one shock wave. The theoretical drag of the body can then be deduced from the shape of this head shock wave. The drag associated with more than one shock wave exceeds the drag computed from the head shock wave. The relation between the wave shape and the drag is deduced and discussed in this Memorandum.

Patterson, G. N., "Some Properties of the General Equations for the Hypersonic Flow of a Continuous Fluid," NOLM 9514

Abstract: The large range of thermodynamic states which accompany a flow at hypersonic speeds necessitates some reconsideration of the general equations of motion. The ideal gas law must be replaced by that for a real gas. It is suggested that the Beattie-Bridgeman for of the equation of state be used except at very low temperatures.

Patterson, G. N., "Theory of the Shock Tube," NOLM 9903

Abstract: A theory of the shock tube is given to facilitate the design and operation of such tubes for research purposes and to indicate new directions of investigation. The importance of the pressure ratio across the diaphragm has already been recognized. This report draws attention to an equally important factor, the ratio of internal energies, and a parameter of smaller effect which involves combinations of gases.

Polachek, H., "Solution of Systems of Differential Equations by Method of Least Squares - Part I," NOLM 9374

Abstract: An extension is made to the method of least squares for application to problems in which the governing conditions are given in the form of a system of ordinary differential equations. For such problems the experimental data may consist of three types of information: initial values of the system of equations, parameters entering in the equations, or values obtained as a result of the solution. The problem of reduction firing data, which involved the numerical solution of a system of second order non-linear differential equations is an illustration of such a problem.

Polachek, H., "On the Solution of Systems of Linear Equations of High Order," NOLM 9522

Abstract: The solution of systems of linear equations of high order is required in a variety of problems; viz., flutter analysis, determination of correlation coefficients, subsonic flow about airfoils. In this Memorandum an iterative procedure for solving such systems of equations is discussed. The computational work involved is of the same order of magnitude as for matrix inversion. An analysis of the errors incurred indicates that much higher accuracy can be obtained by this procedure than can be realized by any direct method.

Polachek, H. and Seeger, R. J., "On Shock-Wave Phenomena - Refraction of Shock Waves at a Gaseous Interface," NOLM 9971

Abstract: The characteristics of shock-wave interaction are of importance in the study of supersonic flow, jet propulsion, and nozzle design. In this Memorandum, the properties of shock configurations occurring as a result of the refraction of a shock wave at a gaseous interface are investigated. Actual computations were carried out on the IBM selective sequence calculator for a large

number of gas combinations, shock strengths, and angles of incidence. What are believed to be the physically realizable families of solutions have been found in each case and are presented graphically in the text of this report.

Prim, R. C., 3rd and Munk, M. M., "On the Canonical Form of the Equations of Steady Motion of a Perfect Gas," NOLM 9169

Abstract: See Munk, M. M. and Prim, R. C., 3rd

Prim, R. C., 3rd and Munk, M. M., "Surface-Pressure Gradient and Shock-Front Curvature at the Edge of a Plane Ogive with Attached Shock Front," NOLM 9259

Abstract: See Munk, M. M. and Prim, R. C., 3rd

Prim, R. C., 3rd and Munk, M. M., "On the Multiplicity of Steady Gas Flows Having the Same Streamline Pattern," NOLM 9271

Abstract: See Munk, M. M. and Prim, R. C., 3rd

Rogers, M., DeMeritte, F. J., and Fagin, S., "Proposed Method for the Design of Ramjet Spike Diffusers," NOLM 9858

Abstract: See DeMeritte, F. J., Fagin, S., and Rogers, M.

Schwartz, R. N. and Truesdell, C. A., "The Newtonian Mechanics of Continua," NOLM 9223

Abstract: See Truesdell, C, A. and Schwartz, R. N.

Seeger, R. J. and Polachek, H., "On Shock-Wave Phenomena - Refraction of Shock Waves at a Gaseous Interface," NOLM 9971

Abstract: See Polachek, H. and Seeger, R. J.

Shanks, D., "Solution of a Quartic Equation," NOLM 8705

Abstract: A method of solving quartic equations by a combination of algebraic formulae and Newton's Method is given. Its advantages over the usual methods are discussed.

Shanks, D., "The Mathematical Theory of Backlash as Applied to the Depth Hunting of a Torpedo," NOLM 8832

Abstract: An approximate steady state theory of backlash hunting

is developed and checked against the exact Moore School solutions and also against the experimentally measured frequencies. A mathematical relation between backlash hunting and constant time-lag hunting is obtained showing that a backlash cycloid exists equivalent to the constant time lag circle.

Shanks, D. and Walton, R. S., "The Use of Rational Functions as Approximate Solutions of Certain Trajectory Problems," NOLM 9524

Abstract: Some functions may be better approximated by rational functions than by polynomials. Certain trajectory functions fall into this category and therefore the trajectories may be obtained approximately in terms of explicit rational formulae. These formulae, two types of second approximation, and some examples are given in the following Memorandum.

Shepard, B. M., "Evaluation of the Tests and Reports Written on Tests of a 5/38-inch Gun Silencer; final report on," NOLM 9392

Abstract: NOLM 8510 covers the acoustic tests on subject very thoroughly, and indicates a reduction of 60% of noise level. NPG letter S74-1(11) (BPO 97414) to BuOrd, dated 9 April 1946, covers the test procedure and results of the 8 shots fired. The information obtained as to mechanical strength and details of failure is sufficient to enable the Laboratory to design successfully the silencers for the Aerodynamics Range.

Shortley, G., "The NOL Ballistics Program," NOLM 7936

Abstract: This Memorandum is prepared in response to a request of Comdr. Walter of BuOrd, made at a conference on ballistics held at the Bureau of Ordnance 14 September 1945, between members of the Bureau of Ordnance, the Naval Ordnance Laboratory, Inyokern, Dahlgren, and the Applied Physics Laboratory of Johns Hopkins University. It is intended to contain an informal discussion of the proposed Naval Ordnance Laboratory ballistic facilities and program, insofar as they can be visualized at this time.

Shue, G. L., "Method for Calculation of the Drag Coefficient from Data Obtained in a Precision Aeroballistics Range," NOLM 10,234

Abstract: By use of a spark-shadowgraph technique to record a short-range trajectory of a model in free flight in a precision ballistic range it is possible to determine the speed and drag

coefficient. The time intervals between the sparks at successive stations along the range must be accurately determined. The corresponding distances are measured on the photographic plates which also record accurate fiducial marks. The method, here suggested, for obtaining the basic parameters of drag and speed differs from other published methods in that the identity of the basic parameters is retained in the final equation, which is non-linear and in closed form. This Memorandum presents an engineering method for obtaining the solution and is intended primarily for desk and reference use of NOL personnel.

Slawsky, Z. I., "Summary of Abstracts of Problems Treated by the Analytical Mechanics Section," NOLM 7941

Abstract: The following, a summary of brief abstracts of the problems treated in the Analytical Mechanics Section, is published for the information of those in the Laboratory who may have occasion to use not only the information that has been accumulated by this Section, but the skills that have been developed in the course of solving the problems assigned to it.

Slawsky, Z. I., "Fundamental Data Required in the Study of Underwater Ballistics of Torpedoes - Preliminary Program for the Obtaining of," NOLM 8011

Abstract: The theoretical study of torpedo motion and its control has been severely handicapped by the lack of precise data on several fundamental quantities. This Memorandum proposes a program for the measurement of seven quantities: (a) angle of attack; (b) elevator and control pendulum position; (c) turning radius and velocity in a turn; (d) R.P.M. as a function of time; (e) angle of heel in a circular run; (f) angle of yaw in a turn; and (g) depth of run. It is pointed out that the measurement of most of the above quantities is extremely difficult. A brief discussion of possible methods pointing out some sources of difficulty is presented. It is concluded that an extensive development program and thorough analysis of the results will be required but that the need for such data amply justifies this research.

Slawsky, Z. I., "Report of a Conference held 18 March 1948 to Resolve the Controversy Arising from the Review of the David Taylor Model Basin Report on the Stability of Torpedoes," NOLM 9656

Abstract: Title of report is abstract.

Staab, H. G., "Redesign and Adaptations of a German Laboratory Wind Tunnel to the NOL Wind Tunnel Building at White Oak, Maryland," NOLM 8619

Abstract: This Memorandum discusses the Kochel design of a supersonic laboratory wind tunnel and design changes which would adapt it for installation in the Naval Ordnance Laboratory.

Truesdell, C. A., "On the Functional Equation," NOLM 8975

Abstract: In problems of compressible flow Chaplygin's method employs hypergeometric functions, and a new approximation introduced by von Karman employs Bessel functions. Practical use of these functions often demands an extensive set of complicated formulas, appearing in the literature in a profuse and scattered fashion. It is shown here that many of these formulas may be discovered and correlated by a general method.

Truesdell, C. A. and Schwartz, R. N., "The Newtonian Mechanics of Continua," NOLM 9223

Abstract: The purpose of this project is to formulate the differential equations and boundary conditions governing various Newtonian continua as inclusively as possible, and to discuss the general properties of such continua.

VanTuyl, A., "On the Axially Symmetric Flow Around a New Family of Half-Bodies," NOLM 9539

Abstract: This Memorandum deals with a new family of axially symmetric, incompressible flows discussed recently by A. Weinstein, who has given the stream function for the flow around a new family of blunt-nosed half-bodies in terms of definite integrals which involve Bessel functions. For the purpose of numerical computation, these integrals are evaluated here in terms of elliptic integrals. A set of graphs is obtained by means of which any given profile can be plotted. Some details of the flow along the half-bodies are investigated.

Walton, T. S., "Response of the Torpedo Mk 18 to Sinusoidal Variations in the Position of the Elevators," NOLM 8997

Abstract: The steady-state solution of the equations of motion of a torpedo is obtained for the case of sinusoidal driving function on the

elevators. The relative amplitudes and phase angles of the various components of the motion are plotted as functions of the impressed frequency.

Walton, T. S. and Shanks, D., "The Use of Rational Functions as Approximate Solutions of Certain Trajectory Problems," NOLM 9524

Abstract: See Shanks D. and Walton, T. S.

Wegener, P. P., "Investigation of Possible Air Condensation in the Supersonic Wind Tunnel at High Mach Numbers," NOLM 8659

Abstract: In this Memorandum the physical bases for the air condensation expected at high Mach numbers are discussed and equipment and methods for experimental observation of this phenomenon are described.

Wegener, P. P., "On the Experimental Investigation of Hypersonic Flow," NOLM 9629

Abstract: The expected range of model testing in the proposed hypersonic wind tunnel at NOL is discussed in comparison with free-flight conditions. The physical problems to be investigated, such as air liquefaction, gas nonideality, and others, are discussed. A survey of requisite instrumentation is given. Finally a research program is discussed which should give experimental solutions to the various problems that must be overcome to achieve homogeneous and parallel flow in wind tunnels for Mach numbers up to about 10.

Wegener, P. P., "Sub- and Supersonic Wind-Tunnel Tests on Rectangular Airfoils of Small Aspect Ratio," NOLM 9928

Abstract: Experimental data are given on some basic airfoils of small aspect ratio for possible use as wings and control surfaces on guided missiles.

Weinstein, A., "Nonlinear Problems in the Theory of Fluid Motion With Free Boundaries," NOLM 9547

Abstract: This paper is a report on the theory of jets, wakes, and cavitations occurring in plane motion of a nonviscous fluid. It covers mainly the progress made during the last 25 years (1923-1948). The mathematical methods developed in these investigations have found an application to other branches of hydrodynamics.

Weinstein, A., "Separation Theorems for the Eigenvalues of Partial Differential Equations," NOLM 9589

Abstract: It is shown by a variational method introduced in previous papers that some results connected with the oscillation theorems of the theory of ordinary differential equations can be extended to the field of partial differential equations.

Weinstein, A., "On Surface Waves," NOLM 9870

Abstract: The present paper gives a complete survey of all possible progressive waves on a sloping beach. It supersedes previous results given by several authors who have considered only a particular solution of the problem.

Whelan, W. T., "A Shunt for Monitoring Large Transient Currents with Duration Less than a Microsecond," NOLM 9306

Abstract: It is pointed out that the problem of measuring large current pulses which last for a microsecond or less presents certain inherent difficulties which arise because of the residual inductance of the current shunt. To overcome this difficulty, a shunt was developed having a residual inductance of less than 0.01 microhenries which was capable of carrying crest currents of several thousand amperes at high recurrence rates.

Winkler, Eva, "Characteristics Required of X-Ray Equipment with Ionization Chamber for Air Density Measurements," NOLM 9883

Abstract: This memorandum discusses the characteristics of X-Ray absorption equipment to be used for measuring the air density distribution around models of projectiles or guided missiles in a supersonic wind tunnel. The possible accuracy of such density measurements is considered in its relation to the quality of the X-rays used, to the magnitude of the density of the air itself, and to the sensitivity of the X-Ray intensity-measuring device used.

Zettler-Seidel, P. W., "Supersonic Diffusers," NOLM 8634

Abstract: This Memorandum presents the results of a series of wind tunnel investigations made in the NOL 40 x 40 cm Aeroballistics Tunnel No. 1 on a two-cone, Oswatitsch-type, ramjet diffuser. A large-scale model of this diffuser had been tested already in free-flight at WSPG in June 1949, using the Aerobee as

the test vehicle. The correlation between the wind tunnel results and these older free-flight pressure values is excellent. The results are also in good agreement with theoretical values. Difference between theory and experiment are reviewed and discussed. A rapid engineering method for the estimation of the boundary layer at the first throat of the diffuser is presented. Scaling requirements are briefly discussed and the effects of boundary layer on the flow over the spike and in the annulus are also indicated.

Zettler-Seidel, P. W., "Monograms for three Ramjet Performance Equations (continuity equation, pressure equation, combustion equation)" NOLM 9564

Abstract: The general nomographical principles used in this paper and their application to the above three ramjet performance equations are discussed and the nomograms designed for practical use are presented in reduced scale and full size. The nomograms themselves can be used without detailed understanding of their theory. The nomogram presented here for the combustion equation can be used only for Mach numbers which are not too small. Another one for small Mach numbers will be published later.

Zettler-Seidel, P. W., "Differential Relations of a Rotationally Symmetric Supersonic Flow," NOLM 9431

Abstract: In this report, differential relations for a rotationally symmetric or plane supersonic flow will be derived as a consequence of the characteristic equations. These differential relations are derived for the special purpose of application to high-speed computing machines. Only the case of ordinary points of the flow and of boundary points with continuous boundary slope are considered explicitly. One way of treatment of the first shock wave in parallel flow is mentioned. Further shock waves; multiple shock configurations; and discontinuities in the flow magnitudes and in the first derivatives of the flow magnitudes, and in the boundary slope are not discussed. Vorticity is included.

II. List of Unclassified NOLMemoranda Published During the Period 1 July 1949 - 31 December 1950

Allmand, D. E. and Whelan, W. T., "A Spark Light Source and Trigger," NOLM 10,622

Abstract: A double-gap spark source is described which was found to give more reliable performance than had previously been experienced with single-gap sources. To decrease the fluctuation in ignition time, a special trigger transformer was constructed.

Allmand, D. E., March R. S., McMillen, J. H., and Kramer, R. L., "Pressure Fields Surrounding High-Speed Spheres in Water," NOLM 10,712

Abstract: See McMillen, J. H., et al

Bitondo, D., Lobb, R. K., and Patterson, G. N., "A Proposal for a New Type of Aerodynamic Range," NOLM 10,334

Abstract: In this report a proposal for the combination of a shock tube with a ballistics range is given.

Cheydleur, F. B. and Kaplan, S., "Numerical Analysis of the Distribution Problem for Pit Fragmentation," NOLM 10,817

Abstract: This paper presents the development of an automatic computing technique for use in the analysis of pit-fragmentation distribution. Emphasis is placed on the theory of distribution and computation procedure.

Cheydleur, F. B. and Kaplan, S., "Calculation of the Transition Angles for Shock-Wave refraction at a Free Surface," NOLM 10,813

Abstract: See Kaplan, S. and Cheydleur, F. B.

Cheydleur, F. B., "Sea-Test Analysis of VT Fuze Development," NOLM 10,973

Abstract: This report illustrates the techniques of mechanized multiple-factor survey which are useful in any problem that involves detection and measurement of relations between many categories.

Crown, J. C. and Heybey, W. H., "Supersonic Nozzle Design," NOLM 10,594

Abstract: The theory of supersonic flow in nozzles is discussed. In addition, the analysis of given nozzle shapes to determine velocity distribution and possible existence of shock waves is considered. A description of a supersonic protractor is included in conjunction with a discussion of its application to nozzle analysis and design.

Crown, J. C., "Supersonic Nozzle Design, Supplement I," NOLM 10,594

Abstract: An analytic method for designing nozzles is described herein. This method (Nilson's) allows for the nonuniformity of flow across the throat.

Eber, G. R., "Heat Transfer Measurements on Cones in the NOL 40 x 40 cm Supersonic Wind Tunnel No. 2," NOLM 10,106

Abstract: One of the design limits of supersonic missiles is the high temperature which is reached in flight due to the high boundary-layer temperatures and high rate of heat flow involved resulting from air friction and compression.

Temperature measurements were made in the wind tunnel at Mach numbers between 1.5 and 5.0 inclusive on three thick-walled copper cones of 10, 20, and 60 degree total angle and on a 20-degree copper cone subdivided into frustra to determine heat transfer coefficients for heat flow into and out of the wall of the cone.

Eber, G. R., "Determination of Temperature-Recovery Factors in Cones in the NOL 40 x 40 cm Supersonic Wind Tunnel No. 2," NOLM 10,107

Abstract: This Memorandum considers the effect of aerodynamic heating in the compressible boundary layer at supersonic velocities.

Edelson, H., Rawling, G., and Frenkiel, F., "Statistical Analysis of Turbulence Data," NOLM 10,815

Abstract: See Frenkiel, F. N., Edelson, H. and Rawling, G.

Fagin, S. and Rogers, M., "Free-Flight 'cold flow' pressure test results of a Two-Cone, Large-Scale, Oswatitsch-Type, Ramjet Diffuser Correlation with Free-Flight Results Obtained at WSPG in June 1949, Part II," NOLM 10,124

Abstract: See Rogers, M. and Fagin, S.

Frenkiel, F. N. and L. Malavard, "Mathematical Problems That Can Be Solved by Rheoelectrical Analogy," NOLM 10,546

Abstract: A translation of a lecture which was delivered by Dr. L. Malavard at the NOL is enclosed. The paper treats a method of computational analogies using physical phenomena for which the theoretical equations are similar to the mathematical equations which are to be solved.

Frenkiel, F. N., Edelson, H., and Rawling, G., "Statistical Analysis of Turbulence Data," NOLM 10,815

Abstract: Various statistical characteristics of turbulence recordings are investigated by the use of automatic computing equipment. This Memorandum reports the numerical procedure used in the investigation.

Frenkiel, F. N. and Polachek, H., "An Algorithm for the Construction of a Polynomial Representing a Given Tabular Function," NOLM 10,972

Abstract: A simple scheme (algorithm) is developed for the purpose of carrying out interpolation, differentiation, or other mathematical operations.

Fuller, S. J. and Shapiro, N. M., "Measurement of Pressure Distribution with Water-Vapor Condensation in the 18 x 18 cm Wind Tunnel," NOLM 10,125

Abstract: This report presents data obtained from investigations with water-vapor condensation occurring in the nozzle which were performed in the 18 x 18 cm wind tunnel of the Naval Ordnance Laboratory. Pressure data are presented.

Gieseler, L. P., "Wind-Tunnel Pitching Moment Balance Using Strain Gages (Symbol XI-3Z)," NOLM 10,357

Abstract: A Wind-tunnel balance utilizing straim measurements

on a short flat portion of the model sting is described. Calculations of elastic properties of this section are made. Calibration results and wind-tunnel tests are also given in this Memorandum

Gruenewald, K. H., "Investigation of Several Desiccants with Regard to Their Use in the Dryer System of the 40 x 40 cm Supersonic Wind Tunnels," NOLM 10,518

Abstract: Title is abstract.

Hall, N. A. and Harrison, J. W., "Determination of Ramjet Propulsive Forces From Experimental Drag Data and Calculated Thrust," NOLM 10,315

Abstract: A critical examination is made of the several factors which are to be included in the calculation of the total propulsive force of a ramjet.

Harrison, J. W. and Hall, N. A., "Determination of Ramjet Propulsive Forces From Experimental Drag Data and Calculated Thrust," NOLM 10,315

Abstract: See Hall, N. A. and Harrison, J. W.

Henderson, H. W., "Naval Ordnance Laboratory 18 x 18 cm Supersonic Wind Tunnel - Design Criteria, Description of Tunnel, Operating Technique," NOLM 10,379

Abstract: This report covers in detail the mechanical features of the 18 x 18 cm Tunnel and is intended as a guide for the operation of the tunnel and the planning of experimental work with it.

Heybey, W. H., "Comparison of Survey Data for Rectangular Airfoils in Supersonic Flow with Results Given by Linearized Theory," NOLM 10,249

Abstract: In the present Memorandum a comparison between theory and experiment has been made for the special case of rectangular airfoils of small aspect ratio.

Heybey, W. H. and Crown, J. C., "Supersonic Nozzle Design," NOLM 10,594

Abstract: See Crown, J. C.

Heybey, W. H., "A Solution of Lagrange's Problem of Interior Ballistics By Means of Its Characteristic Lines," NOLM 10,819

Abstract: The one-dimensional nonsteady motion set up in a highly compressed gas when it accelerates a piston in a cylinder represents a problem of long standing. It is solved in the present paper by developing the net of its characteristic lines.

Hyman, M. A., Kaplan, S. and O'Brien, G. C., "A Study of the Numerical Solution of Partial Differential Equations," NOLM 10,433

Abstract: See O'Brien, G. C., Hyman, M. A., and Kaplan, S.

Kaplan, S., "Computation of Flows Formed by Jets from Orifices," NOLM 10,818

Abstract: With the use of IBM machines, the Applied Mathematics Division has calculated the flow patterns of an incompressible fluid from a slotted orifice for four different angles of aperture.

Kaplan, S., O'Brien, G. C. and Hyman, M. A., "A Study of the Numerical Solution of Partial Differential Equations," NOLM 10,433

Abstract: See O'Brien, G. C., Hyman, M. A., and Kaplan, S.

Kaplan, S. and Cheydleur, B. F., "Calculation of the Transition Angles for Shock-Wave Refraction at a Free Surface," NOLM 10,813

Abstract: Calculations were carried out on IBM machines to determine the transition angles of shock waves interacting with free boundaries.

Kaplan, S. and Cheydleur, B. F., "Numerical Analysis of the Distribution Problem for Pit Fragmentation," NOLM 10,817

Abstract: See Cheydleur, B. F. and Kaplan, S.

Kendall, J. M., "Time Lags Due to Compressible-Poiseuille Flow Resistance in Pressure-Measuring Systems," NOLM 10,677

Abstract: The time response of pressure-measuring systems is basically analyzed in this report for the case where compressibility and viscosity are predominating factors.

Kramer, R. L., Allmand, D. E., March, R. S., and McMillen, J.H., "Pressure Fields Surrounding High-Speed Spheres in Water," NOLM 10,712

Abstract: See McMillen, J. H., Kramer, R. L., Allmand, D. E., and March, R. S.

Kurzweg, H. H., "New Experimental Investigations on Base Pressure in the NOL Supersonic Wind Tunnels at Mach Numbers 1.2 and 4.24," NOLM 10,113

Abstract: A plausible explanation for the apparent discrepancy between the results from former wind-tunnel measurements and free-flight tests has been found. The disagreement of the former results was caused by nonsimilar flow conditions. A new effect caused by the heat flow from the model to the air and vice versa on the base pressure has been observed.

Lehnert, R., "Calibration of the NOL 40 x 40 cm Supersonic Wind Tunnels Number 1 and Number 2," NOLM 10,679

Abstract: The NOL 40 x 40 cm supersonic wind tunnels have been calibrated using nozzles of design Mach numbers of 1.22, 1.56, 1.86, 2.48, 2.92, 3.25, 4.38, and at subsonic velocities corresponding to the range of Mach numbers from 0.40 to 0.89.

Lin, C. C., "A New Variational Principle for Isenergetic Flows," NOLM 10,365

Abstract: When an aircraft is moving in an initially undisturbed, perfect, compressible gas, the relative flow of the gas is isenergetic (rotational with variable entropy). In a previous study, an integral I was given whose variation yields the two equations of isenergetic flow. By introducing a new stream function, these two equations have been replaced by one equation whose solution gives the flow characteristics.

Lin, C. C., "On Taylor's Hypothesis in Wind-Tunnel Turbulence," NOLM 10,775

Abstract: An estimation is made of the order of magnitude of the various terms in the equations for homogeneous and isotropic turbulence. This enables one to estimate the error involved in using Taylor's hypothesis; e.g., for the determination of the microscale λ of turbulence.

Lobb, R. K., "On the Length of a Shock Tube," NOLM 10,494

Abstract: In this report a theoretical treatment of the reflected waves is given and the results are presented in graphs.

Lobb, R. K., Patterson, G. N., and Bitondo, D., "A Proposal for a New Type of Aerodynamics Range," NOLM 10,334

Abstract: See Bitondo, D., Lobb, R. K., and Patterson, G. N.

Malavard, and Frenkiel, F., "Mathematical Problems That Can Be Solved by Rheoelectrical Analogy," NOLM 10,546

Abstract: See Frenkiel, F. and Malavard

Martin, M. H., "Steady, Rotational, Plane Flow of a Gas," NOLM 10,274

Abstract: The problem of determining the steady, rotational, plane flow of a gas is reduced by taking the streamlines and isobars for curvilinear coordinate lines to the integration of a quasilinear partial differential equation in which the pressure and the stream function are the independent variables and the unknown function is the direction of flow.

May, A. and Woodhull, J. C., "The Virtual Mass of a Sphere Entering Water Vertically," NOLM 10,636

Abstract: An investigation of virtual mass for spheres shortly after vertical water entry is described.

McMillen, J. H., Kramer, R. L., Allmand, D. E., and March, R. S., "Pressure Fields Surrounding High-Speed Spheres in Water," NOLM 10,712

Abstract: A comparison was made between the refraction pattern observed experimentally and one calculated by assuming that the flow was a steady-state flow and could be represented by a point-source model of flow.

Munk, M. M. and Rawling, G., "Tables of Chaplygin Functions," NOLM 10,816

Abstract: This report is a collection of tables of the Chaplygin functions occurring in the computations, by means of the hodograph method, of plane two-dimensional flows of perfect gases.

Munk, M. M., "The Transonic Similarity Law," NOLM 10,836

Abstract: It is demonstrated that the basic assumption supporting the transonic similarity rule is not well founded except for the plane, two-dimensional, slightly supersonic profile flow.

Nemenyi, P. F. and Van Tuyl, A., "Two Dimensional Plastic Stress Systems with Isometric Principal Stress Trajectories," NOLM 10,430

Abstract: Caratheodory and Schmidt discussed the possibility of maximum shear trajectories forming an isometric net. The authors generalize the above study to an arbitrary yield function.

O'Brien, G. G., Hyman, M. A., and Kaplan, S., "A Study of the Numerical Solution of Partial Differential Equations," NOLM 10,433

Abstract: This paper defines in a precise manner convergence and stability and shows how these concepts are related to the choice of a numerical procedure which will give accurate solutions of the partial differential equation.

Patterson, G. N., Bitondo, D., and Lobb, R. K., "A Proposal for a New Type of Aerodynamic Range," NOLM 10,334

Abstract: See Bitondo, D., Lobb, R. K., and Patterson, G. N.

Polachek, H. and Frenkiel, F., "An Algorithm for the Construction of a Polynomial Representing a Given Tabular Function," NOLM 10,972

Abstract: See Frenkiel, F. and Polachek, H.

Rawling, G., Edelson, H., and Frenkiel, F. N., "Statistical Analysis of Turbulence Data," NOLM 10,815

Abstract: See Frenkiel, F. N., Edelson, H., and Rawling, G.

Rawling, G. and Munk, M., "Tables of Chaplygin Functions," NOLM 10,816

Abstract: See Munk, M. and Rawling, G.

Rogers, M. and Fagin, S., "Free-Flight 'Cold-flow' Pressure Test Results of a Two-Cone, Large-Scale, Oswatitsch-Type, Ramjet

Diffuser Correlation with Free-Flight Results Obtained at WSPG in June 1959. Part II," NOLM 10,124

Abstract: This Memorandum presents the results of a series of wind-tunnel investigations.

Rogers, M. and Whittaker, J. R., "Wind-Tunnel Investigation of the Aerodynamic Forces Acting on the Basic Aerobee Missile and a Modified Aerobee Missile Employing a Two-Cone Spike-Type Diffuser Nose. Part III," NOLM 10,124

Abstract: Results of a wind-tunnel investigation are presented.

Shanks, D., "An Analogy Between Transients and Mathematical Sequences
al and Some Nonlinear Sequence-to-Sequence Transforms Suggested By It. Part I," NOLM 9994

Abstract: In mathematics one wishes to obtain accurate answers rapidly. One obstacle often met with is that the simplest and most
s obvious analysis gives mathematical sequences which are slowly convergent or even divergent. The proper treatment of such sequences is therefore a general problem of real importance. This Memorandum gives and discusses some methods of treating such sequences.

Shanks, D., "Drag and Velocity Determination in a Ballistic Range," NOLM 10,530

'2 Abstract: Three methods of reducing ballistic range data for the determination of velocity and drag are discussed and compared.

Shapiro, N. and Fuller, S. J., "Measurement of Pressure Distribution with Water-Vapor Condensation in the 18 x 18 cm Wind Tunnel," NOLM 10,125

Abstract: See Fuller, S. J. and Shapiro, N.

16 Smelt, R., "Scale Effects Research at the NOL Aeroballistic Research Facilities," NOLM 10,837

Abstract: It is pointed out that although many aerodynamic characteristics at supersonic speeds can be measured in low Reynolds number wind tunnels, some are modified by change of Reynolds number. The facilities of BuOrd capable of studying these changes are listed, and maximum Reynolds numbers are given.

Smelt, R. and Wegener, P. P., "Summary of NOL Research on Liquefaction Phenomena in Hypersonic Wind Tunnels," NOLM 10,772

Abstract: See Wegener, P. P. and Smelt, R.

Van Tuyl, A., "The Solution of Some Integral Equations Occurring in the Determination of Gas Flow Densities from x-ray Absorption Measurements," NOLM 10,431

Abstract: This Memorandum deals with the solution of the integral equations which connect the unknown density with the measured values of X-ray Absorption.

Van Tuyl, A. and Nemenyi, P. F., "Two Dimensional Plastic Stress Systems with Isometric Principal Stress Trajectories," NOLM 10,430

Abstract: See Nemenyi, P. A. and Van Tuyl, A.

Walton, T. S., "Equations for the Numerical Determination of the Steady Flow of a Viscous Liquid Past a Solid of Revolution," NOLM 9778

Abstract: Among the most difficult mathematical problems encountered in applied science are those governed by partial differential equations of the elliptic type. This Memorandum deals with a typical example; viz., the motion of a viscous liquid around a solid.

Wegener, P. P. and Smelt, R., "Summary of NOL Research on Lique-Faction Phenomena in Hypersonic Wind Tunnels," NOLM 10,772

Abstract: Liquefaction of air is a major factor limiting the achievement of very high Mach numbers in hypersonic wind tunnels. NOL work on this problem is described.

Weinstein, A., "New Methods for the Estimation of Torsional Rigidity," NOLM 10,416

Abstract: This Memorandum gives a review of some recent investigations on inequalities and estimates for torsional ridigity.

Weinstein, A., "On the Helmholtz Problem of Conformal Representation," NOLM 10,481

Abstract: Theory of jet and wakes in an incompressible fluid is discussed.

Whelan, W. T. and White, E. L., "Certain Electrical Characteristics of Gaseous Flashlamps When Operated Repetitively," NOLM 9766

Abstract: An experimental method of measuring the behavior of gaseous flashlamps when operated many times per second as pulsed light sources is presented.

Whelan, W. T. and White, E. L., "Circuit Considerations for Electronic Flashlamps Operation," NOLM 10,428

Abstract: This Memorandum reviews the circuit and component experiences of using lamps in synchronism with high-speed optically-shuttered cameras.

Whelan, W. T. and Allmand, D. E., "Spark Light Source and Trigger," NOLM 10,622

Abstract: See Allmand, D. E. and Whelan, W. T.

Whittaker, J. R. and Rogers, M., "Wind-Tunnel Investigation of the Aerodynamic Forces Acting on the Basic Aerobee Missile and a Modified Aerobee Missile Employing a Two-Cone Spike-Type Diffuser Nose. Part III," NOLM 10,124

Abstract: See Rogers, M. and Whittaker, J. R.

White, E. L. and Whelan, E. L., "Certain Electrical Characteristics of Gaseous Flashlamps When Operated Repetitively," NOLM 9766

Abstract: See Whelan, W. T. and White, E. L.

White, E. L. and Whelan, W. R., "Circuit Considerations for Electronic Flashlamps Operation," NOLM 10,428

Abstract: See Whelan, W. T. and White, E. L.

Winkler, E. H., "Principle and Design of a New Type Stieltjes Integrator," NOLM 10,798

Abstract: Principle and Design of a new type of Stieltjes integrator are described.

Winkler, E., "Density Measurements by Means of the X-Ray Absorption Method," NOLM 10,118

Abstract: Experimental results of air-density measurements are presented.

Winkler, E., "Comparison of Methods for Measuring the Density in Hypersonic Tunnels," NOLM 10,936

Abstract: Several methods for density measurements in gas flows are discussed with respect to their applicability to the NOL hypersonic wind tunnel.

Woodhull, J. C. and May, A., "The Virtual Mass of a Sphere Entering Water Vertically," NOLM 10,636

Abstract: See May, A. and Woodhull, J. C.

III. List of Unclassified NavOrd Reports Published During the Period 1 January 1951 - 31 December 1952

Burgers, M. J., "Investigation on the Behavior of Solutions of a Non-linear differential Equation Connected With Problems of Turbulence and Shock Waves," NavOrd 1587

Abstract: This Report contains a detailed investigation of the properties of the solution of a non-linear differential equation that is connected with the study of turbulent flow and the formation of shock waves.

Crown, J. C., "Flow of a Beattie-Bridgeman Gas With Variable Specific Heat," NavOrd 2148

Abstract: In Part I of this Report the usual aerothermodynamic relations for isentropic flow in a quasi-unidimensional channel were rederived using the Beattie-Bridgeman equation of state in place of the perfect-gas law and allowing for the component of specific heat due to the vibrational mode of freedom. In Part II of this Report the analysis has similarly been extended to consider normal and oblique shock waves.

Crown, J. C., "The Laminar Boundary Layer at Hypersonic Speeds," NavOrd 2299

Abstract: A theoretical study was made of the laminar boundary at hypersonic speeds using a modification of the crocco method of solution. Specific heats are taken variable and dissociation of air considered, both on an equilibrium basis.

Crown, J. C., "On the Attenuation of the Shock Wave About an Axially-Symmetric Body," NavOrd 2475

Abstract: It is shown theoretically that the pressure rise across the shock wave about a body of revolution decays asymptotically as the inverse three-fourths power of the radial distance from the body axis. Experimental data is presented to support the theory.

Diggins, J. L., "Diffuser Investigations in a Supersonic Wind Tunnel," NavOrd 1570

Abstract: Some results are presented from the first tests in a program to determine the most efficient diffuser configuration for use in a supersonic wind tunnel.

Eddy, R. P., "Gradient Methods of Solving Systems of Linear Algebraic Equations," NavOrd 2582

Abstract: In this Report two practical choices of k are discussed (1) the optimum gradient method wherein on each step k is chosen to give S the smallest possible value, and (2) the constant k method wherein k is chosen once for all. It is shown how to choose this k to achieve most rapid convergence.

Eddy, R. P. and Good, R. A., "On the Iterative Solution of a System of Equations," NavOrd 2577

Abstract: See Good, R. A. and Eddy, R. P.

Eddy, R. P., "A Method for the Numerical Solution of a Heat Conduction Problem," NavOrd 2725

Abstract: A scheme for the numerical integration of parabolic or hyperbolic partial differential equations is set up for use in solving a particular problem in heat conduction.

Elgot, C., "The Square Root Method," NavOrd 2609

Abstract: Conditions under which solution of a set of linear equations can be effected by the square root method are given.

Fagin, S., Schermerhorn, V. and Rogers, M., "Theoretical Characteristics of a Shockwave Activated Fuze," NavOrd 1755

Abstract: See Rogers, M., Fagin, S., and Schermerhorn, V.

Good, R. A. and Eddy, R. P., "On the Iterative Solution of a System of Equations," NavOrd 2577

Abstract: The modification of an iterative process is discussed. Several illustrative examples are included to show the powerfulness of the method in accelerating the determination of the root.

Halbmillion, V. and Kulishek, C. J., "Geometric and Aerodynamic Data on Ogives," NavOrd 2239

Abstract: This report presents a set of numerical data, mostly in graphical form, on the geometric and aerodynamic properties of ogives.

Heybey, W. H., "Significant Parameters for the Expansion of Propellant Gases in an Idealized Gun," NavOrd 1582

Abstract: In a previous report, a method was developed which permits one to calculate the muzzle velocity and acceleration of a projectile in an idealized gun. The present report deals with the problem of simplifying the calculations by reducing the number of parameters to a minimum.

Heybey, W. H., "A General Solution for One-Dimensional Non-Steady Flow of a Perfect Gas," NavOrd 2210

Abstract: A new general solution for one-dimensional non-steady flow of a perfect gas is given involving integrals instead of differential quotients used exclusively heretofore.

Heybey, W. H., "The Unsteady Compressible Flow with Rotational Symmetry," NavOrd 2444

Abstract: In order to investigate the effect of chambrage on the gas flow in the explosive chamber of a gun, a study of three-dimensional flow with rotational symmetry was undertaken.

Hyman, M. A., "Non-Iterative Numerical Solutions of Boundary-Value Problems," NavOrd 1813

Abstract: This paper describes an effective procedure for the non-iterative numerical solution of boundary-value problems. Use is made of the exact analytical solution of a related difference-equation problem, which can be found under a large variety of circumstances.

Kendall, J. M., "The NOL Interferometer Fringe Pattern Analyzer," NavOrd 1596

Abstract: The interferometer fringe pattern analyzer described here is a type of comparator which directly determines the fringe shift occurring in interferograms of gas density variations in gas flows, and automatically plots this information on a sheet of co-ordinate paper as a series of dots.

Kendall, J. M., "Equipment and Techniques for Making Pressure Measurements in Supersonic Wind Tunnels at Mach Numbers up to 5," NavOrd 2580

Abstract: The equipment and techniques described in detail in this report were developed especially for use in the intermittent supersonic wind tunnel for measuring pressures where the stabilization time is very important.

Kuerti, G., McFadden, J. A., and Shanks, D., "Virtual Mass of Cylinders with Radial Fins and of Polygonal Prisms," NavOrd 2295

Abstract: The classical theory of virtual mass of a cylindrical body in two-dimensional translatory motion through a perfect fluid is briefly reviewed and applied to compute the coefficients of induced mass for bodies with the two types of cross sections described in the title.

Kuerti, G., "Flow Without Dissipation of a Viscous Compressible Fluid," NavOrd 2463

Abstract: Validity of the Stokes relation between the two viscosity coefficients of a compressible fluid being assumed, the conditions for vanishing dissipation are developed and a detailed analysis of the possible fluid motions is given.

Kulishek, C. J. and Halbmillion, V., "Geometric and Aerodynamic Data on Ogives," NavOrd 2239

Abstract: See Halbmillion, V. and Kulishek, C. J.

Lewis, D. C., "Inequalities for Complex Linear Differential Systems of the Second Order," NavOrd 1864

Abstract: Inequalities have been obtained for solutions of systems of linear differential equations.

Lin, C. C., "On Taylor's Hypothesis and the Acceleration Terms in the Navier-Stokes Equations," NavOrd 2306

Abstract: For isotropic turbulence, a systematic discussion of the various acceleration terms in the Navier-Stokes equations is made, including a study of their correlations. These correlations are expressed in terms of double and triple velocity correlation,

Lobb, R. K. and Wegener, P., "NOL Hypersonic Tunnel No. 4 Results II: Diffuser Investigation," NavOrd 2376

Abstract: See Wegener, P. and Lobb, R. K.

Lobb, R. K., "NOL Hypersonic Tunnel No. 4 Results III: Diffuser Investigation with Models and Supports," NavOrd 2435

Abstract: The results of an investigation in the NOL 12 x 12 cm Hypersonic Tunnel No. 4 to determine the effect of models and supports on diffuser performance at Mach number 7.2 are presented.

Lowan, A. N., "On Some Two-Dimensional Problems in Heat Conduction for Irregular Domains with Regular or Mixed Boundary Conditions," NavOrd 1740

Abstract: This paper deals with the problem of heat conduction in an infinite cylinder of arbitrary cross section with either "regular" or mixed boundary conditions.

Lowan, A. N., "On the Problem of Heat Conduction in the Finite Wedge of an Angle, in the Case of Radiation at the Bounding Planes," NavOrd 1822

Abstract: This paper deals with the problem of heat conduction in an infinite cylinder of arbitrary cross section with either "regular" or mixed boundary conditions.

Lowan, A. N., "On Some Two- and Three-Dimensional Problems in Heat Conduction," NavOrd 1837

Abstract: The accompanying article deals with the two- and three-dimensional problems in heat conduction in domains bounded by one, two, or three of the planes $x = 0$, $y = 0$, and $z = 0$, when either the temperature or the temperature gradient is prescribed on the entire boundary or portions thereof or when radiation into a medium at given temperature takes place on the entire boundary or portions thereof.

Lowan, A. N., "On the Problem of Heat Conduction in Certain Quasi-Infinite Two- and Three-Dimensional Domains," NavOrd 2159

Abstract: Title is abstract.

Lundquist, G., "The NOL 8 x 8 inch Shock Tube: Instrumentation and Operation," NavOrd 2449

Abstract: An 8 x 8 inch shock tube was constructed in support of the research and development program carried out in the hypersonic wind tunnel. A detailed description of the instruments and operation of the shock tube is given.

Lundquist, G., Wegener, P., Stollenwerk, E., and Reed, S., "NOL Hyperballistics Tunnel No. 4 Results I: Air Liquefaction," NavOrd 1742

Abstract: See Wegener, P., Stollenwerk, E., Reed, S., and Lundquist, G.

Martin, M. H., "The Monge-Ampere Partial Differential Equation $rt - s^2 + \lambda^2 = 0$," NavOrd 2201

Abstract: The propagation of a plane shock in a shock tube leaving a nonisentropic disturbance behind it leads to the solution of a problem of Cauchy for a Monge-Ampere equation.

May, A., "Dependence of the Water-Entry Cavity on Surface Condition of a Missile Model," NavOrd 1763

Abstract: Since the cavity formed when a missile enters water may affect the trajectory and the general performance of the missile, an investigation was carried out on those factors which influence the cavity formation at velocities near the minimum velocity for cavity production.

May, A., "On the Entry of Missiles Into Water," NavOrd 1809

Abstract: Since the behavior of weapons after entry into water is strongly dependent on the cavity which accompanies the entry, the formation and development of such cavities has been studied in detail. This report describes the results of investigations carried out principally on the vertical water entry of steel spheres.

May, A., "On the Drag Coefficient of Spherical Missiles After Entry Into Water," NavOrd 2241

Abstract: Drag coefficients for spherical missiles have been determined from the total force experienced by the missiles as they pass through the water just after vertical water entry.

May, A. and Witt, W. R. Jr., "Free-Flight Determinations of the Drag Coefficients of Spheres," NavOrd 2352

Abstract: The drag coefficient has been determined in the Pressurized Ballistics Range for steel and aluminum spheres 1/4 to 3/4 inches in diameter. This permits a plotting of the variation of drag coefficient over a large region of Mach numbers and Reynolds numbers.

McFadden, J. A., "Initial Behavior of a Spherical Blast," NavOrd 2378

Abstract: At time $t = 0$ a unit sphere containing a perfect gas at uniformly high pressure is allowed to expand suddenly into a homogeneous atmosphere. Solutions for short times later are sought by analytic methods.

McFadden, J. A., Kuerti, G. and Shanks, D., "Virtual Mass of Cylinders with Radial Fins and of Polygonal Prisms," NavOrd 2295

Abstract: See Kuerti, G., McFadden, J. A. and Shanks, D.

Munk, M. M., "On Turbulent Fluid Motion," NavOrd 1572

Abstract: The tendency of fluids to move in turbulent fashion is traced back qualitatively to kinematics and simple dynamics. It is demonstrated that vortices cumlate discriminatively; i.e., only those vortices that turn corotationally with the general fluid motion cluster together. This tendency leads to increase the energy supply, and thus a foundation for generation and for maintenance of turbulence is laid.

Munk, M. M., "On the Mechanism of Turbulent Fluid Motion," NavOrd 2298

Abstract: The discussion of NavOrd Report 1572 is brought to conclusion. A system of interacting fluid motions and motion effects is described.

Munk, M. M. and Rawling, G., "Calculation of Compressible Subsonic Flow Past a Circular Cylinder," NavOrd 2477

Abstract: The solution of the problem of compressible potential flow about a circular cylinder by the Rayleigh-Jansen method is extended through the fourth approximation by the use of an automatic calculator carrying out the mathematical operations as well as numerical computations.

Munk, M. M., "The Gas Flow Past Slender Bodies," NavOrd 2490

Abstract: Each subsonic flow of gas past an obstacle requires a definite momentum for its creation. This new theorem is explained, demonstrated, and applied to the computation of airforces on a missile body.

Potter, J. L., "Friction Drag and Transition Reynolds Number on Bodies of Revolution at Supersonic Speeds," NavOrd 2150

Abstract: Results of an exploratory investigation to determine the total skin friction coefficient on bodies of revolution are reported.

Potter, J. L., "New Experimental Investigations of Friction Drag and Boundary-Layer Transition on Bodies of Revolution at Supersonic Speeds," NavOrd 2371

Abstract: Total friction drag coefficients for bodies consisting of twenty and twenty-five degree cone forebodies and cylindrical afterbodies have been determined at zero angle of attack by investigations in NOL 40 x 40 cm Aeroballistics Wind Tunnel No. 2.

Rawling, G. and Riley, Jr., "Glancing Reflection of Shock," NavOrd 2165

Abstract: Title is abstract

Rawling, G. and Munk, M., "Calculation of Compressible Subsonic Flow Past a Circular Cylinder," NavOrd 2477

Abstract: See Munk, M. and Rawling, G.

Reed, S., Lundquist, G., Wegener, P. and Stollenwerk, E., "NOL Hyperballistics Tunnel No. 4 Results I: Air Liquefaction," NavOrd 1742

Abstract: See Wegener, P., Stollenwerk, E., Reed, S., and Lundquist, G.

Riley, J. and Rawling, G., "Glancing Reflection of Shock," NavOrd 2165

Abstract: See Rawling, G. and Riley, J.

Rogers, M., Fagin, S., and Schermerhorn, V., "Theoretical Characteristics of a Shockwave Activated Fuze," NavOrd 1755

Abstract: Theoretical calculations to determine the magnitude of

the instantaneous pressure rise behind a normal shock as it passes through another shock wave have been made. The results of these calculations and their application to a shock-wave activated fuze are presented in this report.

Roberts, R. C., "Some Difficulties Encountered in Using the Method of Characteristics in Three Dimensions," NavOrd 2491

Abstract: This report is concerned with the examination of some of the difficulties encountered in applying the method of characteristics to the numerical solution of problems in three dimensions.

Ruderfer, H., "Solution of LaPlace's Equation for Regular Polygon Regions with a Given Boundary Condition," NavOrd 1597

Abstract: The method of orthogonal polynomials has been used to obtain an infinite series solution of LaPlace's differential equation for a regular polygonal simply-connected region and for a given symmetric boundary condition that is applicable to problems of torsional rigidity.

Sauer, R., "Recent Advances in the Theory of Supersonic Flow," NavOrd 1593

Abstract: This report contains a series of lectures on supersonic and hypersonic flow delivered by Prof. Robert Sauer at NOL during the summer of 1950.

Schermerhorn, V., Rogers, M. and Fagin, S., "Theoretical Characteristics of a Shockwave Activated Fuze," NavOrd 1755

Abstract: See Rogers, M., Fagin, S., and Schermernorn, V.

Shanks, D., Kuerti, G., and McFadden, J. A., "Virtual Mass of Cylinders with Radial Fins and of Polygonal Prisms," NavOrd 2295

Abstract: See Kuerti, G., McFadden, J. A., and Shanks, D.

Stollenwerk, E., Wegener, P., Reed, S., and Lundquist, G., "NOL Hyperballistics Tunnel No. 4 Results I: Air Liquefaction," NavOrd 1742

Abstract: See Wegener, P., Stollenwerk, E., Reed, S., and Lundquist, G.

Turetsky, R. A., "Reduction of Data Obtained in a Spark Range for Free-Flight Motion of a Finned Projectile," NavOrd 2126

Abstract: A presentation is given of the theory of the angular motion of a finned projectile without roll. A modification is made of existing techniques for reduction of related spark range data, leading to considerable improvement in the accuracy of the determination of the aerodynamic coefficients.

vonMises, R., "One-Dimensional Adiabatic Flow of an Inviscous Fluid," NavOrd 1719

Abstract: The basic equations governing the one-dimensional non-steady flow of a perfect gas are reformulated in such a way that general integrals can be derived. Complete solutions for the problem of wave interference and other problems with given initial values are presented.

Wegener, P., Stollenwerk, E., Reed, S., and Lundquist, G., "NOL Hyperballistics Tunnel No. 4 Results I: Air Liquefaction," NavOrd 1742

Abstract: Since the presence of condensed air in a hypersonic wind tunnel can make the operation of the tunnel difficult, and since liquefaction can occur when the temperature and pressure in the test section are below the condensation values, an investigation was carried out on the liquefaction of air in a hypersonic wind tunnel.

Wegener, P. and Lobb, R. K., "NOL Hypersonic Tunnel No. 4 Results III: Diffuser Investigation," NavOrd 2376

Abstract: Results of a diffuser investigation are presented. A brief introduction describes previous supersonic diffuser work. The diffuser investigated and the experimental techniques are then discussed.

Wilson, R. E., "Wind-Tunnel Experiments with the Defense Research Laboratory Apparatus for the Measurement of Longitudinal Dynamic Stability Derivatives at Supersonic Speeds," NavOrd 2206

Abstract: This report presents in detail the results of an investigation of a "cantilever spring type" dynamic stability apparatus at Mach number 2.48 in the NOL supersonic wind tunnel. Data are presented and a brief qualitative comparison is made with data from tests made at the Ordnance Aerophysics Laboratory.

Winkler, E. M., "NOL Hypersonic Tunnel No. 4 Results II: High Supply Temperature Measurement and Control," NavOrd 2574

Abstract: Results of a recent high supply temperature measurement and control investigation are presented.

Witt, W. R., Jr. and May, A., "Free-Flight Determinations of the Drag Coefficients of Spheres," NavOrd 2352

Abstract: See May, A. and Witt, W. R. Jr.

IV. List of Unclassified NavOrd Reports Published During the Period 1 January 1953 - 31 December 1953

Cheydleur, R. F., "Manual of Programming for the Card-Programmed Calculator," NavOrd 2755

Abstract: A brief description of the Card-Programmed Calculator is given. Instructions on how to program for the machine as used with the NOL General Purpose Panel are given in detail.

Diggins, J. L. and Lange, A. H., "A Systematic Study of a Variable Area Diffuser for Supersonic Wind Tunnels," NavOrd 2421

Abstract: A diffuser of variable geometric shape was tested in the Aerophysics Tunnel No. 3. The effect of closed or half open test section on diffuser efficiency and that of a model in the airstream were investigated.

Dunhan, W. H. and Gauzza, H. J., "Aeroballistic Research Investigation of the Specialities, Inc. Airborne Fire-Control Component," NavOrd 2572

Abstract: See Gauzza, H. J. and Dunham, W. H.

Elgot, C., "Single vs. Triple Address Computing Machines," NavOrd 2741

Abstract: "Which is more desirable--a single address or a triple address computing machine?" A partial answer to this question is obtained by proving a mathematical theorem.

Gauzza, H. J. and Dunham, W. H., "Aeroballistic Research Investigation of the Specialities, Inc. Airborne Fire-Control Component," NavOrd 2572

Abstract: This report presents the results of an investigation in the NOL 40 x 40 cm Aeroballistics Tunnel No. 2 at Mach numbers of 0.609, 0.805, 0.953, 1.197, and 1.572 to determine the pressure distribution over a cylindrical probe with the body axis normal to the airstream.

Gieseler, L. P., "Continuous Recording of Pressure for Supersonic Wind-Tunnel Calibration," NavOrd 2744

Abstract: This report is a description of equipment designed to record on the chart of an electronic potentiometer recorder the pitot and static pressure distribution in the test section of supersonic wind tunnels.

Gieseler, L. P. and Lange, A. H., "Measurement of Boundary-Layer Transition on a Standard Model to Determine the Relative Disturbance Level in Two Supersonic Wind Tunnels," NavOrd 2752

Abstract: See Lange, A. H. and Gieseler, L. P.

Grunewald, K. H., "Temperature Recovery Factors in the Transitional and Turbulent Boundary Layer on a 40° Cone Cylinder at Mach No. 2.9," NavOrd 2954

Abstract: Investigations on drag and evaporation of dry ice models were conducted.

Heybey, W. H. and Reed, S. G., Jr., "Condensation Shocks, Weak Detonations, and Related Phenomena," NavOrd 2779

Abstract: Condensation shock phenomena are discussed from the standpoint of the theory of detonations.

Kendall, J. M., "Precision Drag Balance of One Component," NavOrd 2420

Abstract: In the design of the drag balance of one component, considerable effort was made to design a balance capable of yielding precise measurements of drag. The novel design arrived at here eliminates static friction of all moving parts including the sting by supporting them on a system of rotating bearings.

Korobkin, I., "Local Flow Conditions Recovery Factors and Heat-Transfer Coefficients on the Nose of a Hemisphere Cylinder at a Mach number of 2.8," NavOrd 2865

Abstract: The investigations were carried out in the NOL 40 x 40 cm Aeroballistics Tunnel No. 2 and the NOL 18 x 18 cm Aerophysics Tunnel No. 3. The measurements indicate that the recovery factor may be expressed by square root of the Prandtl number even in the presence of a pressure gradient.

Kramer, R. L. and McMillan, J. H., "Shadowgraphic Investigation of Small Spherical Missiles Entering Water Vertically at 7,000 Feet Per Second," NavOrd 2646

Abstract: See McMillan, J. H. and Kramer, R. L.

Lange, A. H. and Walter, L. W., "Pressure and Temperature Measurements of the Flow Produced by a 12 x 12 cm Grating Nozzle," NavOrd 2678

Abstract: The characteristics of the flow produced in the test section of a 12 x 12 cm supersonic wind tunnel by a "grating nozzle" have been investigated.

Lange, A. H. and Gieseler, L. P., "Measurement of Boundary-Layer Transition on a Standard Model to Determine the Relative Disturbance Level in Two Supersonic Wind Tunnels," NavOrd 2752

Abstract: Boundary-layer transition on a slender cone was observed at various Mach numbers in the NOL Supersonic Wind Tunnels No. 2 and 3. The Reynolds number of transition was found to be different in the two tunnels.

Lange, A. H. and Diggins, J., "A Systematic Study of a Variable Area Diffuser for Supersonic Wind Tunnels," NavOrd 2421

Abstract: See Diggins, J. and Lange, A. H.

Lee, R. E., "Measurements of Pressure Distribution and Boundary-Layer Transition on a Hollow-Cylinder Model," NavOrd 2823

Abstract: Static pressure distributions and location of boundary-layer transition were determined on a 4" outer diameter hollow-cylinder model.

Lehnert, R., "Base Pressure of Spheres at Supersonic Speeds," NavOrd 2774

Abstract: Base pressure measurements on spheres with various diameters were carried out at Mach numbers between 1.57 and 5.0 to study Mach number and Reynolds number effects in a Reynolds number region between approximately 10^5 and 10^6.

Lobb, R. K., Winkler, E. M., Wegener, P. P. and Sibulkin, M., "NOL Hypersonic Tunnel No. 4 Results V: Experimental and Theoretical Investigation of a Cooled Hypersonic Wedge Nozzle," NavOrd 2701

Abstract: See Wegener, P. P., Lobb, R. K., Winkler, E. M., Sibulkin, M., and Staab, H.

McMillan, J. H. and Kramer, R. L., "Shadowgraphic Investigation of Small Spherical Missiles Entering Water Vertically at 7,000 Feet Per Second," NavOrd 2646

Abstract: An investigation was made of spherical missiles entering at supersonic speeds up to 7,000 ft/sec. By using exploratory beams from the spark it was possible to obtain a qualitative picture of the pressure field between the shock front and the water surface.

Reed, S. G., Jr. and Heybey, W. H., "Condensation Shocks, Weak Detonations, and Related Phenomena," NavOrd 2779

Abstract: See Heybey, W. H. and Reed, S. G., Jr.

Riley, J. D., "Iteration Procedures for the Dirichlet Difference Problem," NavOrd 2348

Abstract: This report further analyzes the common iteration procedures for solving the Dirichlet difference problem. One such method is revised and made in some ways superior to the method which is generally considered the best.

Riley, J. D. and Roberts, R., "A Guide to the Use of the MIT Cone Tables," NavOrd 2606

Abstract: See Roberts, R. and Riley, J. D.

Roberts, R. and Riley, J., "A Guide to the Use of the M.IT Cone Tables," NavOrd 2606

Abstract: This report contains information which is necessary for the proper use of the MIT cone tables. Specific directions and formulas are given which enable the velocity, pressure, etc., to be computed directly from the information in the cone tables.

Seigel, A. E., "An Experimental Solution to the LaGrange Ballistic Problem," NavOrd 2693

Abstract: An experimental gun was employed to check experimentally the theoretical solutions to the Lagrange ballistic problem. This constant cross-sectional area gun was previously developed so that an accurate study of the rapid expansion of a compressed gas for well-determined initial conditions could be made.

Seigel, A. E., "A Study of the Applicability of the Unsteady One-Dimensional Isentropic Theory to an Experimental Gun," NavOrd 2692

Abstract: A study was made of the rapid expansion of a compressed gas behind a piston.

Seigel, A. E., "Thermodynamic Properties of Argon at Temperatures Below Room Temperature as Obtained from an Experimental Gun," NavOrd 2694

Abstract: The ERMA experimental position-time data of a few argon runs were analyzed to obtain the pressure-density isentrope of argon.

Seigel, A. E., "A Convenient and Accurate Semi-Empirical Entropic Equation for Use in Internal Ballistic Calculations," NavOrd 2695

Abstract: A semi-empirical equation of state has been developed which permits the solution of the internal ballistics problem and represents accurately the effects of the intermolecular forces over a wide range of pressures and densities.

Staab, H., Wegener, P. P., Lobb, R. K., Winkler, E. M., and Sibulkin, M., "NOL Hypersonic Tunnel No. 4 Results V: Experimental and Theoretical Investigation of a Cooled Hypersonic Wedge Nozzle," NavOrd 2701

Abstract: See Wegener, P. P. et al

Sibulkin, M., Wegener, P. P., Lobb, R. K., Winkler, E. M., and Staab, H., "NOL Hypersonic Tunnel No. 4 Results V: Experimental and Theoretical Investigation of a Cooled Hypersonic Wedge Nozzle," NavOrd 2701

Abstract: See Wegener, P. P. et al

Walter, L. W., "Surface Temperature and Pressure Distributions on a Circular Cylinder in Supersonic Cross-Flow," NavOrd 2854

Abstract: Surface pressure and equilibrium temperature were measured on a circular cylinder of 1/2 inch diameter placed perpendicularly to the flow and completely spanning the continuous 18 x 18 cm Aerophysics Wind Tunnel at NOL.

Walter, L. W. and Lange, A. H., "Pressure and Temperature Measurements of the Flow Produced by a 12 x 12 cm Grating Nozzle," NavOrd 2678

Abstract: See Lange, A. H. and Walter, L. W.

Wegener, P. P., Lobb, R. K., Winkler, E. M., Sibulkin, M., and Staab, H., "NOL Hypersonic Tunnel No. 4 Results V: Experimental and Theoretical Investigation of a Cooled Hypersonic Wedge Nozzle," NavOrd 2701

Abstract: This report presents results of theoretical and experimental investigations covering the performance of a new water-cooled, wedge-type nozzle which has been in operation in the NOL 12 x 12 cm Hypersonic Tunnel No. 4 since January 1952.

Winkler, E. M., Wegener, P. P., Lobb, R. K., Sibulkin, M., and Staab, H., "NOL Hypersonic Tunnel No. 4 Results V: Experimental and Theoretical Investigation of a Cooled Hypersonic Wedge Nozzle," NavOrd 2701

Abstract: See Wegener, P. P. et al

Witt, W. R., Jr., "Reynolds Number Effects on the Drag of Spinning Projectiles in Free Flight," NavOrd 2355

Abstract: Experiments were performed to obtain a systematic series of data on the influence of Reynolds number on coefficients of total drag, base drag, and skin-friction drag.

V. List of Unclassified NavOrd Reports Published During the Period 1 January 1954 - 31 December 1954

Baum, G. E., Brewbaker, W. E., and Platnick, A. E., "Centrifugal Compressor System for the Continuous Supersonic Wind Tunnel," NavOrd 2773

Abstract: This report describes the Centrifugal Compressor System whose primary purpose is to provide air for continuous operation of the NOL 40 x 40 cm Supersonic Wind Tunnel No. 2 which had previously operated intermittently from the 52-foot diameter vacuum sphere.

Brewbaker, W. E., Baum, G. E., and Platnick, A. E., "Centrifugal Compressor System for the Continuous Supersonic Wind Tunnel," NavOrd 2773

Abstract: See Baum, G. E., Brewbaker, W. E., and Platnick, A.E.

Crown, J. C., "Approximate Analysis of Non-Linear Oscillations," NavOrd 3550

Abstract: This paper deals with oscillations of missiles having non-linear pitching moments. Several different pitching-moment equations are considered and an approximate solution found which is independent of the analytic form of the equation.

Elgot, Calvin, "Least Squares Over the Complex Field," NavOrd 3797

Abstract: The least square solution of a set of linear equations with complex coefficients and its relation to the equivalent real equation is discussed.

Gieseler, L. P., "Mathematical Analysis of the Ring Modulator Circuit," NavOrd 3673

Abstract: A solution is obtained for the output current of a ring modulator circuit with arbitrary inputs and arbitrary load resistance. The operation of the circuit for various operating conditions is considered.

Gieseler, L. P., "Magnetic Decision Element Reliability," NavOrd 3812

Abstract: This report describes a series of tests made at NOL for the purpose of evaluating the reliability of magnetic decision elements.

Gieseler, L. P., "Magnetic Switching Network for Data Handling Systems," NavOrd 3824

Abstract: A magnetic switching network is described which will switch a number of low level AC analog signals into a single data-handling channel.

Gilbert, B. D., "Automatic Data Processing System (ADAPS) for the Supersonic Wind Tunnels," NavOrd 2813

Abstract: This report describes the Automatic Data Processing System which is used in the NOL 40 x 40 cm Supersonic Wind Tunnels.

Hastings, S. M., "Performance of a Converging-Diverging Wind Tunnel Diffuser in the Presence of a Scavenging Scoop," NavOrd 3665

Abstract: This investigation was conducted at nominal Mach numbers in the continuous NOL 18 x 18 cm closed-jet Aerophysics Tunnel No. 3. The diffuser consisted of a converging-diverging, two-dimensional variable area duct. The scavenging scoop was essentially a hollow cylinder whose axis of symmetry lay along the tunnel centerline.

Hastings, S. M. and Lehnert, R., "Spin Effects on Base Pressure of Cone Cylinders at Mach No. 2.86," NavOrd 2956

Abstract: See Lehnert, R. and Hastings, S. M.

Heybey, W. H., "Shock Distances in Front of Symmetrical Bodies," NavOrd 3594

Abstract: A method is presented to determine theoretically the distance at which a detached shock may be found in front of a symmetrical body placed at angle of attack zero into supersonic uniform flow.

Korobkin, I., "Laminar Heat Transfer Characteristics of a Hemisphere for the Mach Number Range 1.9 to 4.9," NavOrd 3841

Abstract: Pressure and heat transfer measurements were made on the hemispherical nose of a 2-inch diameter hemisphere-cylinder with laminar boundary layer flow. Pressure distributions were measured over the Mach number range from 0.26 to 4.87 and the heat transfer measurements were made in the range from 1.90 to 4.87.

Lee, R. E., "Measurements of Blockage Area Ratio, Pressure Distribution, and Boundary-Layer Transition on Hollow Cylinders," NavOrd 3650

Abstract: Wind-tunnel tests were conducted to determine the feasibility of using hollow cylinder models for boundary-layer measurements. Both internal and external flows were surveyed by pitot and static pressure probes. Boundary-layer transition locations on the inner and outer surfaces were measured. For the case of the outer surface, data were compared with transition locations measured from schlieren photographs.

Lehnert, R., and Hastings, S.M., "Spin Effects on Base Pressure of Cone Cylinders at Mach No. 2.86," NavOrd 2956

Abstract: The effect of spin on the base pressure of several 25° cone cylinder models of various lengths has been determined at zero angle of attack and Mach number 2.86. The general conclusion is drawn from this investigation that spin destabilizes the laminar boundary layer.

Peucker, M. P., "Internal Pressure Gage for Instantaneous Static and Dynamic Pressure Measurements," NavOrd 3640

Abstract: This report describes a new electrical pressure gage for measuring absolute or differential pressures as low as 10 mm of mercury full scale with an accuracy of 0.1 percent full scale or as high as one atmosphere.

Persh, J. and Winkler, E. M., "NOL Hypersonic Tunnel No. 4 Results VI: Experimental and Theoretical Investigation of the Boundary Layer and Heat Transfer Characteristics of a Cooled Hypersonic Wedge Nozzle at a Mach Number of 5.5," NavOrd 3757

Abstract: See Winkler, E. M. and Persh, J.

Platnick, A. E., Baum, G. E., and Brewbaker, W. E., "Centrifugal Compressor System for the Continuous Supersonic Wind Tunnel," NavOrd 2773

Abstract: See Baum, G. E., Brewbaker, W. E., and Platnick, A.E.

Redman, E. J. and Walter, L. W., "Needle Static-Pressure Probes Insensitive to Flow Inclination in Supersonic Airstreams," NavOrd 3694

Abstract: See Walter, L. W. and Redman, E. J.

Schmid, L. and Smart, J. S., "Tables of Some Thermodynamic Functions Which Occur in the Theory of Magnetism" NavOrd 3640

Abstract: Tables of the Brillouin function, its first derivative, and the entropy function for a paramagnetic system have been prepared.

Schwartz, R. N., "The Equations Governing Vibrational Relaxation Phenomena in Carbon Dioxide Gas," NavOrd 3701

Abstract: Relaxation equations have been developed which are applicable to the more complex case of the thermal excitation of the two lowest modes of vibration in carbon dioxide. The equations have been applied to the shock tube.

Seigel, A. E., "The Influence of Chamber Diameter on the Muzzle Velocity of a Gun With an Effectively Infinite Length Chamber," NavOrd 3635

Abstract: This report is a theoretical study of the influence of chambrage on the muzzle velocity of a gun.

Shantz, I., "Cone Static Stability Investigation at Mach Numbers 1.56 Through 4.24," NavOrd 3584

Abstract: Results are presented of a wind-tunnel investigation conducted to obtain static stability data for four different cones. The effect of model scale was studied through the use of two different size models for three configurations. Experimental data is compared with linear and non-linear theories.

Smart, J. S. and Schmid, J., "Tables of Some Thermodynamic Functions Which Occur in the Theory of Magnetism," NavOrd 3640

Abstract: See Schmid, L. and Smart, J. S.

Theodorides, P. J., "A Review of Investigation on Turbulent Flow with Heat at Smooth Walls," NavOrd 2958

Abstract: This is a survey of recent developments about turbulent motion with heat transfer at smooth walls. Characteristics are discussed for such a flow in prismatic ducts with symmetric cross sections as well as in the boundary layer of a flat plate.

Walter, L. W. and Redman, E. J., "Needle Static-Pressure Probes Insensitive to Flow Inclination in Supersonic Air Streams," NavOrd 3694

Abstract: Tests were made to develop small static pressure needle

probes insensitive to flow inclination in a two-dimensional supersonic flow. A probe configuration was obtained which could be used to measure static pressure within ± 2 percent at angles of attack from -8° to + 16° at Mach number 1.5 and from -4° to +12° at Mach number 2.5.

Winkler, E. M., "Stagnation Temperature Probes for Use at High Supersonic Speeds and Elevated Temperatures," NavOrd 3834

Abstract: Stagnation temperature probes with single platinum or gold coated shields made of silica were built for use at high supersonic speeds and elevated temperatures. A single calibration curve is obtained for each probe by relating the calibration data to the flow conditions inside the probe.

Winkler, E. M. and Persh, J., "NOL Hypersonic Tunnel No. 4 Results VI: Experimental and Theoretical Investigation of the Boundary Layer and Heat Transfer Characteristics of a Cooled Hypersonic Wedge Nozzle at a Mach Number of 5.5," NavOrd 3757

Abstract: Experimental and theoretical investigations were conducted of the nozzle wall heat transfer and boundary layer transition at a Mach number setting of the wedge nozzle of 5.5 and a constant supply temperature of 430°K. Theoretical studies give a method by which the boundary layer development and heat transfer to the nozzle wall can be computed from properly selected initial conditions and the measured position of the transition point along the nozzle wall.

VI. List of Unclassified NavOrd Reports Published During the Period 1 January 1955 - 31 December 1955

Eckerman, J. and Schwartz, R. N., "Shock Location in Front of a Sphere as a Measure of Real Gas Effects," NavOrd 3904

Abstract: See Schwartz, R. N. and Eckerman, J.

Gruenewald, K. H. and Heybey, W. H., "A Device for Slope Determinations on Curves Recorded in a Curvi-Linear System," NavOrd 2981

Abstract: A simple device is described which facilitates the determination of the gradients of any physical quantity from curves recorded in a certain curvi-linear coordinate system.

Gruenewald, K. H., Honecker, H. J., and Korobkin, I., "Blowing Time of an Open Circuit Supersonic Wind Tunnel Exhausting to a Continuously-Operating Vacuum Pumping System," NavOrd 3981

Abstract: A method is presented for estimating the blowing times of an open-circuit supersonic wind tunnel having a finite pressurized and heated supply and emptying into a vacuum vessel.

Hastings, S., "Performance of the Supersonic Open-Jet Wind Tunnel Diffuser," NavOrd 2873

Abstract: Tests were made with clear tunnel and with a typical model mounted in the test section over the Mach number range 1.2 to 5.0. The diffuser acted both as a pressure-recovery device and as a test chamber pressure regulator at Mach number 2.5 and below.

Heybey, W. H. and Gruenewald, K. H., "A Device for Slope Determinations on Curves Recorded in a Curvi-Linear System," NavOrd 2981

Abstract: See Gruenewald, K. H. and Heybey, W. H.

Honecker, H. J., Gruenewald, K. H., and Korobkin, I., "Blowing Time of an Open Circuit Supersonic Wind Tunnel Exhausting to a Continuously-Operating Vacuum Pumping System," NavOrd 3981

Abstract: See Gruenewald, K. H., Honecker, H. J. and Korobkin, I.

Kendall, J. M., "Equipment for Continuously Recording the Ratio of Two Pressures," NavOrd 4201

Abstract: To avoid the laboriousness of a point-by-point procedure in making pressure ratio surveys in supersonic wind tunnels, new equipment has been developed at NOL which accomplishes this automatically. The equipment makes use of one Statham pressure gage for measuring the supply pressure, and a second Statham gage for measuring Pitot probe pressures.

Korobkin, I., Gruenewald, K. H., and Honecker, H. J., "Blowing Time of an Open Circuit Supersonic Wind Tunnel Exhausting to a Continuously-Operating Vacuum Pumping System," NavOrd 3981

Abstract: See Gruenewald, K. H., Honecker, H. J. and Korobkin, I.

Krahn, E., "The Laminar Boundary Layer on a Rotating Cylinder in Cross Flow," NavOrd 4022

Abstract: A rotating cylinder in a stream produces a circulation which is regarded as the cause of the Magnus force. The problem is to find the dependence of the circulation on the rotational speed of the cylinder. This question is treated in the present report for a stationary flow about a circular cylinder with the axis perpendicular to the direction of the stream under the assumption that the flow in the boundary layer is laminar. Two approximate methods are used for the calculation of the boundary layer.

Krider, L. D., "A Speed Code System for the IBM Type 650 Magnetic Drum Calculator," NavOrd 4169

Abstract: A speed code system constructed by the members of the Applied Mathematics Division of NOL for use on the IBM type 650 Magnetic Drum Calculator is presented. The system is explained first in a form convenient to the user and second the basic 650 subroutines which constitute the system are described.

Lee, R. and Persh, J., "A Method for Calculating Turbulent Boundary Layer Development in Supersonic and Hypersonic Nozzles Including the Effects of Heat Transfer," NavOrd 4200

Abstract: See Persh. J. and Lee, R.

Lee, R. and Persh, J., "Tabulation of Compressible Turbulent Boundary Layer Parameters," NavOrd 4282

Abstract: See Persh, J. and Lee, R.

Liccini, L., "NOL Hypersonic Tunnel No. 4 Results 8: Development and Calibration of Mass Flow Probes in Hypersonic Flow," NavOrd 4078

Abstract: Rectangular and Circular mass flow probes were investigated at Mach numbers of 5.0 to 6.8 over a Reynolds number range from 2,000 to 34,000 based on the probe height. It was found that a boundary layer profile could be accurately measured with a mass flow probe.

Lobb, R. K., Winkler, E. M., and Persh, J., "NOL Hypersonic Tunnel No. 4 Results 7: Experimental Investigation of Turbulent Boundary Layers in Hypersonic Flow," NavOrd 3880

Abstract: Naturally turbulent boundary layers on the wall of a wedge-type water-cooled nozzle have been investigated at Mach numbers of 5.0 to 8.2 with and without steady state heat transfer to the surface. The Reynolds number based on boundary layer momentum thickness was varied from 5,000 to 13,000.

Persh, J., "A Theoretical Investigation of Turbulent Boundary Layer Flow with Heat Transfer at Supersonic and Hypersonic Speeds," NavOrd 3854

Abstract: This investigation is based on a simple physical model of the flow suggested first by Prandtl and used later by Donaldson. Comparisons between theory and experiment demonstrate that the analysis yields good results for compressible turbulent boundary layer with and without steady state heat transfer.

Persh, J., "A Theoretical Investigation of Turbulent Boundary Layer, Heat Transfer Coefficients for Supersonic and Hypersonic Flow," NavOrd 4099

Abstract: This investigation is based on a simple physical model of the flow which has been shown to yield good results for compressible turbulent boundary-layer skin-friction coefficients. The physical model consists of a laminar sublayer region with a linear velocity profile, and an outer turbulent portion with a power law velocity profile.

Persh, J. and Lee, R., "A Method for Calculating Turbulent Boundary Layer Development in Supersonic and Hypersonic Nozzles Including the Effects of Heat Transfer," NavOrd 4200

Abstract: A method for calculating the development of turbulent boundary layers in supersonic and hypersonic nozzles has been devised. A number of examples of the results obtained using the method described herein are presented.

Persh, J. and Lee, R., "Tabulation of Compressible Turbulent Boundary Layer Parameters," NavOrd 4282

Abstract: The tabulated results of an extensive series of

calculations of the momentum thickness ratio, displacement thickness ratio, and the boundary-layer shape parameter for compressible, turbulent boundary layers are presented. The power profile form of the velocity profile was used for these calculations, in conjunction with the quadratic form for the temperature profile.

Persh, J., Lobb, R. K., and Winkler, E. M., "NOL Hypersonic Tunnel No. 4 Results 7: Experimental Investigation of Turbulent Boundary Layers in Hypersonic Flow," NavOrd 3880

Abstract: See Lobb, R. K., Winkler, E. M., and Persh, J.

Redman, E. J. and Walter, L. W., "Investigation of the Flow in the Wake of a Circular Cylinder at Mach Number 2.86," NavOrd 3705

Abstract: Pitot pressure and static pressure surveys were made across the wake of a circular cylinder of 1/2-inch diameter placed perpendicular to the flow of Mach number 2.86. The cylinder extended the full height of the closed jet. Surveys were taken at six downstream stations.

Schlichting, H., "The Laminar Boundary Layer on a Spinning Body of Revolution in Axial Flow (translated by A. H. Lange)," NavOrd 4195

Abstract: The following is a translation of a paper on the development of a laminar boundary layer on a spinning body in axial flow. The summary on page 31 furnishes a concise abstract of the paper.

Schwartz, R. N. and Eckerman, J., "Shock Location in Front of Sphere as a Measure of Real Gas Effects," NavOrd 3904

Abstract: Spheres were fired at supersonic speeds into monatomic gases and into chlorine gas. By carrying out shock position measurements at several different pressures, it is possible to infer the order of magnitude of this relaxation time; the present results are in agreement with shock tube measurements of the relaxation time.

Shen, S. F., "The Steady Laminar Boundary Layer Over Flat Plate With Injection of a Different Gas," NavOrd 4235

Abstract: The steady laminar boundary layer over a flat plate with injection of a foreign gas through the plate is analyzed. The possibility of similarity solutions and an iterative scheme for such are discussed.

Walter, L. W. and Redman, E. J., "Investigation of the Flow in the Wake of a Circular Cylinder at Mach Number 2.86," NavOrd 3705

Abstract: See Redman, E. J. and Walter, L. W.

Winkler, E. M., Lobb, R. K., and Persh, J., "NOL Hypersonic Tunnel No. 4 Results 7: Experimental Investigation of Turbulent Boundary Layers in Hypersonic Flow," NavOrd 3880

Abstract: See Loss, R. K., Winkler, E. M., and Persh, J.

VII. List of Unclassified NavOrd Reports Published During the Period 1 January 1956 - 31 December 1956

Blum, E. K., "Polynomial Approximation," NavOrd 3740

Abstract: One of the most frequently encountered mathematical problems in a digital computer installation is that of curve fitting the data. Polynomials constitute one of the most economical solutions to this problem when they can be applied. The theory of polynomial approximation is rather diffuse. In this report the fundamental ideas and theorems are presented in a compact form for easy reference.

Blum, E. K., "Automatic Digital Encoding System II (ADES II)," NavOrd 4209

Abstract: The automatic digital encoding system II (ADES II) is a system for the automatic translation of mathematical formulas into programs of coded instructions for an electronic digital computer. The system consists of a formulation language, an encoder, and a digital computer. The formulation language closely resembles ordinary mathematical language, and is based on the theory of recursive functions.

Blum, E. H. and Stern, S., "An ADES Encoder for the 650 Calculator," NavOrd 4412

Abstract: An experimental model of an Encoder has been constructed to translate the mathematical language of ADES into programs for the 650 Magnetic Drum Calculator. Although this model is not recommended for production, it can be studied profitably as a source of ideas for machine techniques which can be

used in a production model. The experience gained with this model indicates that ADES is a feasible automatic programming system for computers with magnetic tape storage.

Conlan, J., "The acceleration of Metals for Detonation of One Dimension," NavOrd 4332

Abstract: The problem of the acceleration of metals by detonation in one dimension has been solved by a method developed by Von Neumann and Richtmeyer. A description of this method as applied to this particular problem is given. The solution is compared to that given by the method of characteristics.

Fleming, W. J. and Gruenewald, K. H., "Laminar Heat Transfer to a Hemisphere at Mach Number 3.2 and at Low Heat-Transfer Rates," NavOrd 3980

Abstract: See Gruenewald, K. H. and Fleming, W. J.

Gruenewald, K. H. and Fleming, W. J., "Laminar Heat Transfer to a Hemisphere at Mach Number 3.2 and at Low Heat-Transfer Rates," NavOrd 3980

Abstract: Local heat-transfer coefficients and "effective" temperatures were measured on the hemispherical noses of 2-inch diameter cylinders in laminar boundary-layer flow at Mach number 3.21. The investigation was undertaken to check and possibly to refine earlier findings at NOL on a model of the same shape but of different structure and material. Results substantially agree with the previous work at NOL, but the deviation of the heat-transfer data from theory is less than that of the earlier data at approximately the same Mach number.

Liccini, L. L., "Hypersonic Tunnel No. 4 Results IX: The Development of a Water-Cooled Strain-Gage Balance (Including Sting Effects) and its Application to a study of Normal Force of a Cone and Cone-Cylinder at Mach Numbers 5 to 8," NavOrd 4334

Abstract: A two-component internal water-cooled strain-gage balance designed to minimize temperature effects was developed for operation in the NOL 12 x 12 cm Hypersonic Tunnel No. 4. Calibration indicated that the balance is as accurate as the present-day internal strain-gage balances used in supersonic wind tunnels. Investigations of the effect of the sting on the balance readings confirmed Harkin's results obtained at a Mach number of 5.8.

Long, J. E., "Supersonic Drag Coefficients of Circular Cylinder to Mach Number 6," NavOrd 4382

Abstract: Drag coefficients were obtained for circular cylinders in free flight between Mach number 3 and 8 These drag coefficients near Mach number 3 are in good agreement with wind-tunnel data obtained by Walchner.

Persh, J., "A Study of Boundary-Layer Transition from Laminar to Turbulent Flow," NavOrd 4339

Abstract: A large amount of boundary-layer data in the region of transition from laminar to turbulent flow has been collected from a number of experimental investigations of boundary-layer flows on flat plates, circular cylinders, and airfoils. These data are for both incompressible and compressible flows without heat transfer.

Stern, S. and Blum, E. K., "An ADES Encoder for the 650 Calculator," NavOrd 4412

Abstract: See Blum, E. K. and Stern, S.

Williams, T. J. and Witt, W. R., Jr., "Reynolds Number Effect on Drag of Cone Cylinders in Free Flight," NavOrd 4007

Abstract: Experiments were performed to determine the effect of Reynolds number changes on the drag coefficient. Results show that at a fixed Mach number the drag coefficient decreased with increasing Reynolds number until transition occurs, then increases through transition and eventually becomes constant at higher Reynolds numbers throughout the range of Reynolds numbers covered.

VIII. List of Unclassified NavOrd Reports Published During the Period 1 January 1957 - 31 December 1957

Brooke, E., "Heat Transfer to Dry Ice Spheres Subjected to Supersonic Air Flow," NavOrd 5719

Abstract: Heat-transfer rates to a 5 cm. diameter dry ice sphere for Mach numbers 1.86, 2.87, and 4.25 were determined from ablation experiments. Results are compared with heat-transfer rates to a non-evaporative model subjected to the same flow conditions. This report shows that heat conduction effects internal to the dry ice model are significant especially at the highest Mach number tested where the greatest change in environmental pressure occurred.

Cornett, R. H., "Design of a Miniature High-Speed Air Turbine for Spinning Wind-Tunnel Models," NavOrd 4206

Abstract: A miniature air turbine was designed and built for spinning wind-tunnel test vehicles at speeds which would simulate the rotation of projectiles fired from rifled guns. Performance tests were carried out on the turbine to determine power output.

Danberg, J. and Winkler, E. M., "Heat-Transfer Characteristics of a Hemisphere Cylinder at Hypersonic Mach Numbers," NavOrd 4259

Abstract: See Winkler, E. M. and Danberg, J.

Darling, J. A., "Aeroballistic Research Investigation of Body-Alone Models of NOTS Rockets at Mach Number 2.48," NavOrd 4283

Abstract: Normal force and pitching moment coefficients of a family of NOTS body-alone rockets at Mach number 2.48 are presented.

Darling, J. A., "Roll Damping of the Spinner Finner Model at Mach Number 2.47," NavOrd 4502

Abstract: Presented in this report are the results of a preliminary test to determine the roll damping of the spinner finner model at a Mach number of 2.49 using a strain-gage balance system in the NOL Supersonic Tunnel No. 1.

Diaz, J. B., "On An Analogue of the Euler-Cauchy Polygon Method for the Numerical Solution of $u_{xy} = f(x,y,u,u_x,u_y)$" NavOrd 4451

Abstract: This paper develops an analogue of the classical Euler-Cauchy polygon method. The method presented here has the advantage over previously-proposed methods that only the tabulated values of the given functions σ (x) and τ (y) are required for its numerical application. Particular attention is devoted to the proof that a certain sequence of approximating functions, constructed in a specified way, actually converges to a solution of the boundary value problem under consideration.

Dmohoski, S., "Temperature Recovery Factors on a 40-Degree Cone Cylinder With Turbulent Boundary Layer at Mach Numbers 4.1 and 4.8," NavOrd 5763

Abstract: Measurements were made with and without a turbulence promoter immediately upstream of the nozzle in Supersonic Tunnel No. 2 at Mach numbers 4.1 and 4.8. Though turbulent recovery factors have been studied extensively at lower Mach numbers, only isolated investigations have been reported at Mach numbers of 4 and above. Results demonstrate that turbulent recovery factor is approximately equal to the cube root of the Prandtl number.

Fisher, E. R., Squires, R. K., and Roberts, R. C., "A Method for Designing Supersonic Nozzles Using the Centerline Mach Number Distribution," NavOrd 3995

Abstract: See Squires, R. K., Roberts, R. C., and Fisher, E. R.

Gilbert, B., "Automatic Data Handling Methods," NavOrd 4300

Abstract: This report outlines the advantages of handling scientific data automatically. It describes the operating principles of general purpose analog and digital computers, and various schemes for automatically converting scientific data into forms suitable for application to digital computers.

Groves, R. T. and Shantz, I., "Dynamic and Static Stability Measurements of the Basic Finner at Supersonic Speeds," NavOrd 4516

Abstract: Dynamic stability data in the form of damping force and moment coefficients were obtained. Static stability data in the form

of normal force and pitching moment coefficients were determined. Both dynamic and static stability coefficients are compared with free-flight results obtained in the NOL and BRL ballistics ranges.

Hastings, S. and Roberts, R. C., "Analysis of the Performance of a Two-Dimensional, Variable-Area Supersonic Wind Tunnel Diffuser With and Without Scavenging Scoop and Model," NavOrd 4384

Abstract: This report presents results of experimental and theoretical research on variable-area diffusers for closed-jet supersonic wind tunnels. A method is presented for computing diffuser performance. The experimental data and the values computed using the theoretical analysis agree quite well.

Hastings, S. and Korobkin, I., "Mollier Chart for Air in Dissociated Equilibrium at Temperatures of 2,000°K to 15,000°K," NavOrd 4446

Abstract: See Korobkin, I. and Hastings, S.

Hastings, S., Persh. J., and Redman, E., "Experimental Investigation of the Pressure Distribution on Axisymmetric Flat-Face Cone-Type Bodies at Supersonic and Hypersonic Speeds," NavOrd 5659

Abstract: This report contains the results obtained from the initial phase of an investigation of the pressure distribution on blunt body shapes at supersonic and hypersonic speeds. The experimental wind-tunnel results reported are for six variations on a general truncated cone-type body shape. The data cover a Mach number range from about 1.75 to 8.00 for bodies with 2-inch and 5-inch base diameters.

Korobkin, I. and Hastings, S., "Mollier Chart for Air in Dissociated Equilibrium at Temperatures of 2,000°K to 15,000°K," NavOrd 4446

Abstract: A Mollier diagram has been constructed for the thermodynamic properties of argon-free air in dissociated equilibrium for temperatures up to 15,000°K from tables computed by Hilsenrath and Beckett (NBS). By means of the diagram the thermodynamic state points for various processes in air at high temperatures may now be quickly determined with a fair degree of accuracy, obviating the need for lengthy and laborious interpolation in the Hilsenrath and Beckett tables.

Krahn, E., "The Storage Heater for Tunnel No. 8 at NOL," NavOrd 4449

Abstract: For the prescribed design conditions of Hypersonic Tunnel No. 8 the size of the heater and the characteristics of its performance are calculated.

Lee, R., Persh., "A Method for Calculating Turbulent Boundary-Layer Development in Supersonic and Hypersonic Nozzles Including the Effects of Heat Transfer," NavOrd 4200

Abstract: See Persh, J. and Lee, R. E.

Lee, R. E. and Persh, J., "Tabulation of Compressible Turbulent Boundary Layer Parameters," NavOrd 4282

Abstract: See Persh, J. and Lee, R. E.

Long, J., "Effects of Mass Asymmetry on the Pitching and Yawing Motion of a Missile," NavOrd 4433

Abstract: Experimental tests have been made to verify the adequacy of the tricyclic theory of motion of an asymmetrical missile. Three types of 20-mm cone cylinder models were fired in the Pressurized Ballistics Range.

Menzel, W., "Computing of Aerodynamic Coefficients from Raw Data Coefficients with Analog Methods," NavOrd 4532

Abstract: The algebraic equations for the aerodynamic coefficients are transferred by analog computational methods into equivalent electronic circuits using operational amplifiers. A strain-gage balance calibration is described which provides for the initial computer setting and gives an automatic check of the proper computing setting.

Persh, J. and Witt, W. R., Jr., "A Correlation of Free-Flight Transition Measurements on Various Blunt Nose Shapes by Use of the Momentum Thickness Reynolds Number," NavOrd Report 4400

Abstract: See Witt, W. R., Jr. and Persh, J.

Persh, J. and Lee, R. E., "A Method for Calculating Turbulent Boundary-Layer Development in Supersonic and Hypersonic Nozzles Including the Effects of Heat Transfer," NavOrd 4200

Abstract: A method for calculating the development of turbulent

boundary layers in supersonic and hypersonic nozzles has been devised. Although the present method is basically the same as that previously used, it contains several improvements and also includes the previously neglected effects on heat transfer.

Persh, J. and Lee, R. E., "Tabulation of Compressible Turbulent Boundary Layer Parameters," NavOrd 4282

Abstract: For these calculations the power profile form of the velocity profile was used in conjunction with the quadratic form for the temperature profile. Results are presented for power profile exponents 5, 7, 9, and 11; Mach numbers from 0 to 20; and a range of heat transfer parameters from -10 to +10.

Persh, J., "A Procedure for Calculating the Boundary-Layer Development of the Region of Transition from Laminar to Turbulent Flow," NavOrd 4438

Abstract: The method for calculating the development of the boundary layer in the region of transition from laminar to turbulent flow is given. This method is based on empirical correlations of a large amount of experimental velocity profile data in the transition region for incompressible and compressible flows with and without pressure gradients. The velocity profile correlations and an assumed skin-friction law are used in conjunction with the boundary-layer momentum equation to predict the development of the boundary-layer parameters. Several examples are given which illustrate the boundary-layer profile history in the transition region of general body shapes.

Persh, J., Hastings, S., and Redman, E., "Experimental Investigation of the Pressure Distribution on Axisymmetric Flat-Face Cone-Type Bodies at Supersonic and Hypersonic Speeds," NavOrd 5659

Abstract: See Hastings, S., Persh, J., and Redman, E.

Pomerantz, J., Winkler, E. H., and Seigel, A. E., "Thermodynamic Properties and One-Dimensional Flow of a Partially Ionized Monatomic Gas," NavOrd 4222

Abstract: Formulae are presented for the calculation of the thermodynamic properties and the one-dimensional flow of a monatomic gas which becomes partially ionized and electronically excited. Equations are given for isentropic flow and for the conditions in a hypersonic shock tunnel under the assumption that radiation losses can be neglected.

Redman, E., Hastings, S., and Persh, J., "Experimental Investigation of the Pressure Distribution on Axisymmetric Flat-Face Cone-Type Bodies at Supersonic and Hypersonic Speeds," NavOrd 5659

Abstract: See Hastings, S., Persh, J., and Redman, E.

Roberts, R. C., Squires, R. K., and Fisher, E. R., "A Method for Designing Supersonic Nozzles Using the Centerline Mach Number Distribution," NavOrd 3995

Abstract: See Squires, R. K., Roberts, R. C., and Fisher, E.R.

Roberts, R. C. and Hastings, S., "Analysis of the Performance of a Two-Dimensional, Variable-Area Supersonic Wind Tunnel Diffuser With and Without Scavenging Scoop and Model," NavOrd 4384

Abstract: See Hastings, S. and Roberts, R.

Seigel, A. E., Pomerantz, J., and Winkler, E. H., "Thermodynamic Properties and One-Dimensional Flow of a Partially Ionized Monatomic Gas," NavOrd 4222

Abstract: See Pomerantz, J., Winkler, E. H., and Seigel, A. E.

Seigel, A. E., "Theoretical Study of the Effect of the Non-Ideality of a Dense Shocktube Driver Gas With Special Reference to Non-Uniform Shocktubes," NavOrd 5707

Abstract: It is shown that the performance of a dense driver gas in a shocktube may be considerably different from an ideal driver gas as a result of the attractive and repulsive forces which exist between the gas molecules. An amazing result of the density effect is that at moderately high densities the non-ideality may decrease the driving efficiency in a uniform shocktube while in a non-uniform shocktube it increases the driving efficiency.

Shanks, D. and Walton, Thomas S., "A New General Formula for Representing the Drag on a Missile Over the Entire Range of Mach Number," NavOrd 3634

Abstract: An analysis of previous formulae used for representing the drag on a missile as a function of the Mach number shows the desirability of developing a new formula. This is done with the result that a simple formula is now available for fitting drag data throughout the entire range of Mach number--subsonic, transonic, and supersonic.

Shantz, I. and Croves, Robert T., "Dynamic and Static Stability Measurements of the Basic Finner at Supersonic Speeds," NavOrd 4516

Abstract: See Groves, R. T. and Shantz, I.

Shen, S., "The Theory of Stability of Compressible Laminar Boundary Layers with Injection of a Foreign Gas," NavOrd 4467

Abstract: The stability theory of laminar boundary layers with regard to infinitesimal disturbances is extended to the case involving binary gas mixtures, as may occur when a different coolant is injected into the free-stream through pores along the surface. The "inviscid" solutions are given. The "viscous" solutions, asymptotic solutions, and eigenvalue problem are discussed.

Squires, R. K., Roberts, R. C., and Fisher, E. R., "A Method for Designing Supersonic Nozzles Using the Centerline Mach Number Distribution," NavOrd 3995

Abstract: This report describes a new method for computing supersonic nozzle potential flow contours which is based on a combination of three existing theories.

Walton, Thomas S., "Numerical Integration by a Method of Interlocked Parabolas," NavOrd 3892

Abstract: A general numerical method for integrating systems of first-order differential equations is described. Two integration formulas are given. Formulas are also given for estimating the sizes of the associated truncation errors.

Walton, Thomas S. and Shanks D., "A New General Formula for Representing the Drag on a Missile Over the Entire Range of Mach Number" NavOrd 3634

Abstract: See Shanks, D. and Walton, Thomas S.

Winkler, E. H., Pomerantz, J., and Seigel, A. E., "Thermodynamic Properties and One-Dimensional Flow of a Partially Ionized Monatomic Gas," NavOrd 4222

Abstract: See Pomerantz, J., Winkler, E. H., and Seigel, A. E.

Winkler, E. M. and Danberg, J., "Heat-Transfer Characteristics of a Hemisphere Cylinder at Hypersonic Mach Numbers," NavOrd 4259

Abstract: The heat-transfer characteristics of the laminar compressible boundary layer on a hemisphere cylinder were investigated at free-stream Mach numbers of 5, 6.5 , and 8. The Reynolds number was varied from 70,000 to 700,000. Various conditions of steady-state heat transfer to the model were realized by circulating a coolant through the model and by varying the tunnel supply air temperature. The heat transfer was evaluated from the temperature differences measured across the model wall under steady-state conditions.

Winkler, E. M., Pomerantz, J., and Seigel, A. E., "Thermodynamic Properties and One-Dimensional Flow of a Partially Ionized Monatomic Gas," NavOrd 4222

Abstract: See Pomerantz, J., Winkler, E. M., and Seigel, A.E.

Witt, W. R., Jr. and Persh, J., "A Correlation of Free-Flight Transition Measurements on Various Blunt Nose Shapes by Use of the Momentum Thickness Reynolds Number," NavOrd 4400

Abstract: A systematic series of blunt nose shapes has been fired in the Pressurized Ballistics Range for boundary-layer transition studies. The transition of the boundary-layer flow from laminar to turbulent is determined directly from the shadowgraph plates.

Witt, W. R., Jr., "Spark Shadowgraph Pictures from Tests with Two 20-mm Muzzle Blast Reducers," NavOrd 5759

Abstract: An investigation of the performance of two muzzle blast reducers for a 20-mm barrel has been carried out in the NOL Block Mount Range. Spark shadowgraph pictures were taken in order to obtain a qualitative measure of the muzzle blast intensity. No analysis of the data was made at NOL.

IX. List of Unclassified NavOrd Reports Published During the Period 1 January 1958 - 31 December 1958

Brenner, F., "Special Purpose Analog Computer for Real Time Reduction of Wind Tunnel Force and Moment Data," NavOrd 6125

Abstract: This report describes the design and operation of an

analog computer which is used for real time computation of wind tunnel force and moment data. The computer operates in conjunction with the wind tunnel Automatic Data Processing System (ADAPS) and is used in aerodynamic tests in the NOL intermittent supersonic wind tunnel.

Conlan, James, "The Cauchy Problem and the Mixed Boundary Value Problem for a Non-Linear Hyperbolic Partial Differential Equation in Two Independent Variables," NavOrd 6107

Abstract: This report proves existence theorems for the partial differential equation

$$u_{xy} = f \quad x,y,\ u(x,y),\ u_x(x,y),\ u_y(x,y)$$

for the Cauchy problem and the mixed boundary value problem. The methods of proof are such as to lead directly to simple numerical methods for the construction of numerical solutions to these two problems.

Greene, John E., "An Investigation of the Rolling Motion of Cruciform-Fin Configurations," NavOrd 6262

Abstract: An experimental investigation of the rolling motion of a cruciform fin-alone and body-fin configuration at angles of attack through 90 degrees has been made by NOL. It has been found that large variations in the steadystate rolling velocity occur with change in angle of attack. The mechanism causing these variations is discussed.

Hall, R. T., "The Lift and Drag on a Rotating Cylinder in Supersonic Crossflow," NavOrd 6039

Abstract: Experimental results are presented in the lift and drag on a rotating cylinder in supersonic crossflow. The data were obtained using smooth and roughened, two-dimensional, 3-inch diameter cylinders. A discussion of the data is presented in which variations within the three parameters (Mach number, rotational speed, and Reynolds number) are shown, along with magnitudes of the lift and drag. A further review of the data presents possible correlations with similar subsonic data.

Lehnert, R. and Schermerhorn, V. L., "Wake Investigation on Sharp and Blunt Nose Cones at Supersonic Speeds," NavOrd 5668

Abstract: The relationship between local flow conditions at the downstream end of sharp nose and spherical nose, 10-degree semi-apex angle cones and the corresponding base pressure and wake flow configuration was studied at supersonic speeds. Base pressure and wake angle were found to be the same for both the sharp and the blunt nose cone when the local Mach number and momentum thickness Reynolds number at the end of the cone surface was the same.

Luchuk, W., "The Dependence of the Magnus Force and Moment on the Nose Shape of Cylindrical Bodies of Fineness Ratio 5 at a Mach number of 1.75," NavOrd 4425

Abstract: This report presents the results of wind-tunnel measurements of the Magnus force and moments on cylindrical bodies of fineness ratio 5 at a free-stream Mach number of 1.75 and a Reynolds number of 5.5 million (based on model length).

Orlow, Theodore A., "Numerical Solution of LaPlace's Equation for Various Three Dimensional Regions with Axial Symmetry," NavOrd 6038

Abstract: This report discusses the application of the Liebmann method of solving partial differential equations by iteration and over-relaxation on a digital computer to the problem of steady-state heat transfer in shapes composed of a spherical cap on either a conical or cylindrical body.

Pomerantz, J., "The Influence of the Absorption of Radiation in Shock Tube Phenomena," NavOrd 6136

Abstract: A method is developed for finding the influence of radiation absorption on the gas flow variables behind strong shock waves. The effects of the lowering of the ionization potential are also considered.

Schermerhorn, V. L. and Lehnert, R., "Wake Investigation on Sharp and Blunt Nose Cones at Supersonic Speeds," NavOrd 5668

Abstract: See Lehnert, R. and Schermerhorn, V. L.

X. List of Unclassified NavOrd and NavWeps Reports Published During the Period 1 January 1959 - 31 December 1959

Brady, John J., and Nicolaides, J. D., "Magnus Moment on Pure Cones in Supersonic Flight," NavOrd 6183

Abstract: See Nicolaides, J. D. and Brady, John J.

Cha, Moon H. and Winkler, Eva M., "Investigation of Flat Plate Hypersonic Turbulent Boundary Layers with Heat Transfer at a Mach Number of 5.2," NavOrd 6631

Abstract: See Winkler, Eva M. and Cha, Moon H.

Chamberlin, A. A. and Jusino, J. B., "Range Studies of Boundary-Layer Transition on 8-inch Hemisphere Cylinders," NavOrd 6182

Abstract: See Jusino, J. B. and Chamberlin, A. A.

Chones, A. J., "Heat-Transfer and Pressure Measurements on Flat-Faced Flared-Tail Circular Cylinders and Normal Disks," NavOrd 6669

Abstract: Experimental pressure and temperature distribution data were obtained. The disk measurements permitted an extremely accurate determination of the velocity gradient at the stagnation point. Comparison of the heat-transfer determinations is made with theory, and the agreement is within 10 percent.

Crogan, Leonard E., "Drag and Roll Coefficients at Subsonic to Supersonic Velocities of 1/7-Scale Free-Flight Models of the 1,000 Pound Low-Drag Bomb (EX-10)," NavOrd 6661

Abstract: Drag and roll coefficients at various velocities have been obtained for the Low-Drag Bomb (EX-10) by firing 1/7-scale models of the 1,000 pound bomb in the NOL Aerodynamics Range. Drag coefficients for models with and without carrying lugs were corrected to zero yaw. Roll coefficients for models with carrying lugs were also corrected to zero yaw.

Danberg, James E., "Measurement of the Characteristics of the Compressible Turbulent Boundary Layer with Air Injection," NavOrd 6683

Abstract: Turbulent boundary-layer velocity and temperature profiles were measured on a porous flat plate. Experimental temperature and velocity profiles and the associated skin-friction coefficients were compared with the theories of Rubesin and Persh.

Dawson, V. C. D., "Piston Type Strain Gages," NavOrd 6251

Abstract: For the past several years piston-type strain gages have been used at the NOL's ballistic range facilities to record pressures. The theory used to predict the frequency response, sensitivity and pressure limit of such gages is presented in this report.

Enkenhus, Kurt R., "The Flight Environment of Long-Range Ballistic Missiles and Glide Vehicles," NavOrd 6745

Abstract: The flow conditions encountered in the flight of long-range ballistic missiles and glide vehicles are reviewed. Flow parameters were calculated using the flight trajectory equations of Eggers, Allen and Niece with a simplified atmospheric model. Graphs are given indicating the relationships of aerodynamic drag and heating, real-gas effects, and rarefied-gas phenomena to vehicle trajectories. It is concluded that rarefied-gas effects are dominant in the decay of satellite orbits but are of little importance in most surface-to-surface missions. The most severe environmental conditions are encountered in hypersonic continuum flow.

Jusino, J. B. and Chamberlin, A. A., "Range Studies of Boundary-Layer Transition on 8-inch Hemisphere Cylinders," NavOrd 6182

Abstract: The purpose of this study was to obtain experimental evidence of boundary-layer transition on a spherical nose at high Reynolds numbers and subsonic Mach numbers. Velocities obtained were high subsonic (Mach number 0.8) and the Reynolds numbers were approximately 4×10^6. Boundary-layer transition was observed from direct spark shadowgraph pictures.

Kendall, James M., "Portable Automatic Data Recording Equipment (PADRE)", NavOrd 4207

Abstract: The PADRE provides a means of automatically punching IBM cards to record data on pressures, forces and moments, temperatures, small temperature differences, mean square values of turbulence, positions of probes during boundary-layer surveys, angles of attack of models in wind tunnels, and any other quantity represented by a voltage, either A.C. or D.C. Because of its portability and versatility, PADRE is particularly useful for research work that requires special set-ups.

Krahn, Edgar and Powers, John O., "Heat Transfer in Dissociated Air By a Two-Thickness Integral Method," NavOrd 6673

Abstract: See Powers, John O. and Krahn, Edgar

Nicolaides, J. D. and Brady, John J., "Magnus Moment on Pure Cones in Supersonic Flight," NavOrd 6183

Abstract: By aeroballistic range techniques, the Magnus moment is measured on 20-degree pure cones at a supersonic Mach number of about 2. The results indicate that the Magnus moment may be critically dependent on the nature of the boundary layer. The normal force and damping moment are also found to be significantly dependent on the nature of the boundary layer. The characteristics of the boundary layers are revealed in the spark shadowgraphs of the aeroballistic range technique and its transient and sometimes chaotic character noted.

Parr, W. E., "Upper and Lower Bounds for the Capacitance of the Regular Solids," NavWeps 6318

Abstract: Upper and lower bounds are given for the Dirichlet integral, principally based on an extension of a method of Polya and Szego. Numerical bounds are calculated for the capacitance of the five regular solids.

Powers, John O. and Krahn, Edgar, "Heat Transfer in Dissociated Air By a Two-Thickness Integral Method," NavOrd 6673

Abstract: A theoretical investigation of the compressible laminar boundary layer including the effects of dissociated air in equilibrium has been conducted by a two-thickness integral method. The method has been used for determining stagnation point heat-transfer and boundary-layer characteristics at pressures near one atmosphere and for wall and stream temperatures ranging from 400°R to 3,000°R and 600°R to 14,000°R respectively.

Shen, S. F., "Some Considerations of the Laminar Stability of Incompressible Time-Dependent Basic Flows," NavOrd 6654

Abstract: The concept of "momentary stability" is proposed as a stability criterion for infinitesimal disturbances in a time-dependent basic flow, and is said to exist when the ratio of kinetic energy of the disturbances to the kinetic energy of the basic flow tends to

decrease instantaneously. Stability phenomena for unsteady basic flows are analyzed for the case of the inviscid limit. For finite Reynolds numbers it is shown that stability calculations based on instantaneous profiles are valid only for extremely small accelerations or decelerations, and generally the neutral curve so obtained has little significance.

VanTuyl, A., "The Use of Rational Approximations in the Calculations of Flows with Detached Shocks," NavOrd 6679

Abstrac t: Calculations by VanDyke indicate that the Taylor series for the stream function behind an axially symmetric bow shock in the neighborhood of the nose does not converge at the body. In this report is shown that certain sequences of Pade fractions obtained from the Taylor series seem to converge at the bcdy and can be used for calculation of the flow.

Winkler, Eva M. and Cha, Moon H., "Investigation of Flat Plate Hypersonic Turbulent Boundary Layers with Heat Transfer at a Mach Number of 5.2," NavOrd 6631

Abstract: Naturally turbulent boundary layers on a flat plate have been investigated at several distances from the leading edge of the plate for three rates of steady-state heat transfer to the surface. The results support the validity of Colburn's version of Reynolds analogy for all conditions of the present experiments. For a fixed value of the momentum thickness Reynolds number, the skin-friction coefficient was found to decrease with increasing rate of heat transfer to the surface. A simple relation has been devised which describes closely the variation of the skin-friction coefficient with Mach number, heat-transfer rate, and momentum thickness Reynolds number.

XI. List of Unclassified NavOrd and NavWeps Reports Published During The Period 1 January 1960 - 31 December 1960

Bramble, J. D., "Continuation of Solutions of the Equations of Elasticity Across a Spherical Boundary," NavOrd 6739

Abstract: Let u_i and τ_{ij} satisfy: (a) $\Delta u_i + \frac{1}{1-2\Delta} u_{j,ji} = 0$, and (b) $\Delta \tau_{ij} + \frac{1}{1+\Delta} \tau_{kk,ij} = 0$ in the three dimensional region D, a portion of whose boundary Q is an open subset of $r = a$.

Let $p \in D$ and i' be inverse point with respect to the sphere $r = a$. If for all $p \in D$ the line joining p and p' is completely contained in $D^* = DUD'UQ$ where D' is the reflection of D in $r = a$, then u_i and τ_{ij} may be continued into D* as solutions of (A) and (B) respectively provided that on Q, (1) $u_i = 0$, (2) $x_j \tau_{ij} = 0$, or, even more generally (3) $a_1 x_j \tau_{ij} + a_2 u_1 = 0$ (a_1, a_2, constants).

Furthermore, in each case, if $p \in D$ then the values of u_i and τ_{ij} at p' may be computed explicitly in terms of the known values of u_i and τ_{ij} in D. Conditions (1) have been treated previously by the author in a paper to appear in the Proceedings of the London Mathematical Society. The present treatment of this case is slightly different and yields a considerably simpler form of the results.

Butler, J. B., "A FORTRAN II (IBM 704) Subroutine for the Solution of Ordinary Differential Equations with Automatic Linkage Termination and Output Features," NavOrd 6701

Abstract: A FORTRAN II integration subroutine is described. The program provides automatic termination and output features and is written in a manner which simplifies linkage with other programs or subprograms. This subroutine greatly speeds up the programming of many problems such as trajectory computations. A complete listing of the subroutine is included in the report.

Conlan, J., "An Existence Theorem for the Equation $u_{xyz} = f$" NavOrd 6921

Abstract: This paper proves an existence theorem for a boundary value problem for the partial differential equation

$$u_{xyz} = f(x, y, z, u, u_x, u_z, u_{xz}, u_{yz})$$

The method of proof is such as to lead directly to a simple scheme for the numerical solution of such a problem.

Conlan, J., Diaz, J. B., and Parr, W. E., "On the Capacity of the Icosahedron," NavWeps 7302

Abstract: The numerical estimation of the capacity is one of the chief examples of the actual application of variational methods. The main purpose of the present report is to obtain upper bounds for the capacity of a regular solid by means of a simple trial function.

Dawson, V. C. D., "Elastic and Plastic Stress Equations for Hollow Cylinders and Spheres Subjected to Internal and External Pressure," NavOrd 6786

Abstract: The equations used to design high-pressure vessels, both cylindrical and spherical, are given. Where strength requirements are not severe, the elastic equations, together with the distortion energy theory of failure, are used. For chambers having high-pressure requirements, it is necessary to resort to a shrink fit or autofrettage construction. The equations for these processes are derived herein. A short discussion of bursting strength of high-pressure chambers is also included.

DeMeritte, F. J., "The Correlation of Range and Wind-Tunnel Dynamic Stability Measurements," NavOrd 6765

Abstract: NOL has been making dynamic stability investigations in supersonic wind tunnels since 1950. These data were derived from measurements of pitch damping, roll damping, and Magnus forces and moments. The techniques used for making these measurements in wind tunnels are described briefly, and data are compared with ballistic range results.

DeMeritte, F. J. and Shantz, I., "Limited Wind-Tunnel Tests of the Mk 89 Practice Bomb," NavOrd 6852

Abstract: This report presents the results of an investigation in the NOL Supersonic Tunnel to determine the pitch stability and drag of the Mk 89 Practice Bomb.

Diaz, J. B., Conlan, J., and Parr, W. E., "On the Capacity of the Icosahedron," NavWeps 7302

Abstract: See Conlan, J., Diaz, J. B., and Parr, W. E.

Douglis, Avron, "On Discontinuous Solutions of Quasi-Linear, First Order Partial Differential Equations," NavOrd 6775

Abstract: Economical ways to calculate the action and interaction of shocks in the solution of non-linear hyperbolic differential equations are well tested empirically but have not been completely founded in theory. In this report theoretical justifications are given of a family of such methods for a simple equation.

Douglis, Avron, "On Calculating Solutions of Quasi-Linear, First Order Partial Differential Equations," NavWeps 7254

Abstract: In the case of a simple type of equation, we shall give convergence proofs for a class of explicit tempering schemes including versions of the von Newmann-Richtmyer, and the Lax-Wendroff methods. These results supplement those of a previous report devoted to tempering schemes of implicit type (and to an explicit scheme with linear viscosity).

Galloway, Howard L., "Pressure Distribution Over Models of Dome and Arch Structures," NavOrd 6699

Abstract: This report presents the results of an investigation in the NOL Supersonic Tunnel No. 2 to measure the static pressure distribution over dome-shaped buildings and arch-shaped buildings. These data were obtained to provide information on instantaneous airloads acting on protective structures exposed to air blasts.

Gates, D. F. and Watt, J. W., "Stagnation Point Heat Transfer to a Sphere in the NOL 6-inch Shocktube," NavOrd 6788

Abstract: Heat-transfer measurements with a calorimeter-type heat-transfer gage were taken on 3/4-in. and 1-in. diameter spheres. Shock strengths of Mach number 3 to 5 into 30 millimeters (Hg) of air produced high-temperature flows of approximately one-half millisecond duration. The experimental stagnation point heat-transfer values were determined and compared with the values predicted by the theory of Fay and Riddell.

Hastings, S. M. and Chones, A. J., "Supersonic Aerodynamic Heating of a Yawed Sphere-Cone Wind-Tunnel Model," NavOrd 6812

Abstract: The steady-state pressure and heat-transfer distributions on a sphere-cone configuration with laminar boundary layer have been determined in a wind tunnel at yaw angles 0 degrees and 6 degrees, and at nominal Mach numbers 3 and 5. Comparison of the 0 degree yaw local heat-transfer rates with those of the windward body streamline at 6 degrees yaw show a maximum increase for corresponding body stations of approximately 100 percent. The 0 degree yaw heat-transfer results show good agreement with the recent theory of Powers and Krahn.

Hubbard, Bert, "Bounds for Eigenvalues of the Free and Fixed Membrane By Finite Difference Methods," NavOrd 6874

Abstract: This paper gives explicit upper and lower bounds for the eigenvalues of both free and fixed membrane problems in terms of eigenvalues of analogous finite difference problems.

Korobkin, Irving, "The Effects of Electronic Exchange on the Efficiency of Vibrational Excitation by Molecular Collisions," NavWeps 7268

Abstract: A theoretical study has been made of the mechanism for the transfer of molecule translation energy into the internal energy of vibration by molecular collisions. Research considered the interaction between molecules which can combine chemically to form a covalent bond.

Korobkin, Irving, "The Effects of the Molecular Properties of an Injected Gas on Compressible Air Laminar Boundary Layer Skin Friction and Heat Transfer," NavWeps 7410

Abstract: This study was made using a rigid sphere model for describing transport properties of 27 hypothetical gases. Specific heat was computed from the equipartition of energy. Research demonstrated that small molecular weight and large molecular diameter reduced skin friction and heat transfer most effectively.

Lankford, J. L., "Preliminary Results of Flow Surveys about an Inclined Body of Revolution at Mach Number 3.5 (Phase I of Aft-Entry Program)," NavOrd 6708

Abstract: An experimental study of the flow field about an ogive-nosed body of revolution has been made and results evaluted with consideration of the effects of the flow field on multiple, aft-inlet installations. Surveys were made with a combination Pitot-conical probe developed for previous flow field studies.

Lankford, J. L., "The Effect of Heat Transfer on the Separation of Laminar Flow over Axisymmetric Compression Surfaces - Preliminary Results at Mach Number 6.78," NavWeps 7402

Abstract: The strong effect of heat transfer on the laminar separation phenomena on hypersonic compression surfaces has been clearly demonstrated using a simple transient model technique. These preliminary hypersonic tunnel results confirm previous theoretical and experimental work done at this Laboratory and demonstrate the feasibility of the experimental technique employed.

Lundquist, G. A., "A Pressure-Telemetering System for Gun-Launched Models," NavOrd 6730

Abstract: A pressure-telemetering system has been developed for measuring and telemetering base pressures on models launched at transonic speeds in a ballistic range. A simple and rugged transistorized FM-FM telemetering transmitter was contained in a small, cylindrical model. Details of construction and circuitry are given and typical results are presented.

Parr, W.E., Conlan, J., and Diaz, J. B., "On the Capacity of the Icosahedron," NavWeps 7302

Abstract: See Conlan, J., Diaz, J. B., and Parr, W. E.

Seigel, A. E. and Slawsky, Z. I., "A Two-Stage Driver for Shocktubes and Shock Tunnels," NavOrd 5669

Abstract: This report discusses a method of improving the performance of the driver for shocktubes and shocktube wind tunnels. The basic principle is the use of a chemical reaction to produce a low-molecular weight, high-temperature gas and then a shock to further compress and heat this gas. This two-stage scheme has previously been presented in NavOrd Report 4345 where it was applied to high-speed guns. Here the performance of shocktube and shocktube wind tunnel using such an improved driver is described.

Slawsky, Z. I. and Seigel, A. E., "A Two-Stage Driver for Shocktubes and Shock Tunnels," NavOrd 5669

Abstract: See Seigel, A. E. and Slawsky, Z. I.

Watt, J. W. and Gates, D. F., "Stagnation Point Heat Transfer to a Sphere in the NOL 6-inch Shocktube," NavOrd 6788

Abstract: See Gates, D. F. and Watt, J. R.

XII. List of Unclassified NavOrd Reports, NavWeps Reports, and NOLTR's Published During the Period 1 January 1961 - 31 December 1961

Bixler, D. N. and Gates, D. F., "The Measurement of Aerodynamic Forces and Moments in the NOL 4-in. Hypersonic Shock Tunnel No. 3," NOLTR 61-100

Abstract: See Gates, D. F. and Bixler, D. N.

Crogan, Leonard E., "Drag and Stability Data Obtained from Free-Flight Range Firings Within the Mach Number Range of 0.4 to 3.0 for Several Cylindrical Configurations," NavOrd 6731

Abstract: Tests were conducted on several cylindrical configurations to determine their drag and stability characteristics. The configurations consisted of four types: three types of fin-cylinders and an offset C.G. cylinder; i.e., one whose C.G. is off the axis of the cylinder. These were fired within the Mach number range of 0.4 to 3.0.

Dawson, V. C. D., "Pressure-Gage Design for the Measurement of Pressures in Shocktube Wind Tunnels, Shock Tubes and Guns," NavWeps 7326

Abstract: This report describes the pressure-gage design and circuitry of the piston-type strain gages which are used by NOL for the measurement of pressures in shocktube wind tunnels, shocktubes, and guns. The pressures measured with gages of this type cover the range from a few psi to over 1,000 psi.

Dawson, V. C. D., "Measurement of Shock Velocity by Means of a Strain Gage," NOLTR 61-116

Abstract: One of the measurements usually made in a shocktube or shocktube wind tunnel is that of shock velocity. Several techniques have been successfully developed in past years. However, all require a transducer which is inserted through the shocktube wall. A strain-gage system has been developed recently which provides reliable results with the necessity of machining the tube wall. This report deals with this technique and the results obtained.

Dawson, V. C. D., Noonan, B. J., and Waser, R. H., "Experimental Stress Analysis of a Spherical Combustion Chamber," NavWeps 7319

Abstract: The advantages of spherical combustion chambers with respect to strength and ignition make their use particularly desirable for shock tunnels and high-speed launchers. The difficulties of design and fabrication have generally limited their widespread application. A spherical type of chamber has been designed and fabricated during the past year. This report describes the experimental stress analysis of the chamber that was made during its acceptance test, together with the subsequent modification of the chamber.

DeMeritte, F. J. and Schermerhorn, V., "Wind Tunnel Tests of the Navy Low-Drag Bomb at Angles of Attack up to 70 Degrees," NavOrd 7291

Abstract: See Schermerhorn, V. and DeMeritte, F. J.

Eckerman, Jerome, "The Measurement of the Rate of Dissociation of Oxygen at High Temperatures," NavOrd 6724

Abstract: A new technique is described with which reaction rates in gases can be determined at high temperatures. A mechanism of the shock location in front of a sphere traveling at supersonic speeds is proposed. Then the relation between the shock separation distance and the rate of dissociation is discussed. The method is applied to the dissociation of diatomic oxygen.

Gates, D. F. and Bixler, D. N., "The Measurement of Aerodynamic Forces and Moments in the NOL 4-in. Hypersonic Shock Tunnel No. 3," NOLTR 61-100

Abstract: Light-weight models of missiles are suspended by fine threads in the shock tunnel test section. These models, along with a similarly suspended sphere, break free from their supporting threads and experience free flight at flow initiation. Motion of the models and sphere is recorded photographically with a high-speed framing camera and coordinates are read from the resulting film strips. Methods of analysis are discussed for determining aerodynamic force and moment coefficients from resulting data.

Gleyzal, Andre, "The Rotation Vector in Computing Trajectories," NOLTR 61-48

Abstract: This report considers a set of variables and equations relating angular velocity and orientation of a rigid body. Three independent variables define an orientation of these variables and time derivatives are related to transformation tensor and angular velocities by means of functions which are rational functions free of singularities except for square root function.

Glick, Irving, "On An Analogue of the Euler-Cauchy Polygon Method for the Partial Differential Equation $u_{x_1 \cdots x_n} = f$," NOLTR 61-26

Abstract: This paper gives constructive proofs of existence theorems for two cases of the partial differential equation $u_{x_1 \ldots x_n} = f$ where f is a function of $x_1 \ldots x_n$, u and the pure mixed partial derivatives of u up through order n-1. The method used is an

analogue of the Euler-Cauchy polygon method and yields a numerically feasible procedure for constructing solutions. Two inequalities of independent interest are proved as lemmata for the existence proofs, and the properties of an interesting class of interpolaratory functions are obtained.

Hill, L. L. and Marshall, T., "Propagation of Plane Electromagnetic Waves Through Lossy Dielectric Media," NavWeps 7311

Abstract: Starting with the electromagnetic field equations, the necessary formulae for describing the propagation of plane electromagnetic waves through a series of dielectric slabs are derived. The results take the form of amplitude reflection and transmission coefficients as functions of the complex conductivity of the dielectrics. The special case of an unknown medium contained between low-loss windows designed as half-wave plates is considered and the simplified equations are presented.

Kendall, James M., "Method of Measuring the Thermal Diffusivity and Specific Heat of an Ablating Body," NavOrd 5771

Abstract: A method is presented for measuring as a function of temperature, the heat capacity and the thermal diffusivity of a material. From these quantities, the thermal conductivity is easily obtained. The method is capable of giving data up to the failing temperature of the thermocouples.

Kilmer, E. Eugene and Montgomery, Rayner A., "The Development of an Explosive High-Pressure Release," NavWeps 7327

Abstract: See Montgomery, Rayner A. and Kilmer, E. Eugene

Levine, David, "Acceleration-Compensating Pressure Transducers for Surface-Pressure Measurements," NavOrd 6834

Abstract: This transducer consists of a pressure-sensing element and an acceleration-compensating element. Tests in the NOL shocktube and in the shocktube wind tunnels have shown that the transducer gives accurate pressure information for the aerodynamic conditions generated in these facilities.

Marshall, T. and Hill, L. L., "Propagation of Plane Electromagnetic Waves Through Lossy Dielectric Media, " NavWeps 7311

Abstract: See Hill, L. L. and Marshall, T.

Montgomery, Rayner and Kilmer, E. Eugene, "The Development of an Explosive High-Pressure Release," NavWeps 7327

Abstract: An experimental investigation was conducted to determine the feasibility of using explosives as a diaphragm for sudden release of high-pressure gas. Although the contemplated use is that of a muzzle diaphragm to release the working gas in a hypersonic shock tunnel, this type of pressure release may be adaptable to other applications.

Noonan, B. J., Dawson, V. C. D. and Waser, R. H., "Experimental Stress Analysis of a Spherical Combustion Chamber," NavWeps 7319

Abstract: See Dawson, V. C. D., Noonan, B. J., and Waser, R.H.

Rast, J. J., "The Design of Flat-Scored High-Pressure Diaphragm for Use in Shock Tunnels and Gas Gun," NavOrd 6865

Abstract: An empirical design curve for flat-scored metal diaphragms is presented, which predicts burst pressures up to 40,000 psi. Also discussed are methods of holding the diaphragms and materials used in their fabrication.

Schermerhorn, V. and DeMeritte, F. J., "Wind-Tunnel Tests of the Navy Low-Drag Bomb at Angles of Attack up to 70 Degrees," NavWeps 7291

Abstract: See DeMeritte, F. J. and Schermerhorn, V.

Wright, John, "Compilation of Aerodynamic Nomenclature and Axes Systems," NOLR 1241

Abstract: A compilation of aerodynamic nomenclature and axes systems is presented. The primary and secondary symbols and aerodynamic coefficients are treated in detail. Transfer equations from the body-axes system to the other systems together with their derivations are included.

XIII. List of Unclassified NavWeps Reports and NOLTR's Published During the Period 1 January 1962 - 31 December 1962

Aziz, A. K. and Diaz, J. B., "On a Mixed Boundary Value Problem for Linear Hyperbolic Partial Differential Equations in Two Independent Variables," NOLTR 61-32

Abstract: Boundary value problem considered consists of linear partial differential equation $L(u) = u_{xy} + a(x,y)u_x + b(x,y)u_y + cu = d(x,y)$ with the boundary conditions:

$$\alpha_0(x)u(x,y)+\alpha_1(x)u_x(x,y)+\alpha_2(x)u_y(x,y) = G(x) \quad \text{on } y = f_1(x)$$

$$\beta_0(y)u(x,y)+\beta_1(y)u_x(x,y)+\beta_2(y)u_y(x,y) = r(y) \quad \text{on } x = f_2(y)$$

$$u(0,0) = \gamma$$

where functions a, b, c, d, r, f_1, f_2 are given functions in closed rectangle: $(0 \leq x \leq x_0,\ 0 \leq y \leq y_0;\ x_0, y_0 > 0)$, and γ is a given constant. For a precise statement of results, see theorems in section 2.

Eixler, D. N. and Gates, D. F., "Force and moment Measurements of Models of the ARGMA Configuration in the NOL 4-in. Hypersonic Tunnel No. 3," NOLTR 61-96

Abstract: With the use of a high-speed camera and a high-intensity rapid-response light source, light-weight models of missiles and a light-weight sphere are photographed as they move freely in the flow of the NOL 4-in. Hypersonic Shock Tunnel No. 3. By comparison of the motion of each model to that of the sphere, the static, aerodynamic moment, lift, and drag coefficients of each of seven configurations of decoy missiles are determined.

Carter, H. L., "The Design and Testing of the Naval Ordnance Laboratory's 2-in. Two-Stage Gun," NOLTR 62-112

Abstract: A 2-in. two-stage gun has been successful in launching complex models in the NOL's 1,000-ft. Hyperballistics Range No. 4 at velocities in excess of 15,000 fps. The design of the 2-inch gun and the results of the first 44 shots are reviewed.

Crogan, Leonard E., "Drag and Stability Data for Models of the Mk 76 Mod 4 Practice Bomb Obtained from Free-Flight Firings," NOLTR 61-152

Abstract: A series of 0.45-scale models of the Mk 76 Mod 4 Practice

Bomb were fired in the NOL Aerodynamics Range No. 1 within the Mach number range of 0.45 to 2.04 to obtain drag and stability coefficients.

Danberg, James E., "The Equilibrium Temperature Probe, a Device for Measuring Temperatures in Hypersonic Boundary Layer," NOLTR 61-2

Abstract: The equilibrium temperature probe is a device which may be used to determine the flow temperature in a hypersonic boundary layer. It consists of a sharp, small-angled cone of low emissivity metal supported by a thermal insulator. A thermocouple is installed to measure the cone temperature. The cone is held with its axis parallel to the flow.

Danberg, James E., "Effect of Velocity and Temperature Fluctuations on Pitot Probe Measurements in Compressible Flow," NOLTR 61-28

Abstract: Effect of velocity and temperature fluctuations on pressure indicated by Pitot probe has been analyzed for compressible case. Analysis is based on assumption that Mach number fluctuations in free stream ahead of probe affect Pitot pressure directly. Results show velocity fluctuations directly and via temperature fluctuations cause indicated Pitot pressure to be greater than Pitot pressure associated with time average velocity and temperature.

Dawson, V. C. D. and Waser, R. H., "Pitot Pressure Measurements in the NOL 4 -in. Hypersonic Shock Tunnel No. 3," NavWeps 7329

Abstract: This report discusses various instruments that have been used in the measurement of pitot pressure in the test section of the NOL 4-in. Hypersonic Shock Tunnel No. 3.

Diaz, J. B. and Metcalf, F. T., "Upper and Lower Bounds for the Apsidal Angle in the Theory of the Spherical Pendulum," NOLTR 62-55

Abstract: In this paper a simple method is developed for obtaining upper and lower bounds for the apsidal angle which occurs in the theory of spherical pendulum. This method is employed to give quick derivation of well-known lower and upper bounds of Puiseux and Halpen for apsidal angle.

Diaz, J. B. and Aziz, A. K., "On a Mixed Boundary Value Problem for Linear Hyperbolic Partial Differential Equations in Two Independent Variables," NOLTR 61-32

Abstract: See Aziz, A. K. and Diaz, J. B.

Douglis, Avron, "Boundedness of Solutions of a Class of Integro-Differential Equations in Several Dimensions," NOLTR 61-185

Abstract: A class of linear, integro-differential equations is discussed which includes linearized, time-dependent forms of Boltzmann's equation. Solutions satisfying suitable homogeneous conditions on the boundary of a finite domain in configuration space are shown to depend boundedly on their initial data and thus, in particular, to be uniquely determined by their initial data.

Gates, D. F., "The Measurement of Aerodynamic Forces and Moments in the NOL 4-in. Hypersonic Shock Tunnel No. 3,"

Abstract: Light-weight models of missiles are suspended by fine threads in the shock tunnel test section. These models, along with a similarly suspended sphere, break free from their supporting threads and experience free flight at flow initiation. Motion of the models and sphere is recorded photographically with a high-speed framing camera and coordinates are read from the resulting film strips. Methods of analysis are discussed for determining aerodynamic force and moment coefficients from resulting data.

Gates, D. F. and Bixler, D. N., "Force and Moment Measurements of Models of the ARGMA Configuration in the NOL 4-in. Hypersonic Tunnel No. 3," NOLTR 61-96

Abstract: See Bixler, D. N. and Gates, D. F.

Glowacki, Walter J., "Effect of Finite Oxygen Recombination Rate on the Flow Conditions in Hypersonic Nozzles," NOLTR 61-23

Abstract: The subject effect is estimated using for air a simplified model gas consisting only of O, O_2, and N_2. For the range of supply conditions considered, the gas composition freezes during expansion with the oxygen atom concentration depending strongly on the supply condition, less significantly on the nozzle geometry. The fractional departure of the flow parameters from equilibrium values then depends to a good approximation only on the oxygen atom concentration.

Enkenhus, K. R. and Maher, E. F., "The Aerodynamic Design of Axi-symmetric Nozzles for High-Temperature Air," NavWeps 7395

Abstract: A method is given for aerodynamic design of contoured axi-symmetric nozzles by the method of characteristics, with a turbulent

boundary-layer correction, for high-temperature air in thermodynamic equilibrium. The method has been coded on an IBM 704 computer, and used to investigate boundary-layer growth and heat transfer in a family of hypervelocity nozzles having exit Mach numbers from 11 to 19, supply pressures from 50 to 500 atmospheres and supply temperatures up to 7500°K.

Enkenhus, K. R., "Aerodynamic Design of a Continuous Hypervelocity Wind Tunnel," NOLTR 62-20

Abstract: An aerodynamic design study is presented of a continuous, hypervelocity wind tunnel for simulating flight environment of ballistic missiles and glide vehicles at Mach numbers up to 20. Problems treated include design of axisymmetric nozzles for high-temperature air in thermodynamic equilibrium, a quantitative assessment of effect of a finite oxygen recombination rate on nozzle flows, nozzle boundary-layer growth and heat transfer, diffuser performance, and application of electric arc as an air heater.

Folz, R. C., "A Ballistics Range Station Identification System to be Used in Conjunction with a Data Recorder-Reproducer," NOLTR 61-135

Abstract: A ballistics range station identification system has been designed and constructed that provides a unique correlation of a series of elapsed time measurements as recorded by a data recorder-reproducer, with their respective sources. The final data readout is presented in a visual manner and is also automatically printed out by a Flexowriter. The identifying information is presented with the elapsed time data for each measurement that was recorded.

Folz, R. C. and Roberts, J. W., "The Data Recorder-Reproducer--a Time Interval Measuring Instrument Used in the Ballistics Facilities of NOL," NavWeps 7307

Abstract: This report describes the data recorder-reproducer now in use at NOL, White Oak, Silver Spring, Maryland.

Haislmaier, R. J., "On Measuring Drag Coefficients in a Ballistics Range Using a Microwave Resonant Cavity," NOLTR 61-58

Abstract: Drag coefficients have been obtained in a ballistics range for spheres traveling through a six-foot long cylindrical resonant cavity with 4.5-inch inside diameter. Discussed is how time-distance information from equivalent timing stations spaced at

5.2-inch intervals along the range is obtained from the electrical reaction of the cavity to an axially directed projectile. Projectile ablation and wake ionization must be prevented over the flight path for precise data to result.

Harris, E. L., "Effect of Free-Stream Shear on an Incompressible, Flat-Plate, Magnetohydrodynamic Laminar Boundary Layer," NOLTR 61-60

Abstract: Theoretical investigation of an incompressible, magneto-hydrodynamic laminar boundary layer on a flat plate has been conducted for an external flow which has uniform shear. Effects of free-stream vorticity and applied magnetic field have been linearized using assumption that vorticity number and magnetic parameter were small. Theoretical expressions for velocity profiles and skin friction were found. Skin friction consists of Blasius skin friction, magnetic drag and contribution caused by free-stream shear.

Harris, E. L., "Re-entry Trajectories of Lifting Ballistic Missiles," NOLTR 62-63

Abstract: Calculations of re-entry trajectories of lifting ballistic missiles with total ranges from 1000 to 7000 nautical miles have been carried out on an IBM 7090 computer. The re-entry calculations were begun at an altitude of 400,000 ft. under the assumption that the vehicle had been launched on a minimum energy trajectory. Values of the ballistic factor, W/C_DA, from 200 to 1200 lbs/ft^2 and lift-to-drag ratios from -0.6 to +0.6 were considered.

Kilmer, E. Eugene and Montgomery, Rayner A., "The Explosive Release of Gas Gun Diaphragms," NOLTR 61-165

Abstract: See Montgomery, Rayner A. and Kilmer, E. Eugene

Krahn, Edgar and Powers, John O., "Heat Transfer in Dissociated Air by a Two-Thickness Integral Method. Part II. The Zero Pressure Gradient Laminar Boundary Layer," NOLTR 61-25

Abstract: See Powers, John O. and Krahn, Edgar

Leverance, Robert A., "A Comparison of the Visible Radiation from Projectile Materials at Velocities from 6,000 to 8,500 Feet Per Second," NOLTR 61-162

Abstract: Investigation has been conducted in NOL Aerophysics

Range 5 to compare magnitudes of visible radiation from a selected group of materials commonly used in models, sabots and projectiles. Spheres and hemispherically blunted cylinders machined from test material were launched at velocities between 6,000 and 8,500 feet per second into still air at pressure of 100 mm of mercury. Oscilloscope traces of projectile radiation between 3,500 and 6,500 angstroms were obtained from output of a multiplier phototube detector system and each peak value was plotted.

Lyons, W. C., Jr. and Sheetz, N. W., Jr., "Free-Flight Experimental Investigations of the Effect of Boundary Layer Cooling on Transition," NOLTR 61-83

Abstract: Free-flight tests have been conducted in the NOL Pressurized Ballistics Range No. 3 for the purpose of investigating boundary layer transition under the conditions of extreme boundary-layer cooling. Tests were conducted on smooth, sharp-nosed, slender cones. The tests were conducted at a nominal Mach number of 3 and a freestream unit Reynolds number per foot of 11.8×10^6. The ratio of wall to adiabatic recovery temperature varied between 0.22 and 0.27.

Maher, E. F. and Enkenhus, K. R., "The Aerodynamic Design of Axi-symmetric Nozzles for High-Temperature Air," NavWeps 7395

Abstract: See Enkenhus, K. R. and Maher, E. F.

Marshall, John M., "A Pressure-Sensitive Detector for Use in Shock-Velocity Measurements in Shocktubes and Tunnels," NOLTR 61-117

Abstract: The pressure-sensitive detector described in this report was designed to overcome various difficulties outlined herein. Two novel features of the design of this detector are absence of soldered connections to transducer, and quick-change components of working parts. The latter feature enables one to select the type of material and the thickness of the diaphragm to suit the pressure and temperature ranges expected.

Marshall, T., "Radio-Frequency Probes for Ionized Wake Studies," NOLTR 62-64

Abstract: A probe technique for measuring the electrical conductivity in a small region of an ionized flow field is described. The technique involves the observation of the interaction between an ionized gas and a perturbing R.F. magnetic field of low strength. The probes are

basically small coils mounted on ferrite supports and are presently undergoing dynamic calibration in a shocktube specially designed for that purpose. The shocktube is instrumented with a 70 KMC microwave interferometer which yields direct electron density information as a comparison parameter.

Metcalf, F. T. and Diaz, J. B., "Upper and Lower Bounds for the Apsidal Angle in the Theory of the Spherical Pendulum," NOLTR 62-55

Abstract: See Diaz, J. B. and Metcalf; F. T.

Miller, Charles F., "A Phototransistor Tachometer for Measuring Spin," NOLTR 61-27

Abstract: The spin rate of a shaft is measured by periodic interruption of a light beam through a rotating, perforated wheel, or by multiple reflections from a spinning assembly of a fixed set of mirrors, to a phototransistor. Miniaturized elements permit mounting within wind-tunnel models or their mounts.

Montgomery, Rayner A. and Kilmer, E. Eugene, "The Explosive Release of Gas Gun Diaphragms," NOLTR 61-165

Abstract: Experimental investigation was conducted to determine feasibility of using explosive materials to open the diaphragm used for release of chamber pressure in a 4-inch gas model launcher. A method was developed, using linear-shaped mild detonating fuse for controlled rupture of the stainless steel diaphragm. The diaphragm is ruptured at predetermined delay time after the gas propellant has reached a given pressure. Tests show that diaphragms can be ruptured at chamber pressures up to 10,500 psi under ultimate rupture pressure for the diaphragm.

Pasiuk, Lionel, "Supersonic Aerodynamic Heat-Transfer and Pressure Distributions on a Sphere-Cone Model at High Angles of Yaw," NOLTR 62-35

Abstract: Measurements of the static pressure and aerodynamic heat transfer on the surface of a sphere-cone model at Mach numbers of 3.23 and 4.83, and angles of yaw of 6 and 18 degrees have been made. The results of several theoretical methods for calculating both the laminar and turbulent heat transfer to the body along the most windward and leeward streamlines are compared with the experimental measurements.

Powers, John O. and Krahn, Edgar, "Heat Transfer in Dissociated Air by a Two-Thickness Integral Method. Part II. The Zero Pressure Gradient Laminar Boundary Layer," NOLTR 61-25

Abstract: The two-thickness integral method of determining boundary-layer characteristics has previously been shown to provide reasonable results for stagnation point flows. Further evaluation of its more general applicability has been explored for the zero pressure gradient case. It appears that of the profile representations considered, a two-parameter, sixth-degree velocity profile gives the most desirable results for a flat plate when used with the present method.

Reid, Walter P., "Linear Heat Flow in a Composite Slab," NOLTR 61-180

Abstract: The temperature is determined as a function of position and time for the case of linear heat conduction in a composite slab of 2, 3, 4, or 5 layers in good thermal contact. The initial temperature throughout, and the two external surface temperatures, are considered to be prescribed functions.

Reid, Walter P., "Free Vibrations of a Circular Plate," NOLTR 61-186

Abstract: An expression is derived for the norm of the radial eigenfunctions. This is used to determine the displacement of a thin, simply supported, circular plate with no central hole which is released from rest. The displacement is also given for a plate which is clamped at its outer edge.

Riess, M., "On Measuring the Coefficient of Drag of an Accelerometer-Instrumented Sphere in a Shock Tube," NOLTR 62-162

Abstract: The purpose of this experiment was to determine the feasibility of measuring the aerodynamic coefficient of drag (C_D) of a sphere in a shock tube by means of an accelerometer. The method involved mounting an accelerometer within the sphere and measuring its response to a known flow. Using an aluminum sphere for a model, 5 shots were made with a constant diaphragm pressure ratio. Agreement with ballistic range data was in the order of 1 to 4 percent.

Roberts, Richard C., "Report of Committee on General Purpose Simulation Facility," NOLTR 62-97

Abstract: This is the final report of the Committee. The need for a General Purpose Simulation Facility was reviewed and analyzed.

The Committee decided that such a facility was needed at NOL and that it should be based on an already existing analog computer installation. Detailed recommendations are given in the report.

Roberts, J. W. and Folz, R. C., "The Data Recorder-Reproducer--A Time Interval Measuring Instrument Used in the Ballistics Facilities of NOL," NavWeps 7307

Abstract: See Folz, R. C. and Roberts, J. W.

Seigel, A. E., "Method of Calculating Pre-Burned Propellant Gun Performance with Special Application of Two-Stage Guns," NOLTR 61-29

Abstract: The method of calculating the behavior of a projectile propelled by a pre-burned propellant in a chambered gun is reviewed. The influence of gas in front of the projectile in the barrel is discussed as is the procedure to take account of gas frictional and heat-transfer effects. The method of calculation by hand of the performance of two-stage guns is then outlined. Some results obtained from an electronic computing machine are compared to experimental results.

Sheetz, N. W., Jr. and Lyons, W. C., Jr., "Free-Flight Experimental Investigations of the Effect of Boundary -Layer Cooling on Transition," NOLTR 61-83

Abstract: See Lyons, W. C., Jr. and Sheetz, N. W., Jr.

Shen, S. F., "An Improved Method for the Transition Regime in Rarefied Gas Flows and Its Application to the Linearized Plane Couette Flow," NOLTR 61-68

Abstract: For approximate calculations of rarefied gas flows in the transition regime, a new model of the distribution function is proposed to be used with the "transfer equations" approach. Its main features are that the correct behaviors in the limiting cases of the free molecule and Navier-Stokes regimes are assured, and that collision effects are explicitly brought out. The linear Couette flow is worked out as an example and comparisons with available theories are made.

Smith, Helen A., "U. S. Naval Ordnance Laboratory Aeroballistic Research Area Presentation and Publications, 1948-1961," NavWeps 7345

Abstract: Listed in this report are the presentations and publications, other than NavOrd reports, NavWeps reports, and NOLTR's of the

Aeroballistic Research Area of the Naval Ordnance Laboratory, White Oak, for the period 1948 through 1961.

Solomon, Jay M., "The Calculation of Laminar Boundary Layers in Equilibrium Dissociated Air by an Extension of the Cohen and Reshotko Method," NOLTR 61-143

Abstract: The method of Cohen and Reshotko for calculation of compressible laminar boundary layer with heat transfer and arbitrary pressure gradient is extended to equilibrium dissociated air. Both products of density and viscosity and density and enthalpy must be assumed constant across boundary layer. Satisfactory results are obtained when product of density and viscosity is evaluated at reference enthalpy and product of density and enthalpy is evaluated at enthalpy at boundary layer edge.

Trytten, George N., "Pointwise Bounds for Solutions of the Cauchy Problem for Elliptic Equations," NOLTR 62-91

Abstract: This report deals with a technique for approximating the solution to a Cauchy problem for a general second-order elliptic partial differential equation defined in an N-dimensional region D. The method is based on the determination of a priori bound for the value of an arbitrary function u at a point P in D in terms of the values of u and its gradient on the Cauchy surface and a functional of the elliptic operator applied to u.

Waser, R. H., "Test Launcher Design for Sonobuoy," NOLTR 62-108

Abstract: This report describes the design, construction and operation of a launcher built to propel an 8-pound sonobuoy at velocities up to 150 feet per second for water impact tests. Further specifications were that the sonobuoy's 9-inch diameter air brake be open, that there be provision for trailing wires, and that the maximum acceleration not exceed 300 g's.

Waser, R. H. and Dawson, V. C. D., "Pitot Pressure Measurements in the NOL 4-in. Hypersonic Shock Tunnel No. 3," NavWeps 7329

Abstract: See Dawson, V. C. D. and Waser, R. H.

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2 OF 2

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