Hydraulic Research in the United States

United States Department of Commerce

National Bureau of Standards

Miscellaneous Publication 208

RELATED PUBLICATIONS . . . . . .

Capacities of Plumbing Stacks in Buildings

A study of the maximum load that can be brought from a horizontal branch into a stack down which water is being discharged from fixtures on higher floors. This phase of a projected complete investigation, intended to make drainage design more economical, is concentrated on the drainage stack and the building drain. The report describes tests to determine terminal velocities and terminal lengths in stacks as well as tests on stacks and drains. It analyzes stack conditions in a multistory building and suggests applications of the study's results.

Order NBS Building Materials and Structures Report 132, Capacities of Plumbing Stacks in Buildings, 28 pages. Price: 20 cents.

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An explanation of the extent to which trap-seal losses are influenced by such considerations as the diameter of the trap and the depth of trap seal, the diameter and slope of the fixture drain, the type of vent fitting used, and the rate of discharge of the fixture. The report shows the importance of standardizing fixture traps and the hydraulic characteristics of plumbing fixtures, such as lavatories, sinks, and trays; and it makes recommendations for use by code-writing authorities.

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A report describing tests involving use of pipes, traps, connections, and vents made of transparent plastics which make all flow phenomena visible. Similar tests were made with regular metal fittings to obtain comparative data and to permit correlation of results. The report discusses and interprets results,

(Continued on page 3 of cover)

UNITED STATES DEPARTMENT OF COMMERCE • Sinclair Weeks, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Hydraulic Research in the United States

Edited by Helen K. Middleton and Sonya W. Matchett

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FOREWORD

The information contained in this publication was compiled from reports by the various raulic and hydrologic laboratories in the United States and Canada. The cooperation of these ncies is greatly appreciated.

Projects are numbered chronologically, and the number once assigned is repeated for identi-ation purposes until a project is completed. Numbers commencing with 1544 refer to projects ch are reported for the first time. All projects are in active state, unless otherwise noted er (f).

It is emphasized that the National Bureau of Standards does not have in its files reports detailed information regarding the research projects reported by other organizations. Such ormation may be obtained from the correspondent listed under (c) or immediately following the le of the organization reporting the work. It is of course understood that any laboratory mitting reports on its work will be willing to supply information to properly qualified uirers.

A similar bulletin, "Hydraulic Research", compiled and published by the International ociation for Hydraulic Research, contains information on hydraulic research being conducted foreign countries. This bulletin is edited by Prof. J. Th. Thijsse, Director of the Hydraulic oratory at the Technical University of Delft, Netherlands, and Secretary of the International ociation for Hydraulic Research. Copies may be obtained from the Secretary at $6.00 each.

A bulletin entitled "Directory of Hydromechanics Research Projects in the United States ated to Naval Architecture and Marine Engineering" is prepared by the Hydrodynamics Committee the Society of Naval Architects and Marine Engineers. Copies may be obtained by addressing Secretary of the Society, Captain W. N. Landers, Society of Naval Architects and Marine ineers, 29 West Thirty-ninth Street, New York 18, N. Y.

A. V. Astin, Director

Contents

Key to Projects

(a) Title of project.
(b) Project conducted for.
(c) Correspondent.
(d) Nature of project.
(e) Description.
(f) Present status.
(g) Results.
(h) Publications.

DAVID TAYLOR MODEL BASIN (see U. S. Government)

GEORGIA INSTITUTE OF TECHNOLOGY 2
School of Civil Engineering, Atlanta, Ga.
Prof. C. E. Kindsvater

HARVARD UNIVERSITY 3
Department of Mathematics,
Division of Applied Science, Cambridge 38, Mass.

IDAHO, UNIVERSITY OF 3
Engineering Experiment Station, Moscow, Idaho
Prof. Allen S. Janssen, Dean, College of Engineering

ILLINOIS INSTITUTE OF TECHNOLOGY 3
Technology Center, Chicago 16, Ill.
Dr. Victor L. Streeter, Director, Fundamental Fluids Research

ILLINOIS STATE WATER SURVEY DIVISION
Engineering Subdivision, Box 232, Urbana, Ill. 3
Mr. H. E. Hudson, Jr., Head.

Engineering Research Subdivision, Box 117, Peoria, Ill. 3
Dr. Max Suter, Head

ILLINOIS, UNIVERSITY OF 3
Department of Theoretical and Applied Mechanics, 214 Talbot Laboratory, Urbana, Ill.
Prof. F. B. Seely, Head

ILLINOIS, UNIVERSITY OF 3
Hydraulic Engineering Laboratory, Urbana, Ill.
Prof. J. J. Doland, Director of Hydraulic Engineering

IOWA INSTITUTE OF HYDRAULIC RESEARCH 3
State University of Iowa, Iowa City, Iowa
Dr. Hunter Rouse, Director

IOWA, STATE UNIVERSITY OF (see Iowa Institute of Hydraulic Research)

IOWA, STATE UNIVERSITY OF 4
College of Engineering, Iowa City, Iowa
Dean F. M. Dawson

JOHNS HOPKINS UNIVERSITY, THE 4
Applied Physics Laboratory, Silver Spring, Md.
Mr. R. E. Gibson, Director

JOHNS HOPKINS UNIVERSITY, THE 4
Institute of Cooperative Research, Baltimore 18, Md.
Dr. John C. Geyer

LEFFEL AND COMPANY, THE JAMES 4
426 East Street, Springfield, Ohio
Mr. J. Robert Groff, President and General Manager

LEHIGH UNIVERSITY 4
Fritz Engineering Laboratory, Bethlehem, Pa.
Dr. W. J. Eney, Director

HYDRAULIC RESEARCH IN THE UNITED STATES

E BALDWIN-LIMA-HAMILTON CORPORATION, Hydraulic Turbine Laboratory.

Inquiries concerning Projects Nos. 271, 1055, 1296, 1544, and 1545 should be addressed to Mr. C. H. Diehl, Hydraulic Turbine Laboratory, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

271) ADJUSTABLE AND FIXED BLADE PROPELLER-TYPE HYDRAULIC TURBINE MODELS.

(b) Laboratory project.
(d) Experimental; applied research for design.
(e) To improve performance of present designs, and to extend the range of application of this type turbine. Propeller runners of various designs in combination with modified turbine settings are being methodically tested in the 11-inch cavitation flume. Efficiency, output, cavitation, runaway speed, hydraulic thrust, and hydraulic blade surge are measured.
(g) Results provide data for improvement of existing design and information for designs which extend the range of application, particularly with respect to head.

055) HIGH HEAD ADJUSTABLE BLADE PROPELLER-TYPE TURBINE MODEL FOR BIG CLIFF PROJECT.

(b) Department of the Army, Corps of Engineers, Portland, Ore. District.
(d) Experimental; applied research for design.
(e) A completely homologous model was tested to determine its performance over a wide range of operating conditions.
(f) Completed.
(g) Results of the model tests indicate that all operating requirements for the prototype were generously exceeded.

.296) HIGH SPECIFIC-SPEED ADJUSTABLE BLADE PROPELLER-TYPE HYDRAULIC TURBINE FOR ALBENI FALLS PROJECT.

(b) Department of the Army, Corps of Engineers, Seattle, Wash. District.
(d) Experimental; applied research for design.
(e) A completely homologous model was tested through the entire operating range expected on the prototype installation.
(f) Completed.
(g) Results of the model tests indicate that all operating requirements for the prototype were generously exceeded.

1544) ADJUSTABLE BLADE PROPELLER-TYPE HYDRAULIC TURBINE FOR DALLES PROJECT.

(b) Corps of Engineers, Portland Ore. District.
(d) Experimental; applied research for design.
(e) A completely homologous model is being manufactured and will be installed and tested to determine the characteristics of the design.

1545) ADJUSTABLE BLADE AXIAL FLOW PUMP FOR SIPHON SETTING.

(b) Laboratory project.
(d) Experimental; applied research.
(e) An axial flow adjustable blade pump is to be installed in several different designs of inflow and discharge chambers to determine the performance under various siphon conditions.

POLYTECHNIC INSTITUTE OF BROOKLYN.

Inquiries concerning Projects Nos. 1546 and 1547 should be addressed to Prof. P. R. DeCicco, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 2, N. Y.

(1546) DESIGN AND CONSTRUCTION OF A FLUID POLARISCOPE.

(b) Laboratory project.
(d) Applied research.
(e) Design and construction of a fluid polariscope, and the qualitative study of various fluid flow phenomena.
(f) Construction about 60 percent complete.
(h) "Study of fluid flow by means of fluid polariscope." Bachelor's thesis, A. M. James.

(1547) DESIGN AND CONSTRUCTION OF A 6-INCH WATER TUNNEL.

(b) Laboratory project.
(d) Applied research.
(e) Design and construction of a 6-inch water tunnel to be used for various laboratory exercises as well as for fluid flow studies.
(f) Design phase 25 percent complete.
(h) "Design and construction of 6-inch water tunnel." Bachelor's thesis, S. Moskowitz.

CALIFORNIA INSTITUTE OF TECHNOLOGY.

Inquiries concerning Projects should be addressed to the following, all at Hydrodynamics Laboratory, California Institute of Technology, Pasadena 4, Calif.

Nos. 6, 805....................to Prof. Vito A. Vanoni
Nos. 15, 804, 806....................to Dr. Robert T. Knapp
No. 16....................to Mr. John T. McGraw
No. 279....................to Dr. A. J. Acosta
Nos. 803, 1548....................to Prof. Milton S. Plesset
Nos. 808, 1549....................to Mr. John H. Carr
Nos. 1299, 1300....................to Mr. Joseph Levy
No. 1301....................to Mr. J. Pat O'Neill

(6) MECHANICS OF SEDIMENT TRANSPORTATION.

(b) Laboratory project.
(d) Experimental and theoretical; basic research.
(e) To investigate the mechanics of transportation of sediment by flowing fluids including studies of the suspended load as well as the bed load phases of the problem.
(h) "Some effects of suspended sediment on flow characteristics." Vito A. Vanoni, Proc. of the Fifth Hydraulic Conference, University of Iowa (in press).

(15) STUDIES OF CAVITATION PHENOMENA.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Characteristics of partially developed cavitation to be thoroughly delineated (between two extremes of cavitation inception and fully developed) and its effects on the hydrodynamic forces on the bodies concerned. Detailed investigation of rate of growth of cavitation zone as a function of the cavitation parameter for a series of different nose shapes, and change of resistance as a function of the degree of cavitation. Basic experimental investigation into the mechanics of various types of cavitation by use of methods to produce (a) the fixed void type of cavitation, and (b) the traveling void type. Results to be studied with an attempt to understand different hydromechanics involved in formation of different types of cavitation, and effect of different physical parameters of body shapes upon which cavitation is produced.

"Cavitation mechanics and its relation to the design of hydraulic equipment." Robert T. Knapp, Clayton Lecture, presented to the Institution of Mechanical Engineers, London, England, April, 1952.

HYDRODYNAMIC FORCES ON SUBMERGED BODIES.

Bureau of Ordnance, Department of the Navy.
Experimental; basic research.
Forces on bodies of different shapes and designs are measured in a water tunnel and the important steady state and damping force coefficients are thus obtained. These data are used to predict full-scale behavior.

) FLOW IN ROTATING CHANNELS.

) Office of Naval Research, Department of the Navy.
) Experimental and theoretical.
) To determine the nature of flow in rotating channels and the mechanism of energy transfer from fluid to rotor or vice versa with a view to the development of design methods for hydraulic machinery.
) "An experimental and theoretical investigation of two-dimensional centrifugal pump impellers." A. J. Acosta, C.I.T. Hydrodynamics Laboratory Report No. E-21.9, June, 1952.
"Pressure distributions on the blade of an axial flow propeller pump." D. A. Morelli and R. D. Bowerman, C.I.T. Hydrodynamics Laboratory Report No. E-19.2, Nov. 1952.

) DYNAMICS OF CAVITATION BUBBLES.

) Office of Naval Research, Department of the Navy.
) Throretical; basic research.
) Dynamic behavior of cavitation bubbles.
) "The growth or collapse of a spherical bubble in a viscous compressible liquid." F. R. Gilmore, C.I.T. Hydrodynamics Laboratory Report No. 26-4, April, 1952.
"Note on the flow of vapor between liquid surfaces." M. S. Plesset, C.I.T. Hydrodynamics Laboratory Report No. 26-5, Dec. 1951.
"The growth of vapor bubbles in superheated liquids." M. S. Plesset and S. A. Zwick, C.I.T. Hydrodynamics Laboratory Report No. 26-6.

) THE EFFECT OF PHYSICAL CHARACTERISTICS OF LIQUID ON THE INCEPTION OF CAVITATION.

b) Office of Naval Research, Department of the Navy.
d) Experimental; basic research.
e) Investigations are continuing on the factors which control the effective tensile strength of liquids, especially as this tensile strength affects the cavitation process. Significant increases in effective tensile strength have been produced by pressurizing the sample at relatively high pressures for a few minutes before testing. The effects of sample size, relative surface of the container, and speed of tests are some of the facts that are being explored.
A parallel investigation is being initiated using precision glass venturi tubes which can be cleaned and pressurized while containing the sample of water to be tested. After pressurizing, these tubes are placed in special equipment in which the sample is caused to flow through the venturi tube under known conditions, the result being recorded by high speed motion pictures. This will permit a direct comparison between the boiling point experiments and actual cavitation in a flowing liquid.

5) DIFFUSION IN TURBULENT FLOW.

b) U. S. Air Force.
d) Experimental.
e) Studies were made of the diffusion of tracer droplets in a flow made turbulent by a grid. A water tunnel with a working section 12" x 12" has been built for continuing this work.
f) Inactive, continuation expected.

(h) "Dynamics of particulate matter in fluid suspensions." Vito A. Vanoni and En-Yun-Hsu, C.I.T. Hydrodynamics Laboratory Report No. E-34, Dec. 1951.
"Turbulence and diffusion as factors in sediment transportation." Vito A. Vanoni and En-Yun-Hsu, Centennial Convocation, A.S.C.E. Preprint 67, Chicago, Sept. 1952.

(806) HYDRODYNAMICS OF CENTRIFUGAL AND PROPELLER PUMPS, TURBINES, AND ALLIED FLOW PROBLEMS.

(b) Laboratory project.
(d) Basic research.
(e) The Hydraulic Machinery Laboratory is designed for carrying out basic and precise research studies in the hydrodynamics of centrifugal and propeller pumps, turbines, and allied flow problems. Horizontal dynamometers up to 450 horsepower and a vertical one up to 30 horsepower are available with precision speed controls. Accurate instruments for measuring pressures, flow rates, speeds and torques are provided. Special equipment for the study of cavitation has been developed.

(808) EXPERIMENTAL STUDIES FOR HARBOR DEVELOPMENT.

(b) Bureau of Yards and Docks, Department of the Navy.
(d) Experimental and theoretical applied research.
(e) The penetration of wave energy into harbors, and the distribution of such energy within harbors was investigated with the aim of developing some general principles of harbor design.
(f) Terminated Dec. 1, 1952.
(g) Methods have been developed which permit the prediction of wave disturbances at any point in harbors of simple geometric shape taking into account diffraction at the entrance and reflection from the harbor periphery.
(h) "Wave protection aspects of harbor design." C.I.T. Hydrodynamics Laboratory Report No. E-11, Aug. 1952.

(1299) AIR-TO-WATER ENTRY OF MISSILES.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental; basic research.
(e) Systematic investigations to determine (1) the variables which affect the behavior of missiles during water entry, and (2) the modeling laws by which such behavior may be studied in small scale. Two-inch diameter models are used and test results are compared with full scale data obtained elsewhere. The model tests are made in a launching tank equipped with a centrifugal launcher and a battery of high-speed cameras for recording the path of the model. The variables studied include body shape, velocity, trajectory angle, pitch angle, and the pressure of the atmosphere above the water.

(1300) BASIC WATER ENTRY STUDY.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) An investigation of the phenomena accompanying the entry into water of solids traveling at moderate speeds. The initial study covers the formation of the cavity, and the measurement of pressure within the cavity formed behind spheres entering the water vertically.

(1301) HYDRODYNAMICS OF FREE-BOUNDARY FLOWS.

(b) Office of Naval Research and Bureau of Ordnance, Department of the Navy.
(d) Experimental and analytical; basic and applied research.
(e) A free-surface water tunnel with force and pressure measuring apparatus devised to meet the specific needs of the investigation is used in an experimental and analytical study of the dynamics of cavity and jet flows in 2 and 3 dimensions. Effects of and on the solid boundary configurations associated with the cavity and jet flows are determined. The influence of channel boundaries and problems of simulitude in cavity-and jet-flow experimentation are being examined.

(g) Characteristics of open cavities have been analyzed. The requirements for maintaining air-filled cavities have been determined. Forces on simple boundary shapes have been measured. A cavity around a liquid jet directed upstream in the water tunnel has been studied as a model of an axially symmetrical cavity with re-entrant jet. Further studies on problems of simulitude in free-boundary flows are in progress.
(h) "The effect of aspect ratio on the lift of flat planing surfaces." Byrne Perry, C.I.T. Hydrodynamics Laboratory Report No. E-24.5, Sept. 1952.

(548) SPECIAL PROBLEMS IN HYDRODYNAMICS.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical; basic research.
(e) Studies of cavitating flow.
(h) "Scale effects in cavitating flow." (A preliminary report). B. R. Parkin, C.I.T. Hydrodynamics Laboratory Report No. 21.7.
"Scale effects in cavitating flow." B. R. Parkin, C.I.T. Hydrodynamics Laboratory Report No. 21.8.
"An experimental and theoretical investigation of two-dimensional centrifugal pump impellers." A. J. Acosta, C.I.T. Hydrodynamics Laboratory Report No. 21.9.
"The rate of growth of vapor bubbles in superheated water." P. Dergerabedian, C.I.T. Hydrodynamics Laboratory Report No. 21.10.
"Evaluation of the integrals occurring in the cavity theory of Plesset and Shaffer." B. Perry, C.I.T. Hydrodynamics Laboratory Report No. 21.11.

(549) WAVE FORCES AND PRESSURES.

(b) Bureau of Yards and Docks, Department of the Navy.
(d) Experimental and theoretical; applied research.
(e) The total force and pressure distribution due to water waves reflecting from and breaking on rigid bulkheads is to be investigated.
(f) Project initiated Dec. 1. 1952.

IVERSITY OF CALIFORNIA, College of Agriculture, Division of Irrigation.

(19) THE EFFECT OF THE DEPTH OF WATER TABLE UPON THE ABILITY OF PLANTS TO EXTRACT WATER.

(b) California Agricultural Experiment Station.
(c) Dr. Robert M. Hagan, Division of Irrigation, University of California, Davis, Calif.
(d) Field and laboratory investigations; basic and applied research.
(e) Studies conducted on behavior of plants grown on waterlogged soils and on soils with controlled water tables during crop season to yield information of value in analyzing cropping problems associated with high water tables.

(20) MOVEMENT OF WATER THROUGH SOILS.

(b) California Agricultural Experiment Station.
(c) Dr. F. J. Veihmeyer, Division of Irrigation, University of California, Davis, Calif.
(d) Field and laboratory investigation; applied research.
(e) The ability of the soil to supply water to plants through capillary movement and the movement of water through soils is being studied under various conditions. Studies are continuing on fundamentals on plant-soil-water relationships.
(h) "Irrigation experiments with grapes." A. H. Hendrickson and F. J. Veihmeyer, Calif. Agr. Exp. Sta. Bul. 728. 1951.
"Prune orchard irrigation." A. H. Hendrickson and F. J. Veihmeyer. Calif. Agric. 6:10-12. 1952.
"A uniformity trial on unirrigated barley of ten years' duration." G. A. Baker, M. R. Huberty, and F. J. Veihmeyer. Agri. Jour. 44:267-270. 1952.

(21) STUDY OF HYDRAULICS OF SPRINKLING SYSTEMS.

(b) California Agricultural Experiment Station.
(c) Prof. C. N. Johnston, Division of Irrigation, University of California, Davis, Calif.
(d) Experimental; operation.
(e) Determination of the characteristics of jets and the distribution of water from sprinklers. Studies of evaporation from sprinkler jets to determine operation losses. Field studies of water losses in sprinkler application. High speed photographs of sprinkler jets record characteristics of these streams.

(22) STUDY OF THERMODYNAMICS OF SOIL MOISTURE.

(b) California Agricultural Experiment Station.
(c) Dr. Robert M. Hagan, Division of Irrigation, University of California, Davis, Calif.
(d) Field and laboratory; basic research.
(e) The ability of soil to supply water to plants, and methods of measuring free energy or potential of soil moisture are being studied. The effect of soluble material added to soils on the potentials of soil moisture is being studied.
(g) Results to date indicate that applications of materials within limits practical under commercial practice do not affect the permanent wilting percentage. The effect of soil additives such as sponge rock, porous glass, etc., respecting water storage in soil, seems open to question.
(h) "Some thermodynamic properties of soil moisture." J. S. Robins, Soil Sci. 74:127-139. 1952.
"Synthetic polyelectrolyte soil conditioners." G. B. Bodman and R. M. Hagan, California Agr. Exp. Sta. Ext. Serv. Leaflet, 8 pages, 1952.
"Synthetic soil conditioners." G. B. Bodman and R. M. Hagan, California Agr. 6:6, 12, 15. 1952.
"Effect of porous soil amendments on water retention characteristics of soils. R. M. Hagan and J. R. Stockton. U.S.G.A. Jr. Turf Management 5:29-31, 1952.

(23) HYDROLOGY OF IRRIGATION SUPPLIES IN CALIFORNIA.

(b) California Agricultural Experiment Station.
(c) Dr. F. J. Veihmeyer, Prof. C. N. Johnston, Division of Irrigation, University of California, Davis, Calif.
(d) Experimental; applied research.
(e) Studies are being continued on the effects of denudation of watersheds upon the water regimen of typical grazing areas. Experimental watersheds and paired plots are located in various counties of California. Soil-moisture histories are obtained from plots from which the brush has been removed by denudation or burning and adjacent plots which are left with original vegetative cover. Laboratory studies of vegetation denudation have been initiated.
(g) Work will be continued for a number of years in connection with the removal of vegetation to permit growth of forage plants and its effect on runoff and erosion. To date, burning of brush has not accelerated erosion or runoff on the areas tested.
(h) "Hydrology of range lands as affected by the presence or absence of brush vegetation." F. J. Veihmeyer. Union Geodesique et Geophysique Internationale, Assoc. Internationale d'Hydrologie Sci., Assemblee Generale de Bruxelles 1951, Tome III, pages 226-234.
"Some effects of fire and ash on the infiltration capacity of soils." R. H. Burgy and V. H. Scott. Amer. Geophys. Union Trans. 33:405-416, 1952.

(24) MEASUREMENT OF IRRIGATION WATER AND IMPROVEMENT IN FARM IRRIGATION STRUCTURES.

(b) California Agricultural Experiment Station.
(c) Prof. C. N. Johnston, Division of Irrigation, University of California, Davis, Calif.
(d) Experimental; design.

Hydraulics of irrigation systems to better the design and efficiency of irrigation structures and equipment are being studied. Investigations conducted on concrete pipe to establish fitting coefficients for flow in concrete pipes with valves attached so that better design of these systems will result. Field studies in progress to investigate drilling technique and casing production in deep wells when water is corrosive. Prefabricated canal linings are being tested in small farm ditches. Calibration of gated concrete turnouts is being made. Studies of gated water distribution pipe and on perforated sprinkler pipe for small application rates have been completed. Further studies on larger capacity perforated pipe are under way.
"Irrigation pumps -- their selection and use." C. N. Johnston, California Agr. Exp. Sta. Cir. 415, 1952.
"Numerical analysis of flow through aquifers toward wells." J. N. Luthin and V. H. Scott, Agr. Engin. 33:279-282, 1952.

PHYSICAL AND CHEMICAL FACTORS AFFECTING SOIL INFILTRATION RATES.

California Agricultural Experiment Station.
Dr. L. D. Doneen, Division of Irrigation, University of California, Davis, Calif.
Field and laboratory; basic and applied research.
Soil infiltration rates are being studied by various types of infiltrometers, with particular reference to quality of water applied. Compaction of soils by harvesting and other equipment has introduced new problems over considerable areas of the State and research is started to find solutions if possible.
Gypsum is the most effective agent to improve infiltration where irrigation water contains 50 percent sodium.
Discussion of "Numerical solutions for tile drainage of layered soils." J. N. Luthin and R. E. Gaskell, Amer. Geophys. Union Trans. 32:779-780, 1951.
"Soil compaction of tractors." L. D. Doneen, D. W. Henderson and G. V. Ferry, Calif. Agr. 6:7-8, 1952.
"Water penetration tests." L. D. Doneen and D. W. Henderson, Calif. Agr. 6:5, 14-15. 1952.

'ERSITY OF CALIFORNIA, College of Agriculture, Department of Irrigation and Soils.

Inquiries concerning Projects Nos. 26, 27, 1058, 1302, and 1303 should be addressed to Prof. M. R. Huberty, Chairman, Department of Irrigation and Soils, University of California, Los Angeles 24, Calif.

) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

) Cooperative between the Coachella Valley County Water District, Coachella, Calif.; U. S. Salinity Laboratory, Riverside, Calif.; U. S. Bureau of Reclamation, Boulder City, Nev. and this laboratory.
) Field investigations; applied research and design.
) To develop and improve techniques for observing shallow ground water movement, for reclamation of saline and alkali soils, and for installation of drainage devices and systems.
) Continuing. No significant new conclusions reached.

) HYDROLOGY OF IRRIGATION WATER SUPPLIES IN CALIFORNIA.

) Laboratory project, coordinated with similar work by the College under Dr. F. J. Veihmeyer, College of Agriculture, Davis, Calif. (Project 23, page 6.)
) Field experiments; applied research.
) To evaluate effects of watershed burning on runoff and erosion in southern California.
) Moderate increases of runoff and erosion indicated following denudation.
) Discussion in Trans., Amer. Geophys. Union. (In press).

(1058) MOVEMENT OF WATER THROUGH SOILS.

(b) Laboratory project coordinated with similar work under F. J. Veihmeyer, University of California, Davis, Calif. (Project 20, page 5.)
(d) Continuing laboratory and field studies; basic and applied research.
(e) Study of soil properties which affect the flow of water into and through soils, the storage of water in soils, and evaporation from soil.
(h) "Soil temperature and plant growth." S. J. Richards, R. M. Hagen, and T. W. McCalla. pp. 303-491. Chapter 5 of "Soil Physical Conditions and Plant Growth" of the Academic Press, 1952.
A paper on unsaturated flow has been prepared by S. J. Richards and L. Weeks and will appear in Soil Science Proceedings early in 1953.

(1302) OXNARD PLAIN IRRIGATION AND RECLAMATION INVESTIGATIONS.

(b) Laboratory project.
(d) Field investigations; applied research and design.
(e) Investigations of drainage conditions, drainage mechanics, and irrigation efficiency with view towards improving reclamation of this rather saline area with a high water table.

(1303) HYDRAULIC CHARACTERISTICS OF IRRIGATION DISTRIBUTION PIPE SYSTEMS.

(b) Laboratory project, cooperative with College of Engineering, University of California, Los Angeles 24, Calif.
(d) Basic and applied research.
(e) (1) Analyses made of characteristics of float valves for semi-closed systems. (2) Mechanism of surge, and its amplification, in open systems has been observed in a model patterned after a prototype which gives considerable trouble. A theory of surge amplification developed, and the theory is being tested in the model.
(g) (1) Wide open losses through float valves have been determined, and characteristics of the valves which affect stability of semi-closed systems have been analyzed. (2) Model studies have shown surge to be initiated by air entrainment and creation of a large bubble, which periodically blows back, immediately downstream from the overflow stands. Any changes in flow have been shown to cause amplification of surge in an open system, but without repeated imposed fluctuations as provided ay air entrainment, surge rapidly dampens out. Vents of diameter greater than half that of the pipe line, and placed immediately downstream from overflow stands have been shown to prevent the initiation of surge in the reach of pipe involved.
(h) "Notes on the design of semi-closed pipe systems for irrigation water distribution." E. H. Taylor and A. F. Pillsbury, 1952, Agricultural Engineering, (in press).
"Preliminary notes on the phenomenon of surge as observed in open type irrigation pipe distribution systems." E. H. Taylor and A. F. Pillsbury, Mimeo. technical progress notes.

UNIVERSITY OF CALIFORNIA, College of Engineering, Fluid Mechanics Laboratory.

Inquiries concerning Projects Nos. 35, 38, 39, 40, 41, 43, 46, 47, 280, 282, 529, 810, 811, 813, 1059 to 1062, incl., 1304 to 1307, incl., and 1550 to 1557, incl., should be addressed to Prof. J. W. Johnson, Department of Engineering, University of California, Berkeley 4, Calif.

(35) OSCILLATORY WAVES.

(b) Laboratory project.
(d) Experimental.
(e) To obtain experimental information on the details of oscillatory waves in shallow water Wave velocity, period, length, height, mass transport, and orbital velocities through depth and length of channel will be measured and compared with theory. Change in wave characteristics will be studied when the waves pass over the various types of bottom discontinuities and through various dampening devices.
(h) "Run-up of ocean waves on breakwaters." M. S. thesis, K. N. Granthem.

STRUCTURES EXPOSED TO WAVE ACTION.

Laboratory and field research, Bureau of Yards and Docks, and Signal Oil and Gas Co.
Experimental.
To obtain experimental data for the design and location of such shore protection works as groins, jetties, piers and bulkheads. Present work involves the measurement of forces exerted on both model and field structural elements subjected to wave action.
"Elwood field pile studies - preliminary report." F. E. Snodgrass, J. R. Morison, M. A. Hall, K. N. Granthem and R. L. Wiegel, Jan. 1952, (unpublished).
"Elwood field pile studies - application of diffraction theory." R. C. MacCamy, Mar. 1952, (unpublished).
"Elwood field pile studies - experimental determination of the coefficient of mass." Kenneth N. Granthem, Mar. 1952, (unpublished).

PHASE BEHAVIOR OF TWO-PHASE FLUIDS IN POROUS MEDIA.

Laboratory project.
Experimental and theoretical basic research, Doctoral and Masters theses.
To determine the degree of departure from thermodynamic and phase equilibrium during flow of a multi-component fluid system through porous media under conditions of gas formation. Fluid saturation, pressure, and temperature distribution determined during steady flow of the ethane-crystal oil system through a linear column of porous media. Experimental results to be compared with theoretical behavior based on assuming instantaneous equilibrium.
Suspended.
P-V-T and viscosity data have been determined for the ethane-crystal oil system at 90° F, 100° F, and 105° F for pressures up to 300 psia. Theoretical calculations for flow assuming equilibrium completed. Preliminary design of flow apparatus completed.
"Properties of a heterogeneous fluid mixture for non-equilibrium flow studies in porous media." W. G. Haymes, M. S. thesis, University of California, June 1952.
"Equilibrium considerations in two-phase flow of hydrocarbons through unconsolidated sand." J. A. Putnam and H. H. Aboul-Seoud, presented before American Institute of Mineral and Metallurgical Engineers, Petroleum Branch, Los Angeles, Oct. 1952; submitted for publication in Journal of Petroleum Technology.

FLOW CHARACTERISTICS OF SOLIDS - GASEOUS MIXTURES IN A HORIZONTAL AND VERTICAL CONDUIT.

Laboratory project. Supported in part by Research Corporation.
Experimental; basic and applied research; design.
The isothermal flow characteristics of a solids-gaseous mixture (Al_2O_3, SiO_3 catalyst and air) are being investigated in a 17 mm I.D. horizontal and vertical glass conduit for various air flow and solids flow rates. Pressure drops across test sections are measured for a series of air flow rates in which the solids to air ratio is varied from zero to 11.0 pounds of solids per pound of air. The solids (catalyst) are introduced into the flow system through a mixing nozzle fed by a slide valve controlled weighing tank, and have a size distribution varying from particles less than 10 microns to particles greater than 220 microns. Investigation on the metering of solids-gas mixtures by nozzles and Venturi tubes has been carried out. Particle size effect is being investigated.
Experimental data have been correlated on the metering of mixtures. Design of equipment underway for the study of the heat transfer characteristics of mixtures (gaseous-solids).
"The metering of powdered solids in gas-solids mixtures." L. Farbar, Industrial and Engineering Chemistry, Dec. 1952.
"The Venturi as a meter for gas-solids mixtures." L. Farbar, presented at Annual Meeting ASME, New York, Dec. 4, 1952, preprint paper No. 52A31. To be published in Trans. ASME.

PRESSURE DROP ACCOMPANYING TWO-PHASE, TWO-COMPONENT FLOW IN PIPES.

Laboratory project supported by Research Corporation.
Experimental and theoretical; Masters and Doctoral theses.
To determine the conditions governing transition under which the gas and/or liquid phases are flowing in viscous and/or turbulent motion or in slug flow for isothermal flow in horizontal and vertical pipes. Mixtures of air and various liquids are made to flow through tubes. Pressure drop and fluid distribution with consideration of flow stability are determined for a range of liquid and gas rates which may be controlled separately.

(g) Work completed on vertical flow for viscous liquid, turbulent gas flow and slug flow.
(h) Report in preparation.

(43) A PITOT TUBE STANDARD FOR FLOW MEASUREMENT.

(b) In cooperation with Turbine Pump Manufacturers Association.
(d) Experimental; applied research and development.
(e) To design, construct, and calibrate a suitable Pitot tube for use with a standard code (to be developed) for application under a variety of field conditions.
(f) Temporarily suspended.
(g) Library study and correlation of existing information in progress.

(46) THE MEASUREMENT OF TURBULENT VELOCITY COMPONENTS BY THE METHOD OF ELECTROMAGNETIC INDUCTION.

(b) Laboratory project.
(d) Faculty research.
(e) Experimental and theoretical investigations.
(f) Temporarily suspended.
(g) Velocity fluctuations are measured by determining the potentials induced in water cuttin transversely across a steady magnetic field. An electrical probe of two closely spaced fine wires is arranged to traverse the pipe cross section in the fluctuating potential gradient. The electrical impulses of the probe are amplified and measured by means of a thermal milliammeter.

(47) GRAVITY WAVES AND RELATED PHENOMENON.

(b) Office of Naval Research and Bureau of Yards and Docks, Department of the Navy.
(d) Theoretical and laboratory investigations; basic research.
(e) To develop methods of forecasting wind waves and swell, surf conditions and beach change measurement of wave characteristics; and to make laboratory investigations to provide experimental checks and other information. A wave channel, ripple tank, model basin, an other facilities are used in the laboratory investigations.
(h) "The generation and decay of wind waves in deep water." C. L. Bretschneider, Trans. Ame Geophys. Union, Vol. 33, No. 3, June, 1952, pp. 381-389.
"Revised wave forecasting relationships." C. L. Bretschneider, Proc. Second Conference on Coastal Engineering, 1952, pp-1-5.
"Damping of water waves by vertical circular cylinders." R. D. Costello, Trans. Amer. Geophys. Union, Vol. 33, No. 4, Aug. 1952, pp. 513-519.
"Engineering aspects of diffraction and refraction." J. W. Johnson, Proc. A.S.C.E., Vol. 78, Separate No. 122, Mar. 1952, 32 p.
"Generalized wave diffraction diagrams." J. W. Johnson, Proc. Second Conference on Coastal Engineering, 1952, pp. 6-23.
"A laboratory investigation of wind-generated waves." J. W. Johnson nnd E. K. Rice, Trans. Amer. Geophys. Union, Dec. 1952, pp. 845-854.
"Wave measurements at the Columbia River light vessel, 1933-1936." M. P. O'Brien, Trans. Amer. Geophys. Union, Vol. 32, No. 6, Dec. 1951, pp. 875-877.
"The forces exerted by waves on objects." M. P. O'Brien and J. R. Morison, Trans. Amer. Geophys. Union, Vol. 33, No. 1, Feb. 1952, pp. 32-38.
"Salinity currents in estuaries." M. P. O'Brien, Trans. Amer. Geophys. Union, Vol. 33, No. 4, Aug. 1952, pp. 520-522.
"Amphibious surveying." D. A. Patrick, Civil Engineer Corps Bulletin, U. S. Navy, Jan. 1952, pp. 11-14.
"Near-coastal storms and associated waves." D. K. Todd and R. L. Wiegel, Trans. Amer. Geophys. Union, Vol. 33, No. 2, April 1952, pp. 217-225.

(280) SEDIMENT TRANSPORT.

(b) Laboratory project.
(d) Experimental and theoretical; for Doctoral thesis.

(e) Determination of the transport characteristics in the transition sizes between bed load and wash load.
(h) "Second approximation to the solution of the suspended load theory." H. A. Einstein and Ning Chien, Institute of Engineering Research, University of California, Tech. Report 47-2, Jan. 31, 1952.

(2) EFFECT OF FLOW RATE ON RELATIVE PERMEABILITY TO MULTIPHASE FLOW IN POROUS MEDIA.

(b) Sponsored by American Petroleum Institute.
(d) Experimental; basic research.
(e) To determine whether or not there is a linear relationship between volume flux per unit area and potential gradient for each fluid phase when two immiscible fluids flow simultaneously through a porous material. Iso-octane and a brine of water and sodium iodide are made to flow through porous materials at constant volume rates. Brine saturation is determined by x-ray absorption, and pressure drops in each phase are measured by means of semi-permeable membranes and electronic gages. Capillary pressure differences between phases is controlled by means of semi-permeable membranes.
(f) Completed.
(g) Results have indicated the possibility of rate sensitivity in the wetting phase saturation range exceeding immobile saturation and approximately 45 percent saturation.
(h) Report in preparation.

(9) LITTORAL SEDIMENT FLOW ON A BEACH.

(b) Beach Erosion Board, Washington, D. C.
(e) Three problems of sand movement along the beach and in shallow water off shore are being studied at Santa Barbara, Calif.: (1) rate of growth of the sand island in Santa Barbara Harbor inside the breakwater in order to indicate rate of movement of sand along the shore; (2) mineral studies of sand along the coast of California at Santa Barbara and westward in direction from which the sand comes in order to indicate the source of the sand and the distance the sand has traveled; and (3) detailed studies of sand movement in the off shore water and on the beach east of Santa Barbara Harbor.
(h) "Effect of a littoral barrier on a sandy coast." Ning Chien, and Huon Li, submitted to Beach Erosion Board, Aug. 1952.
"Sand transport by littoral currents." J. W. Johnson, Fifth Hydraulic Conference, Iowa Institute of Hydraulic Research, Iowa City, June 1952.
"Stationary dredge for by-passing sand at Salina Cruz Harbor, Isthmus of Tehuantepec, Mexico." Parker D. Trask, Beach Erosion Board, Bulletin, Vol. 6, No. 2, pp. 24-31, April, 1952.
"Strength of sediments in the Gulf of Mexico." Proc. Second Conference on Coastal Engineering, Berkeley, Calif., Vol. 2, pp. 145-157, 1952.
"Sand studies at Santa Barbara." Manuscript report of rate of growth of sand island in Santa Barbara Harbor, presented to Beach Erosion Board, July, 1952.
"Source of beach sand at Santa Barbara, California, as indicated by mineral grain studies." Beach Erosion Board, Tech. Memo. 28, Oct. 1952.

(10) VERTICAL SHAFT PUMP SUCTION REQUIREMENTS.

(b) Peerless Pump Division of Food Machinery Corporation.
(d) Experimental; applied research.
(e) An experimental investigation of vortex formation and air entrainment in the suction sumps of typical vertical shaft pump suction sump arrangements. Model and prototype comparisons to determine the feasibility of model tests. Studies of sump geometries for minimum submergence with no air entrainment and with negligible influence on pump performance. Special equipment was installed in the discharge lines from the pumps in order to measure the quantity of air being pumped in terms of the quantity of water. Visual observations were made regarding vortex formation and size under different conditions of geometry and submergence. Pump performance was determined as a function of sump geometry.
(f) Suspended.
(g) Model and prototype submergence and air entrainment results agree qualitatively. Optimum sump geometry for minimum submergence has been determined for rectangular plan form, end inflow sumps. Further work to be done to extend the range of investigated conditions.

(811) STUDY OF DETACHED SHOCK WAVES.

(f) Completed.
(h) "A study of transonic gas dynamics by the hydraulic analogy." E. V. Laitone, Jour. of the Aeronautical Sciences, Vol. 19, No. 4, pp 265-272, April, 1952.
"Study of the flow field behind detached shock waves at transonic velocities by the surface wave analogy." H. L. V. Nielsen, M. S. thesis, University of California, 1952.

(813) FLUID RESISTANCE IN ACCELERATED MOTION.

(b) Laboratory project.
(d) Experimental; for graduate thesis.
(e) The fluid resistance of bodies subject to accelerated motion is being studied. Data have been obtained for flat circular disks moving through water with the plane of the disk perpendicular to the direction of motion. A drag coefficient has been developed in terms of a correlative modulus that includes the acceleration of the system. A continuation with other bodies is planned.
(f) Suspended.

(1059) HEAT TRANSFER AND PRESSURE DROP IN COOLING TOWERS.

(b) American Society of Heating and Ventilating Engineers; laboratory project.
(d) Experimental and analytical.
(e) To determine the heat transfer from water in contact with air in a mechanical draft, packed cooling tower as a function of water rate, air rate, water temperature and packing geometry. To determine the pressure drop as a function of the above-mentioned variables.
(h) "Effect of packing density in a cross flow tower." W. S. Craig, M. S. thesis, 1952.

(1060) MASS TRANSFER TO RISING BUBBLES AND ON BUBBLE PLATES.

(b) Laboratory research.
(d) Experimental and analytical.
(e) A study of diffusion to bubbles and mass of bubbles.
(g) Some equipment has been completed; experimental research in progress on the mass transfer to single bubbles and to masses of bubbles on a 13 inch sieve plate.
(h) "Mass transfer in a rising bubble." G. Humphrey, M. S. thesis, Feb. 1953.

(1061) STREAMFLOW DISTRIBUTION OF SELECTED PACIFIC COAST BASINS IN CALIFORNIA.

(b) Laboratory project; Geophysics Institute, University of California.
(d) Basic research; analysis of available data.
(e) Development and analysis of flow-duration curves for representative drainage areas in order to relate shapes and slopes of the curves to known physical factors.
(f) Completed.
(g) Ten flow-duration curves were prepared for unregulated streams in California. A straight line approximation on logarithmic-probability paper did not accurately express the flow distributions. A fair correlation between percentage of time at the mean discharge and mean annual basic precipitation was indicated.
(h) "Aspects of stream flow distribution in California." Submitted to the Amer. Geophys. Union for publication in the Transactions.

(1304) VELOCITY DISTRIBUTION IN OPEN CHANNEL BENDS.

(b) Laboratory project.
(d) Theoretical and experimental.
(e) To describe and predict the cross-distribution of velocities in open channel bends.
(f) Completed; publication in progress.
(h) "Velocity distribution in channel bends." James A. Harder, M. S. thesis, 1952.

305) FLOW OF AIR-WATER MIXTURES IN OPEN CHANNEL FLOW.

(b) International Engineering Company.
(d) Experimental and theoretical.
(e) To predict the bulking of water by air in the discharge channels of impulse turbines under load rejection.
(g) On the basis of constant energy, it can be shown that both the velocity and the depth increase to various degrees with increasing air content.
(h) "Report on load rejection studies of the Alcan Power Plant." H. A. Einstein, R. C. Cooke, and O. Sibul, IER Series 39, Issue 31, University of California, Berkeley.

306) PARTICLE SEGREGATION IN AN AGGRADING STREAM.

(b) Corps of Engineers, Department of the Army.
(d) Experimental.
(e) Flume studies; one set of flume experiments completed.
(g) It was found that equilibrium equations for sediment transport hold also for aggrading streams, if the bed is defined by the composition of its surface layer. These relationships can be used for the individual grain sizes of mixtures with grains between 1.0 and 0.01 mm diameter over the entire range of sizes.
(h) Report in preparation.

307) DETERMINATION OF PRESSURE FLUCTUATIONS IN TURBULENCE IN LIQUID FLOW.

(b) Laboratory project, Research Corporation Grant.
(d) Experimental.
(e) Development of instruments and methods to measure pressure fluctuations in the free stream and at the flow boundaries. A Rutishauser pressure gage is tested for its applicability to the problem. The frequency response is measured and calculated for various measuring arrangements.

550) PRESSURE DROP ACROSS TAYLOR VORTICES.

(b) Laboratory project.
(d) Applied research.
(e) Measurements are being made of pressure drop across a one-pair system of Taylor vortices stabilized between two concentric rotating cylinders, under conditions of super-imposed axial flow. Possible application to oil seal designs for rotating shafts.
(g) Results are not yet conclusive. So far no pressure drops have been observed which are sufficiently large to be of practical significance in bearing design.

551) STUDY OF VERTICAL GAS-LIQUID FLOW IN PIPES.

(b) Laboratory project.
(d) Experimental and theoretical; basic research.
(e) Collection of data and photographs of gas-liquid flow in less than one inch diameter glass tubes. Analytical work to help explain flow transitions.

552) EFFECT OF WAVELENGTH ON PIPE FRICTION IN TRANSITION REGION FOR WAVED GLASS TUBES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Collection of one component pipe friction data on waved glass tubes to study effect of wavelength and amplitude on transition. Also to show rigid waved wall does not give exceptionally high friction factors.
(g) Early transition shown and correlated; little increase of friction.

553) HYDROFOIL INVESTIGATION.

(b) Laboratory project.
(d) Experimental; applied research, for Master's thesis.

(e) To determine from pressure distribution measurements the shape drag of a hydrofoil at various depths of emergence, and to compare the results with the theory.
(h) "Experimental investigation of the influence of submergence depth upon the wave-making resistance of a hydrofoil." John S. Ausman, M. S. Thesis, June 1952.

(1554) SEA WATER RESEARCH.

(b) State of California.
(d) Experimental; design.
(e) Experimental investigation of three methods of distillation, one of which is that of solar distillation involving certain hydraulic problems. The solar still consists of five units, each 4 feet wide by 50 feet long. A unit consists of a shallow tray in which sea water stands to a depth varying from 1/4 inch to 1 inch. The top is covered with a tent-shaped glass canopy which completely covers the tray. Solar energy coming through the glass heats the water and causes evaporation. Free convection of the water vapor thus formed causes condensation on the inside of the glass canopy. Water condensed is collected in troughs at the bottom of the sloping sides of the glass and flows by gravity toward one end of the unit. The five units differ from each other in constructional details and in bottom insulation. Performance of these units depends upon the circulation of air over the units as well as upon the intensity of solar radiation. Weather data related to air conditions and movements are being collected and performance of the units measured continuously.
(h) "Sea water as a source of fresh water." Everett D. Howe, Jour. Amer. Water Works Assoc., Vol. 44, No. 8, pp 690-700, Aug. 1952.

(1555) FORMATION OF A VAPOR PHASE FROM SUPERSATURATED LIQUIDS IN POROUS MEDIA.

(b) Laboratory project.
(d) Experimental; for Master's Thesis.
(e) Experimentation to see if a distributed gas phase may be evolved from a supersaturated liquid in a sample of porous sandstone by agitation with ultra-sonic irradiation. Present methods for determining capillary pressure-fluid saturation relations for porous materials requires the introduction of a non-wetting fluid phase across the external surface of the material thus requiring excessively long times to establish each equilibrium state. The method under study, if proved feasible, would permit the establishment of true equilibrium states very rapidly.

(1556) TRANSIENT BEHAVIOR OF FLUID SATURATION IN POROUS MEDIA DUE TO GRAVITY AND CAPILLARY FORCE FIELDS.

(b) Laboratory project.
(d) Experimental and theoretical; Doctoral Thesis.
(e) To develop fundamental information which may be used to formulate methods for analyzing petroleum reservoir behavior under gravity drainage and capillary retention. A theoretical solution has been obtained which predicts the change in liquid saturation as a function of time and space in a linear column of sand. If the solution is verified by experiment, it is then proposed to develop the necessary modifications for more complex systems.

(1557) THERMAL CONDUCTIVITY OF POROUS MEDIA AS A FUNCTION OF FLUID SATURATION.

(b) Laboratory project.
(d) Experimental and theoretical; Doctoral Thesis.
(e) To obtain experimental confirmation of a theory of heat conduction in porous material which relates to the structure porosity of the material, and the relative amounts of two different fluids contained in the pores. More complete information may show that parameters determined by heat flow may have possible application to interpretation of borehole measurements and certain other applications. Thermal conductivities to be correlated with electrical conductivities.

RSITY OF SOUTHERN CALIFORNIA, Hydraulic Laboratory, School of Engineering.

) CREATION OF ARTIFICIAL RAIN TO STUDY RUNOFF FROM AIRPORT RUNWAYS.

) Laboratory project; cooperative with Los Angeles District, Corps of Engineers.
) Dr. K. C. Reynolds, University of Southern California, Los Angeles 7, Calif.
) Experimental; basic research, design and M. S. Theses.
) Experiments completed.
) Report on field investigations in preparation by Los Angeles District, Corps of Engineers, assisted by Professor Glenn A. Foy of the University of Southern California.

ERSITY OF SOUTHERN CALIFORNIA, Research Foundation for Cross-Connection Control.

) RESEARCH FOUNDATION FOR CROSS-CONNECTION CONTROL.

b) Laboratory project.
c) Dr. Robert E. Vivian, Director, Research Foundation for Cross-Connection Control, University of Southern California, Los Angeles 7, Calif.
d) Experimental research and field investigations; basic research.
f) Laboratory being used intermittently for tests on backflow prevention devices and on water valves.

EGIE INSTITUTE OF TECHNOLOGY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1310, 1311, and 1558 to 1561, incl., should be addressed to Prof. F. T. Mavis, Carnegie Institute of Technology, Pittsburgh 13, Pa.

0) VIRTUAL MASS - ACCELERATION IN FLUIDS.

b) Laboratory project.
d) Theoretical and experimental; basic research for Doctoral Thesis.
e) Bodies of different shapes were accelerated in fluids to determine the increase in acceleration resistance (added mass) due to the fluid.
f) Completed.
g) In tests on thirty-two bodies from two to twenty inches in largest dimension, the experimental values for virtual mass agreed with theoretical values to two significant figures.
h) "Acceleration of bodies in fluids - a study of virtual mass." T. E. Stelson, D. S. Thesis, Carnegie Institute of Technology, 1952.

1) FLOW THROUGH VERTICAL SHAFTS.

b) Laboratory project; sponsored by Allegheny County Sanitary Authority.
d) Experimental; design.
e) Discharge was determined to be a function of headwater depth, pipe diameter, and shape and size of inlet tank. The dissipation of energy after the fall was studied for both spiral and axial flow. A quantitative study was made of the amounts of air entrained and the design of vents.
f) Completed.

58) CONVERGING AND DIVERGING STREAMS.

b) Laboratory project.
d) Theoretical and experimental; for Master's degree.
e) Tests will be conducted on converging and diverging channels. Relative depths of flow, discharge, and sediment flow will be studied for different angles of convergence and divergence.

(1559) DIFFUSION OF A SUBMERGED JET.

(b) Laboratory project.
(d) Theoretical; for Master's Thesis.
(e) Studies were made on the velocity distribution and diffusion of a submerged water jet in a confined stilling tank.
(f) Suspended.
(g) The boundary of the zone of diffusion and distribution of the longitudinal component o velocity at transverse sections in the zone of diffusion were found experimentally, an methods are presented for determining these values analytically.
(h) "Velocity distribution and diffusion of a submerged jet." Soe Hla, M. S. Thesis, Carnegie Institute of Technology, 1952.

(1560) AIR ENTRAINMENT BY FLOWING WATER.

(b) Laboratory project.
(d) Theoretical and experimental.
(e) The quantities of air entrained by water dropping down a vertical shaft are being measured.
(g) This study is a continuation of Project No. 1310, concentrating on the problem of air entrainment.

(1561) TESTS ON TILE FILTER BLOCKS.

(b) F. B. Leopold Company, Inc., Pittsburgh, Pa.
(c) Mr. L. M. Laushey, Carnegie Institute of Technology.
(d) Experimental and theoretical.
(e) The manifold problem of filter blocks in series was studied, and measurements were made on the loss of head and the discharge from each block. The data are organized to be useful in the design of filter underdrain systems.
(f) Completed.
(h) Report prepared for the sponsor.

COLORADO A AND M COLLEGE, Department of Civil Engineering.

Inquiries concerning Projects Nos. 52, 535, 537, 538, 822, 823, 828, 1073 to 1075, incl 1313 to 1315, incl., 1319, 1563 to 1568 incl., and 1570, should be addressed to Prof. Maurice L. Albertson, Department of Civil Engineering, Colorado A and M College, Fort Collins, Colorado.

(52) HYDRAULIC SAND SEPARATOR.

(b) Laboratory project.
(d) Experimental; applied research.
(e) To obtain data for design of hydraulic models, and to supply means of separating sand and gravel where a narrow size range is desired.
(g) An apparatus designed and built classifies sand according to fall velocity by a continuous flotation process. The process is purely dynamic in that sand is introduced directly into the flow. A check for duplication of results indicates that duplications within plus or minus one percent are obtained. Construction of a pilot apparatus is being completed to perform sand separation on a continuous basis of operation. Preliminary tests indicate satisfactory results.

(53) SAND TRAPS AND SLUICEWAYS.

(b) Soil Conservation Service, Colorado Agricultural Experiment Station.
(c) Mr. R. L. Parshall, Soil Conservation Service, Colorado A and M College, Fort Collins, Colo.

Experimental; applied research.
To develop design data for sand traps using vortex tubes, riffles, and deflectors alone, or in combination, and to perfect the design for sluiceways having a relatively flat grade which will effectively transport the bed load material from sand traps to a point of disposal. A new type of sand trap with automatic control has been designed and is under construction for testing in the laboratory.
Investigations, laboratory and field, of various designs of sand traps show that the vortex tube operated under favorable conditions has been successful. Installations of the riffle-deflector, vortex-tube sand traps, large size, have been efficient in removing the bed load. Based upon previous model studies and field experiences, a riffle-deflector, vortex-tube sand trap has been designed for the Kern County Land Company canal carrying 700 cfs. Final designs have been prepared for the riffle-deflector, vortex-tube sand trap for the Belmonte Hydroelectric Project, Bogota, Columbia, S. A.

SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.

Soil Conservation Service, Colorado Agricultural Experiment Station, Bureau of Reclamation, State Engineer of New Mexico, and State Engineer of Wyoming.
Mr. H. Stockwell, Soil Conservation Service, Colorado A and M College, Fort Collins, Colo.
Field investigations; applied research.
Systematic measurements of depths and water content of snow at high elevations in Colorado mountain areas for the purpose of forecasting the runoff of the principal rivers of the state in the interest of irrigation, power, domestic supplies, and other uses. Snow measurement data are correlated with runoff. Once the relationship is established, the snow measurement data are used to predict the runoff for the coming season.
For 1952, Colorado Agricultural Experiment Station, Miscellaneous Series Papers Nos. 506, 507, 508, 511, 512, 513, 515, 516, 517, 518, 519 and 520. These are the monthly Snow Survey reports for the Rio Grande, Colorado, and Platte-Arkansas Drainage Basin.

PHOTOGRAPHIC METHOD FOR MAKING SNOW SURVEYS.

Laboratory project.
Mr. Maxwell Parshall, Colorado A and M College, Fort Collins, Colo.
Field investigation; applied research.
Photographs of snow cover on a particular area of Cache la Poudre watershed are made.
Fairly good correlation has been obtained.

PERFORMANCE OF WELL SCREENS.

Colorado Agricultural Experiment Station, Soil Conservation Service, and various well screen manufacturers.
Mr. C. H. Rohwer, Soil Conservation Service, Colorado A and M College, Fort Collins, Colo.
Experimental; applied research.
(1) Measurement of loss of head in different types of well screens for discharges suitable for each screen. (2) Determination of the size of opening in well screens, diameter of screen, thickness of gravel envelope, and size and gradation of sand or gravel for most effective control of flow of sands of different finenesses into the well with least loss of head, and to determine the size of openings in well screens and diameter of screen for most efficient operation in natural sands and gravels of a given classification. An additional study is underway on the loss of head at interface of gravels of different sizes.
Using the momentum, energy, and continuity equations, a theoretical analysis has been developed which checked very closely with tests made on simplified well screens. By this means a system has been established for determining a single coefficient which completely describes the hydraulic characteristics of any commercially-manufactured well screen.
"Effect of well screens and gravel envelopes on flow of sand into wells." Carl Rohwer and Frank N. Leatherwood, Progress Report, Aug. 1952.

(535) FLOW IN CHANNELS OF DEFINITE ROUGHNESS.

(b) Laboratory project.
(d) Experimental; for design and Masters' Theses.
(e) To supply experimental data on the flow of water through a channel of definite roughness. An attempt is being made to use a type of roughness which can be easily reproduced and yet adequately serves as an index of roughness for flow in open channels. Preliminary tests have been completed, through the aid of the J. Waldo Smith Fellowship, in which natural gravel of various sizes from canals and rivers is used as the roughness. Future investigations include the determination of the sediment carrying capacity of channels with definite roughness.
(g) Tests have been completed using sheet metal baffle plates as a standard. From these data a single function has been established relating the Chezy resistance coefficient with the Reynolds number and the relative roughness. Preliminary tests have also been completed using natural roughness.
(h) "Artificial roughness standard for open channels." A. R. Robinson and M. L. Albertson, Amer. Geophys. Union Trans., Dec. 1952.

(537) VORTEX-TUBE SAND TRAPS.

(b) Laboratory project.
(d) Experimental; design and Masters' Theses.
(e) To obtain generalized data for design of the most efficient vortex tube as a sand trap in a canal.
(g) A tube placed at a 45-degree angle has been studied, and the relationship has been determined between the efficiency of the tube and such factors as the depth of flow, the discharge, the size of the bed material, the concentration of the bed material, and the relative elevation of the downstream lip of the tube. The resulting design curves permit the design of vortex tubes under prototype conditions for maximum efficiency.

(538) HYDRAULICS OF SPILLWAYS.

(b) Laboratory project.
(d) Experimental; design and Masters' Theses.
(e) To obtain generalized design information for spillways having the shape of the underside of the nappe from a sharp crested weir. Generalized tests are being made to determine the shape of the nappe with various negative pressures under it. Ultimately, the discharge coefficient and the pressure distribution will be obtained for all practical degrees of submergence and ambient pressures. These data will permit the designer to determine in advance the necessary shape of a spillway crest if a certain negative pressure is desired for a given head on the crest.
(g) Using data reported by others, and data obtained in this laboratory, dimensionless design curves have been developed which permit solving directly for the design head, the discharge, the height of the spillway, or the shape of the spillway crest. Further data have been obtained which show the effect of downstream submergence on the discharge and the pressure distribution over the spillway.

(820) THE STUDY OF SEEPAGE LOSSES FROM IRRIGATION CHANNELS.

(b) Soil Conservation Service, Bureau of Reclamation, Colorado Agricultural Experiment Station.
(c) Mr. C. H. Rohwer, Soil Conservation Service, Colorado A and M College, Fort Collins, Col
(d) Experimental and field investigation; applied research.
(e) Study of the factors influencing seepage from channels. It is hoped to perfect methods for making pre-investigations of seepage for the purpose of determining the seepage from existing canals, and predicting the seepage from proposed canals. Methods of measuring seepage will be evaluated to determine the limitations and advantages of each.
(h) "Progress report on the study of seepage losses from irrigation channels." A. R. Robinson, and Carl Rohwer, April, 1952.

1) GROUND WATER FLUCTUATIONS AND THEIR RELATION TO PUMPING.

b) Laboratory project.
c) Mr. W. E. Code, Colorado A and M College, Fort Collins, Colo.
d) Field investigation; applied research.
e) Measurements to the water table are made semi-annually in about 200 observation wells. These wells are located in the South Platte and Arkansas Valleys. As a measure of amount of pumping being done, data on electrical energy used for this purpose are also gathered.
g) There is a loose relationship between water table fluctuation and power used. The relationship is masked by river water-supplies in districts under canals.
h) Reports in Geological Survey Water Supply Papers.

2) DIFFUSION OF HEAT, VAPOR, AND MOMENTUM.

b) Cooperative with Office of Naval Research, Department of the Navy.
d) Experimental; basic research.
e) A controlled study in a wind tunnel of the fundamental principles describing the process of diffusion of vapor, heat and momentum from various surfaces. Eventually it is intended to use the fundamental information to aid in determining evaporation from free surfaces, land areas with various soil and crop covers, and plant surfaces, and heat and moisture losses from animals.
h) "Laminar free convection due to a line source of heat." C. S. Yih, Colorado A and M College, Report No. 7, Sept. 1952.
"On the asymptotic behavior of any fundamental solution of the equation of atmospheric diffusion and on a particular diffusion problem." C. S. Yih, Colorado A and M College, Report No. 8, Sept. 1952.

3) SCOUR IN A STILLING BASIN.

b) Laboratory project.
d) Experimental; for design and Master's Thesis.
e) A laboratory study of the scour in a stilling basin as the energy in a jet of water is being dissipated. It is planned to use jets of various shapes and angles of attack on the stilling basin, and the position of the jet relative to the stilling basin.
f) Inactive.
g) A study has been completed of the special problem of comparing the scour from a solid jet with that from a hollow jet valve. The jet was directed vertically downward at various velocities. Variables considered were the depth of the pool, the fall velocity of the erodable material and the size of the jet. Results showed that the depth and rate of scour depended upon the depth of water in the stilling basin and the size of the bed material. As expected, the larger the bed material, the smaller was the degree of scour. As the depth of the water in the stilling basin increased, the scour likewise increased to a maximum beyond which scour decreased as the depth increased.

28) INFLUENCE OF SHAPE ON THE FALL VELOCITY OF SEDIMENT PARTICLES.

b) Laboratory project.
d) Experimental; for design and Masters' Theses.
e) A controlled study of the fall velocity of various typical sands and gravels obtained from stream beds throughout the western United States, from a wind-blown sand dune, from a rock cruster and from a glacial moraine. Small glass spheres were also used. The fall velocity was correlated with the shape of the particle and the Reynolds number of the flow. Special consideration was given to the problem of determining a shape factor of a particle which would be significant, and yet easily determined. Some of the gravel-sized particles were dropped in mineral oil to obtain data in the lower range of Reynolds number to compare with the data obtained from the small-sand sized particles.
g) Three masters' theses have been written on this subject and a fourth thesis is now in progress. A report covering these theses is now in preparation. A practical shape factor was found to correlate reasonably well considering the irregular and random shape of the particles involved. The shape factor is $c/\sqrt{ab}$ where a, b, and c respectively are the long, intermediate, and short mutually perpendicular axes of the particle.

(h) "Influence of shape on the fall velocity of gravel-sized particles." R. H. Wilde, Master's Thesis, Colorado A and M College, Aug. 1952.
"Effect of shape on the fall velocity of gravel particles." M. L. Albertson, Proc. of Fifth Hydraulics Conference, Iowa City, Iowa, June, 1952.
"Influence of shape on the fall velocity of sedimentary particles." E. F. Schulz, R. H. Wilde, and M. L. Albertson, Report for Corps of Engineers in preparation, Colorado A and M College.

(1073) SEDIMENTATION STUDY USING A TURBULENCE TANK.

(b) Cooperative with U. S. Bureau of Reclamation.
(d) Experimental; basic research.
(e) The apparatus consisted of a rectangular glass-walled tank and a lattice system with a horizontal motion used to generate a relatively uniform turbulence. By using small glass spheres as the sediment, a study was made on the effect of temperature and seepage on the concentration gradient and amount of sediment in suspension. Flat vermiculite particles were used to study the effect of turbulence on fall velocity.
(f) Completed.
(g) Results explain to a considerable extent the variation of sediment concentration with temperature, depth, discharge, and bed material which has been noticed in natural stream
(h) Report in preparation.

(1074) HYDRAULICS OF STILLING BASINS.

(b) Laboratory project.
(d) Experimental; for design and Masters' Theses.
(e) To obtain generalized design information for stilling basins utilizing the hydraulic jump together with chute blocks, floor blocks, and sills.
(f) Inactive.
(g) Generalized tests have been completed using cubical floor blocks to force the hydraulic jump having a length equal to 3 and 5 times the downstream depth when the tailwater elevation is either normal or below normal.
(h) "Stilling basins." Special report by David Navon, Dec. 1951.

(1075) HYDRAULICS OF DROP STRUCTURES.

(b) Laboratory project.
(d) Experimental; design and Masters' Theses.
(e) A series of fundamental experiments to obtain generalized design information for drop structures generally associated with irrigation and drainage canals. In an attempt to develop systematically a simple and yet economical drop structure, an initial two-dimensional study is being made in which the erosion is determined immediately downstream fro a drop structure made of a vertical cut-off wall. The variation of scour with time is being measured for various vertical drops, discharges, tailwater heights, and size range of bed material.

(1076) INVESTIGATION OF THE ECONOMICS AND PRACTICABILITY OF SPRINKLER IRRIGATION IN COLORADO.

(b) Laboratory project.
(c) Mr. W. E. Code, Colorado A and M College, Fort Collins, Colo.
(d) Field investigation; applied research.
(e) The work is principally that of interviewing users of sprinkler systems with a view of obtaining their viewpoint on their particular use and data on costs. Many of these user have been interviewed as many as 10 times over a period of 3 or 4 years. Frequently soi auger tests are made to determine penetration. In connection with this project a four-year comparison has just been completed between sprinkling and furrow irrigation on an apple orchard.
(g) It appears that no further attempt is being made in Colorado to irrigate orchards by sprinkler. There is a continuing substantial growth for pasture irrigation. Cost of operation is about the greatest cause for dissatisfaction.
(h) "When to use sprinkler irrigation in Colorado." W. E. Code and A. J. Hamman, Colorado A and M Extension Service Bul. 405-A, June 1950.

HYDRAULICS OF ALLUVIAL CHANNELS.

Laboratory project and Omaha District, Corps of Engineers, Department of the Army.
Experimental and theoretical; basic research and design; for Masters' and Doctors' Theses.
The long range objectives of the project are to determine the hydraulic characteristics (including the sedimentary aspects) of alluvial channels. Consideration will be given to steady and unsteady flow, uniform and non-uniform flow, transportation of bed load, suspended load, bed material load, and wash load.
An attempt is being made to correlate the resistance coefficient (for wide alluvial channels) with the discharge, the slope, the characteristics of the bed material, and the properties of the fluid using existing data from laboratory channels, natural rivers, and canals.
A laboratory study for the Corps of Engineers has been initiated in which sediment-laden water will be recirculated in the flume to study the formation of dunes on the bed and to determine the variation of the sediment transport and the resistance coefficient with these formations.
Preliminary research has been completed on the development of meanders in alluvial material. For a single natural bed material and bed condition the discharge, the slope, and the time were varied. The results which were measured relative to time were: cross-section shape, meander width, meander length, resistance coefficient, and size and concentration of total sediment load.

MODEL STUDY OF LAKE HEFNER.

Bureau of Ships, Department of the Navy, and the U. S. Geological Survey.
Experimental; basic and applied research.
An attempt is being made to reproduce in a model the wind structure above Lake Hefner and the evaporation which took place from the lake as measured during intensive field investigations.
The model has been constructed and certain phases of the testing have been performed. The preliminary results indicate that the model-prototype comparisons will yield considerable information which may be used in predicting prototype behavior from the results of model studies.

WIND CHILL ON A LIFE-SIZED COPPER MAN IN A WIND TUNNEL.

Office of the Quartermaster General, Department of the Army.
Experimental; basic and applied research.
(1) To determine relationship between the coefficient of heat transfer, the ambient wind velocity, and the difference between skin and air temperature under various conditions of clothing and posture under simulated natural climatic conditions. (2) To develop formulas by which the rate of heat loss from a life-sized man may be predicted under various conditions of climate.
Completed.
"Determination of wind chill on a life-sized clothed copper man." J. E. Cermak, R. K. Thomas, and M. L. Albertson, Final Report, Army Quartermaster Corps Contract No. DA44-109-qm-584, June, 1952, (Available through Office of the Quartermaster General, Department of the Army.)

PARSHALL DEFLECTION-VANE METER FOR MEASUREMENT OF DISCHARGE IN CONDUITS.

Laboratory project; also sponsored by Alfred J. Ryan, Consulting Engineer, Denver, Colo.
Mr. R. L. Parshall, Hydraulics Laboratory, Colorado A and M College, Fort Collins, Colo.
Experimental; development.
To perfect a simple and practical meter for indicating the rate of flow through a uniform rectangular open channel. A specially designed curved vane is suspended from a horizontal axis (on pivot bearings) across the channel. The flow of water against the upstream face of the vane deflects it downstream. The amount of the deflection is controlled by a spring. The rate of flow is indicated on a dial by gear train. The rate of flow independent of the depth of water in the channel. The ultimate goal of this study is to provide an inexpensive meter for measuring irrigation farm deliveries.

(g) Various designs of vanes operated in a 2-foot wide channel for flows ranging from 1/4 10 cfs indicate the successful development of this type of measuring device. One of chief advantages is the small amount of loss in head incident to the measurement.

(1318) REYNOLDS NUMBER FOR FLOW THROUGH SANDS AND GRAVELS.

(b) Laboratory project.
(c) Prof. D. F. Peterson, Colorado A and M College, Fort Collins, Colo.
(d) Experimental; basic research for Masters' and Doctors' Theses.
(e) The length factor in Reynolds number for flow through sands and gravels is based on t diameter of the particle. This does not take into consideration changes in porosity the fact that particle sizes are not uniform. An attempt will be made to find some characteristic length based on the hydraulic properties of the sand or gravel which w result in standard values of Reynolds number.
(g) The permeability of sand was found to be proportional to a porosity function $n^3/(1-n$ where n is the porosity. Standard plots of Reynolds number and resistance coeffici were obtained for several sands using this porosity function. The effective diameter based on the hydraulic properties of graded sand was found to agree closely with the weighted mean diameter obtained by sieve analysis.
(h) Report in preparation.

(1319) PREVENTION OF ICING ON AIRPLANE WINGS BY LINE-SOURCE OF HEAT.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical; basic research.
(e) Differential equations are being solved to yield the temperature distribution near th boundary of a cylinder. The cylinder is placed in the air flow with its longitudinal axis perpendicular to the air stream with a line source of heat at its leading edge.
(h) "Temperature distribution in the boundary layer of an airplane wing with a line sourc of heat at the stagnation edge, Part I. Symmetric wing in symmetric flow." C. S. Yi J. E. Cermak, and R. T. Shen, Rept. under ONR Contract No. Nonr-544(00) Oct. 1952. (Available through Office of Naval Research, Department of the Navy, Washington, D. C

(1320) EVALUATION OF RAINMAKING OPERATIONS IN COLORADO.

(b) Laboratory project; also sponsored by the Northern Colorado Natural Resources Association, Fort Collins, Colo.
(c) Mr. T. H. Evans, Dean of Engineering, Colorado A and M College, Fort Collins, Colo.
(d) Field investigation; applied research.
(e) The study is concerned with analyzing the attempt to increase precipitation and impro precipitation patterns by the artificial nucleation of clouds over North Central Colo The methods of analysis being used are essentially the following (1) statistically studying precipitation on the target area and a control area; (2) comparing snow pack the target area and a control area, and (3) studying individual storms passing over t target and control areas.
(g) The results of the analysis indicate that there was no apparent increase in precipita resulting from cloud seeding during the period Mar. 1, to June 1, 1951 over North Cen Colorado.
(h) "Analysis of climatological data for the spring cloud-seeding period over North Centr Colorado." Final Report, Colorado A and M College Experiment Station, Fort Collins, Colo. June 1952.

(1562) HYDRAULIC HEAD LOSS AT THE INTERFACE BETWEEN SANDS OF DIFFERENT SIZE.

(b) Laboratory project.
(c) Prof. D. F. Peterson, Colorado A and M College, Fort Collins, Colo.
(d) Theoretical and experimental; basic research for Master's Thesis.
(e) Dimensional analysis and experimentation leading to formulas for additional head loss at interface between two sands of different size.
(f) Completed.

(g) Results indicate that in the viscous flow range the hydraulic head loss at the interface between two sands of different sizes may be expressed by the formula $h/d_s = CR$ where h represents the additional head loss at the interface, d_s is the mean diameter of the small-sized sand, R is Reynolds number and C is a constant which is related to the mean size and gradation of the two sands.

(h) "Hydraulic head loss at the interface between porous media of different sizes." Frank N. Leatherwood, Master's Thesis, Colorado A and M College, May, 1952.
"Hydraulic head loss at the interface between uniform sands of different sizes." Frank N. Leatherwood and Dean F. Peterson, Jr., (Report in preparation.)

563) LAMINAR FLOW BETWEEN A STATIONARY AND A ROTATING DISK.

(b) Laboratory project.
(d) Theoretical and experimental; for Master's Thesis.
(e) A study of the flow and the torque transmission between a rotating and a stationary disk. A solution of the Navier-Stokes equations of motion was introduced. Obtaining the velocity distribution between the disks, the torque transmitted from one to the other was computed. This computed value then was compared with the experimentally measured values of the torque.
(g) The tangential component of the velocity in the flow between the disks was found to be linearly distributed. The theoretical and experimental values of a dimensionless torque coefficient compared very well -- verifying the theoretical solution.
(h) "Laminar flow between a stationary and a rotating disk." A. Dad Farmanfarma, Master's Thesis, Colorado Agricultural and Mechanical College, 1952. (Available on loan).

564) CALCULATION OF UNSTEADY FLOW IN OPEN CHANNELS.

(b) Laboratory project.
(d) Theoretical; for Master's Report.
(e) Application of the existing methods to solve a number of practical examples in the fields of flood routing and flow in power, tidal, and irrigation canals. Merits of different methods will be studied.

565) SEDIMENT CARRYING CAPACITY OF CLOSED CONDUITS.

(b) Cooperative with Armco Drainage and Metal Products, Inc., Middletown, Ohio.
(d) Experimental; basic research.
(e) To determine the sediment carrying capacity of 12-inch diameter Hel-cor, corrugated, and smooth pipe; flowing full. Partial flow conditions will be studied if time permits. Bank run sediments will be used with mean sizes of 0.1 to 0.5 mm.

566) DIFFUSION OF GASES INTO AN AIR STREAM HAVING VARIOUS DEGREES OF STABILITY.

(b) Air Force Cambridge Research Center, 230 Albany Street, Cambridge 39, Mass.
(d) Experimental and theoretical; basic research.
(e) By means of a horizontal, heated, metal plate placed in the floor of a wind tunnel, the effect of various artificially created lapse rates upon mean velocity profiles and turbulence structures is being investigated. Also the effect of lapse rates upon the diffusion of gases from a point source and a line source will be studied.

567) BEHAVIOR OF SEA PLANE HULLS.

(b) Bureau of Aeronautics, Department of the Navy.
(d) Experimental.
(e) The behavior of sea plane hulls when towed at different angles to a wave train has never been studied experimentally. As a preliminary investigation, the motion of the models in an oblique sea will be studied by the use of photography.

568) BOUNDARY SHEAR IN OPEN TRAPEZOIDAL CHANNELS.

(b) Laboratory project.
(d) Experimental; for J. Waldo Smith Fellowship of the A.S.C.E.

(e) To supply experimental data on the shear distribution along the boundary of trapezoidal channels. This information is needed in connection with the new theory conceived by E. W. Lane on the design of stable alluvial channels. The shear will be measured instead of calculated from other hydraulic measurements.

(1569) USE OF COMBINED ELECTRICAL ANALOGY AND MEMBRANCE ANALOGY TO INVESTIGATE UNCONFINED FLOW INTO WELLS.

(b) Cooperatively by Departments of Physics and Civil Engineering, Colorado A and M College.
(c) Prof. D. F. Peterson, Colorado A and M College, Fort Collins, Colo.
(d) Theoretical and experimental; basic research.
(e) An analogous well in which the fluid was replaced by electric current and the aquifer by a conducting liquid was modelled for the unconfined case. A rubber membrance was used as an analogue to the unknown gravity boundary. The equipotential surface at the well was modelled by a rod of high conductivity and the seepage surface by a linearly-varying resistance. Flow and potential distribution was investigated for various potential boundary conditions.
(f) Completed.
(g) Following Hansen's dimensional analysis $Q/kr_w^2 = F\ (h_w/r_w), (h_s/r_w)$, where Q is the discharge, k the hydraulic conductivity, r_w the well radius, h_w the depth of water in the well and h_s the height to the top of the seepage surface, graphs were developed leading to the solution of the seepage surface. Similitude of well systems of different geometry was studied.
(h) "Use of combined electrical and membrance analogy to investigate unconfined flow into wells." C. H. Zee, Ph. D. Thesis, Utah State Agricultural College, May, 1952. (On file at Libraries of U.S.A.C., Logan, Utah, and Colorado A and M College, Fort Collins, Colo.) Information on seepage face was also included in "Hydraulics of wells." D. F. Peterson, O. W. Israelsen and V. E. Hansen; Utah Agric. Exp. Sta. Bul. 351 (technical) Mar. 1952. (Available from Director, Exp. Sta., Logan, Utah.)

(1570) DEVELOPMENT OF A CONSTANT FORCE BOTTOM FOR SEAPLANE HULLS.

(b) Bureau of Aeronautics, Department of the Navy.
(d) Experimental; developmental.
(e) To develop a shape of seaplane hull which will experience a constant acceleration upon impact. The procedure used is to determine the empirical corrections necessary to adapt the theoretically ideal bottom contour to actual conditions. The tests are conducted by dropping vertically the two-dimensional hull contours into water. The acceleration-time history is measured by photographing the output from an electronic transducer on an oscilloscope screen. The water surface profile is photographed during impact to measure the "pile-up" of the water.

UNIVERSITY OF COLORADO, Hydraulics Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1571, 1572, and 1573 should be addressed to Prof. Warren DeLapp, University of Colorado, Boulder, Colo.

(1571) FREE OVERFALL STUDIES.

(b) Laboratory project.
(d) Experimental; basic research for Master's Thesis.
(e) Tests are being conducted to determine the effects of channel slope and roughnees on the water surface profile in the vicinity of a free overfall.

(1572) HYDRAULIC JUMP AT JUNCTION OF STEEP AND MILD SLOPES.

(b) Laboratory project.
(d) Analytical; for design and Master's Thesis.
(e) Existing data is being studied and design charts constructed which will permit rapid determination of the location of the hydraulic jump at the toe of a slope.

(73) DESIGN CRITERIA FOR STILLING BASINS.

(b) Laboratory project.
(d) Analytical; for design and Master's Thesis.
(e) Studies are being made of existing data in an effort to establish criteria for the preliminary design of stilling basins in which baffles are used.

UMBIA UNIVERSITY, Fluid Mechanics Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 60, 62, 289, 290, 541, 1323, and 1324 should be addressed to The Director, Fluid Mechanics Laboratory, Department of Civil Engineering, Columbia University, New York 27, N. Y.

(60) FLOW OF FLUIDS THROUGH GRANULAR (POROUS) MEDIA.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic research.
(e) To establish rational expressions for permeability of porous beds consisting of grains of uniform size.
(f) Completed.
(h) "Laminar flow through granular media." S. Tsakonas, Master's Thesis, 1952.

(62) HYDRAULIC STRUCTURES.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic research.
(e) Experimental work is in progress for study of boundary layer regimen in intake reaches in open channels.
(g) Theory and preliminary experiments indicate a definite interaction of the boundary layer growth and the flow outside the boundary in an open channel near critical flow.

(289) SEPARATION PATTERNS IN THEIR RELATION TO LOCAL "FORM RESISTANCES."

(b) Laboratory project.
(d) Experimental; Masters' Theses.
(e) Experimental work has been completed for the case of abrupt expansion of a pipe including the effect of a spiral component of velocity artificially introduced just before the expansion.
(h) Three Masters' theses are being written.

(290) HYDRAULICS OF SHORT OUTLETS IN BODIES OF DAMS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental.
(e) Investigation of the boundary layer regimen in outlet conduits. Pressure distributions along a nozzle and pipe will be measured and velocity distribution will be determined by Pitot tube.

(541) PATTERNS OF FLOW OVER WEIRS OF STANDARD OGEE FORMS.

(b) Laboratory project.
(d) Experimental; M. S. Thesis.
(e) To investigate the physical features of the flow phenomena associated with spillways particularly under submerged conditions.
(f) Completed.
(g) A complete description of the flow patterns and discharge coefficients for flow over standard ogee forms including full range of submerged conditions were obtained.
(h) "Submerged flow over dams." S. Zubkoff, M. S. Thesis, 1952.

(1323) STUDY OF ENERGY EQUATIONS IN TURBULENT FLOW.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical; basic research.
(e) Review of various forms of the equations of motion and of energy for the general case of turbulent flow of a real fluid. Reduction of the equations for special cases is discussed. Emphasis is on physical interpretation of the various terms involved and their correlation to experimentally measureable quantities.
(g) A preliminary analysis has been completed.

(1324) LOSSES IN TWO-DIMENSIONAL JUNCTIONS.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic research.
(e) A study of flow patterns at junctions in rectangular conduits which can be considered two-dimensional flow with particular attention to the influence of initial velocity distribution on the characteristics of the side jet. Preliminary tests have indicated significant departure from potential flow solutions.

UNIVERSITY OF CONNECTICUT, Hydraulic Research Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1574 to 1577, incl., should be addressed to Professor E. V. Gant, Box U-37, University of Connecticut, Storrs, Conn.

(1078) HYDROLOGIC FACTORS INFLUENCING RAINFALL-RUNOFF RELATIONSHIPS ON SMALL WATERSHEDS IN EASTERN CONNECTICUT.

(b) Laboratory project.
(c) Prof. K. C. Tippy, Box U-37, University of Connecticut, Storrs, Conn.
(d) Field investigation; applied research.
(e) Rain gages are being installed on the 4.5 sq mile watershed of the laboratory and on additional sites varying in size from 4 to 400 acres. Runoff weirs have been completed and installed with recording gages on the latter. Measurements are being taken.

(1079) STUDY OF WIND EFFECTS ON STRUCTURES.

(b) Laboratory project.
(c) Mr. A. L. Mirsky, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental; applied research.
(e) A study of wind action and flow on the roofs of various types of buildings and structures is to be conducted in a small wind tunnel.

(1080) STUDY OF HYDRAULIC DESIGN OF CURB INLETS.

(b) Laboratory project; State Highway Department.
(c) Prof. V. Scottron, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental; for design.
(e) Involves the hydraulic and structural design of the curb inlet type of catch basin, with particular reference to the hydraulic efficiency of the grate now used by the State Highway Department. Half-scale models of highway gratings are under test.

(1574) VARIATION IN AMOUNT OF FROST HEAVE WITH DEPTH OF GROUND WATER TABLE.

(b) Laboratory project; State Highway Department.
(d) Experimental; applied research.
(e) Investigation is under way on a series of 12 test cells, 6 containing silt and 6 glacial till at depths from 2 1/2 to 6 ft. Observations taken on heave, depth-temperature variation, and water consumed from water table.

) EFFECT OF WASHED CONCRETE SAND IN INCREASING CAPILLARY RISE AND FROST HEAVING IN ADJACENT SOIL.

) Laboratory project; State Highway Department.
) Theoretical and experimental; applied research.
) Investigations are being made of the effect of washed concrete sand in raising the ground water table in adjacent silt or glacial till.

) CAPILLARY POTENTIAL OF VARIOUS MATERIALS.

) Laboratory project; State Highway Department.
) Theoretical; applied research.
) Preliminary studies are under way.

) FILTER TESTS OF VARIOUS MATERIALS.

) Laboratory project; State Highway Department.
) Experimental; applied research.
) A study of the stability of filters has begun.

LL UNIVERSITY, School of Civil Engineering.

Inquiries concerning Projects Nos. 1579 and 1580 should be addressed to Prof. M. Bogema, and concerning Projects Nos. 1327, 1328, 1578, 1581, 1582, and 1583 to Prof. Andre L. Jorissen, School of Civil Engineering, Cornell University, Ithaca, N. Y.

7) STUDY OF FLOW-METERING DEVICES FOR LOW REYNOLDS NUMBERS.

b) Builders-Providence, Inc., laboratory project.
d) Experimental; development; Master's Thesis.
e) To develop devices for measuring the rate of flow in pipelines maintaining a constant coefficient of discharge at low Reynolds numbers.
g) Cylindrical nozzles with conical diffusers are studied.
h) "Discharge measurements by means of cylindrical nozzles." A. L. Jorissen and H. T. Newton, Trans. ASME, July 1952.

8) EFFECTS OF ROUGHNESS ON DISCHARGE COEFFICIENT OF FLOW-METERING DEVICES.

b) Builders-Providence, Inc., laboratory project.
d) Theoretical and experimental.
e) To investigate the relationship between pipe roughness and Venturi tube coefficient.

8) EVALUATION OF TOLERANCES AND ERRORS ON THE COEFFICIENT OF DISCHARGE OF FLOW-METERING DEVICES.

b) Research Committee on Fluid Meters, American Society of Mechanical Engineers.
d) Analytical.
e) To establish tolerance values for the coefficient of discharge of orifices, nozzles, and Venturi tubes.
g) "On the evaluation of the accuracy of the coefficient of discharge in the basic flow measurement equation." A. L. Jorissen, ASME Annual Meeting, Dec. 1952.

9) FLOW THROUGH BUTTERFLY VALVES.

b) R.-S. Products Corporation, Philadelphia, Pa.
d) Experimental; operation.
e) Head loss coefficients and torque determined for wide range of flows through 10" and 24" Butterfly Valve.
f) Completed.

(1580) FLOW THROUGH 20-INCH ROTOVALVE.

(b) S. Morgan Smith Company, York, Pa.
(d) Experimental; operation.
(e) Head loss coefficients determined for various plug angles and rates of flow. Maximum discharge rate 64 cfs.

(1581) FLOW NOZZLE CALIBRATIONS.

(b) Builders Providence, Inc., Providence, R. I.
(d) Experimental.
(e) Calibration of 11 insert nozzles, 6.421 x 3.957 in.
(f) Completed.

(1582) FLOW CONTROLLER TEST.

(b) Builders Providence Inc., Providence, R. I.
(d) Experimental.
(e) Study of the behavior of a 12 in. flow controller under relatively high head. Determination of the coefficient of discharge and of the rate of leakage.
(f) Completed.

(1583) TESTS OF FLANGED SILENT CHECK VALVES.

(b) Williams Gauge Company, Pittsburgh, Pa.
(d) Experimental.
(e) Loss of pressure at various rates of flow through 6, 10, and 12 inch check valves of different designs.
(f) Completed.

GEORGIA INSTITUTE OF TECHNOLOGY, School of Civil Engineering.

Inquiries concerning Projects Nos. 291, 1332 to 1334, incl., and 1584 should be addressed to Prof. C. E. Kindsvater, and Projects Nos. 1331 and 1585 to Prof. M. R. Carstens, School of Engineering, Georgia Institute of Technology, Atlanta, Ga.

(291) FLOW OF WATER OVER HIGHWAY EMBANKMENTS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Tests on a 1:6-scale model of a typical highway embankment section have been completed. Preliminary tests on a 1:12-scale model are underway. Variables include roughness and shape of crown, slope and height of embankment. Data include discharge calibration, water-surface profiles, and tailwater levels corresponding to (1) free flow, (2) incipient submergence, (3) lower limit of surface flow, (4) upper limit of plunging flow, and (5) submerged flow.
(f) Temporarily suspended. To be reactivated during the next year as a part of a sponsored general investigation of the flow of water over weirs and spillways.

(1331) THE DIFFUSION MECHANISM OF FOREIGN PARTICLES IN A FLUID.

(b) Laboratory project; University Center of Georgia.
(d) Experimental; basic research.
(e) The diffusion of macroscopic foreign particles is being studied by means of the particle concentration in a vertical diffusion chamber. The spherical particle concentration is to be measured by the dispersion of a parallel light beam on a photoelectric cell. The spherical glass particles will be of sufficient size such that the difference in the diffusion of fluid particles and foreign particles can be studied in detail.

) TRANQUIL FLOW THROUGH OPEN-CHANNEL CONSTRICTIONS.

b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
d) Experimental; basic research.
e) Tests have been conducted on various forms of width-constrictions in level channels of various cross-sectional shapes. Flows are limited to the tranquil; range of boundary conditions governed by standard practice in bridge-waterway construction. Present investigation is confined to the discharge characteristics of the contracted channel. Future investigation will include an investigation of the total backwater effect.
f) A satisfactory analysis has been achieved for discharge through a wide variety of constrictions.
h) "Tranquil flow through open-channel constrictions." C. E. Kindsvater and R. W. Carter, Convention Preprint No. 21, A.S.C.E.

3) MODIFICATION OF MARTIN DAM POWERHOUSE DRAFT TUBES.

b) Alabama Power Company.
d) Experimental; for design.
e) Proposed modifications to improve the performance of existing draft tubes were investigated. Performance was judged by the hydraulic efficiency of the draft tube as a diffuser, stability of flow pattern, and pressure and velocity distribution. Each model set-up was tested for various degrees of initial whirl. The adopted modification consisted of a half-pyramid placed in the heel of the tube.
f) Completed.
h) "Martin Dam draft-tube modifications based on hydraulic model studies." The Inter-American Convention of the A.S.C.E., San Juan, Puerto Rico, Nov. 18, 1952, (to be published).

4) DIAMETRIC OBSTRUCTIONS TO FLOW IN CIRCULAR CONDUITS.

b) Laboratory project.
d) Theoretical and experimental; basic research for Masters' Theses.
e) A theoretical analysis of the energy loss due to small obstructions (e.g. rods, struts) in circular conduits will be checked in the laboratory. The effect of shape and relative size of the obstruction will be investigated as a function of fluid properties and upstream flow characteristics.
f) Research for one thesis complete.

4) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
d) Library search, re-analysis and correlation of published data, and original research.
e) A comprehensive study of the discharge characteristics of all practical forms of weirs and spillways, with emphasis on the effect of geometry on the discharge function. Initial phase will involve the preparation of a bibliography and the correction of empirical data from all known sources. Preliminary analyses based on the available data will be supplemented by original research as required.

5) EVALUATION OF AN AXIAL-FLOW TURBINE.

b) Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Ga.
d) Experimental; applied research for design.
e) Tests were conducted on a small axial-flow turbine in the usual manner. The tests were conducted with the fluid confined to pass through the turbine, and the results were interpreted for the case of a turbine suspended in an infinite fluid.
f) Completed.

HARVARD UNIVERSITY, Department of Mathematics.

(1335) MATHEMATICAL THEORY OF WAVES.

(b) Office of Naval Research, Department of the Navy.
(c) Dr. Jack Kotik, 21 Vanserg Building, Harvard University, Cambridge 38, Mass.
(d) Theoretical.
(e) The heat equation has been introduced into the wave resistance problem and has led to new expressions which have both theoretical and computational value.
(h) "Sur les ondes de pesanteur à deux dimensions d'energie finie." J. Kampé de Fériet an J. Kotik, Comptes Rendus de l'Academie des Sciences, July 21, 1952.

(1586) STUDIES OF TWO-DIMENSIONAL FREE JETS.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Allyn Richardson, 307 Pierce Hall, Harvard University, Cambridge 38, Mass.
(d) Experimental.
(e) A vertical 25' x 5' diameter pressure tank provides approach to 3.0" x 1.5" (30-75 fps jet that emerges between two parallel, transparent plates 1.5" apart and impinges symmetrically on plates, wedges, and cylinders. The recirculated water is introduced bel the top of the tank and passes downward through a 1" cellulose sponge filter one foot below the entrance. After 9 ft of unobstructed travel, the flow passes through a bron screen (100 meshes/inch) and enters a 45-degree cone terminating in a 1' diameter opening. A nozzle designed to prevent separation provides transition from the cone to the 3.0" x 1.5" rectangular section. Measurements of location of free boundary velocity a total head in interior are being compared with theory.

UNIVERSITY OF IDAHO, Engineering Experiment Station.

Inquiries concerning Projects Nos. 547, 1091, and 1587, should be addressed to Prof. C Warnick, College of Engineering, University of Idaho, Moscow, Idaho.

(547) STUDY OF PRINCIPLES, DEVELOPMENT, AND USE OF HIGH ALTITUDE PRECIPITATION GAGES.

(b) Laboratory project; cooperative with United States Army Engineers, Weather Bureau, Forest Service, and Bureau of Reclamation.
(d) Experimental; design and development.
(e) Tests conducted on movement of air around precipitation gages using sawdust to simulate snowstorm conditions. Information is being sought regarding proper design of windshields, Precipitation gages have been installed at Mullan Pass, Idaho, and at Priest River Experimental Forest to check the performance of various shield designs under actu operating conditions against performance observed in the wind tunnel.
(g) Photographs obtained illustrating wind behavior with sawdust blowing around the gages, with and without shields. Comparative catch tests made, using sawdust as a simulated snowstorm. Methods have been developed for studying theoretical true catch of sawdust in model precipitation gages.
(h) "Model testing of precipitation gages." T. P. Krein, The Idaho Engineer, Vol. 29, No. 3, April, 1952.

(1091) A STUDY OF CANAL LININGS FOR CONTROLLING SEEPAGE LOSSES.

(b) Laboratory project; cooperative with U. S. Bureau of Reclamation.
(d) Field investigation; applied operational research.
(e) A study is being made of the effectiveness and permanency of different types of canal linings by installing short test sections of lining in operating canals. Information i being obtained on permeability of soil before construction, and seepage loss before anc after lining.
(g) Three years of field study have been completed and much data collected on methods of placing linings, seepage losses, and performance of the test sections.
(h) "A study of canal linings for controlling seepage losses." C. C. Warnick, Progress Report, Engineering Experiment Station, University of Idaho, 50 pages, April, 1952. (Mimeographed copies.)

(87) WIND TUNNEL STUDIES OF WINDSHIELD FOR RADIO-REPORTING RAIN AND SNOW GAGE.

(b) Laboratory project; cooperative with Bureau of Reclamation.
(d) Experimental; design and development.
(e) Wind tunnel tests were conducted on model precipitation gages under artificial snowstorm conditions to determine suitable intake design for precipitation gage and to provide the best type of shielding against the adverse action of winds.
(f) Completed.
(g) Catchment tests and airflow studies gave information for designing a satisfactory intake tube for the precipitation gage; and, from numerous configurations investigated, a new shield design was perfected. Six prototype windshields have been fabricated and furnished the Central Valley Project in California.
(h) "Report on behavior in wind tunnel of models of shelter house and intake section for radio-reporting rain and snow gage--Sacramento River Flood--Bureau of Reclamation, Central Valley Project, California." C. C. Warnick and W. U. Garstka, Progress Report, Engineering Experiment Station, University of Idaho, 18 pages, April 29, 1952. (Available on loan.)
"Wind tunnel studies of windshield for radio-reporting rain and snow gage." C. C. Warnick, Final Report, Project No. 25, Engineering Experiment Station, University of Idaho, 19 pages, September, 1952. (Available on loan.)

ILLINOIS INSTITUTE OF TECHNOLOGY, Technology Center.

(1) FRICTIONAL RESISTANCE IN ROUGH PIPES.

(b) Office of Naval Research, Department of the Navy.
(c) Dr. V. L. Streeter, Illinois Institute of Technology, Chicago 16, Ill.
(d) Experimental; basic research.
(e) An investigation of the Darcy friction factor and of the velocity distribution in artifically roughened pipes at Reynolds numbers less than 20,000. Measurements were made on 4 1/2-inch aluminum pipe with machined square thread type roughnesses using oil as a working fluid. Several longitudinal spacings of each of three different relative roughnesses are yet available for test.
(f) Discontinued.
(g) Measurements of roughnesses, E/D = 0.0203; 0.0112; and 0.00563 completed covering a range of Reynolds number from 1000 to 20,000. In addition, measurements of smooth pipe flow over the same range were completed using 4-inch brass pipe.
(h) "Frictional resistance in rough pipes." E. A. Brunauer, Final Report, Office of Naval Research, Department of the Navy, Contract No. N7onr-32910, Project NR 062-079, July 1952.

ILLINOIS STATE WATER SURVEY DIVISION, Champaign.

(551) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project, cooperative with U. S. Geological Survey.
(c) Mr. W. J. Roberts, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research, design.
(e) Measurements are being made of watershed rainfall and stream flow, of stage, discharge over the spillway, and municipal pumpage on five small water supply reservoirs in Illinois.
(g) Twenty-two years of continuous measurements completed. Annual summaries 1946 to 1952 available for limited distribution.

(552) SEDIMENTATION OF ILLINOIS RESERVOIRS.

(b) Laboratory project, cooperative with Soil Conservation Service and Illinois Agricultural Experiment Station.
(c) Mr. J. B. Stall, Illinois State Water Survey Division, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) For design of water supply reservoirs, measurements of sediment accumulation have been made on sixteen lakes in Illinois. Sediment samples are being analyzed and complete surveys of watershed soil type, slopes, land use, and conservation practices are being made.
(g) Results at Lake Decatur, Decatur, Ill., showed correlation between rate of sedimentation and land use on the watershed.
(h) Reports of Investigation Nos. 4, 7, 8, 9, 10, 12, 15, and 16; sedimentation surveys of Spring Lake, Ridge Lake, Late Chautauque, Carbondale Reservoir, Lake Bracken, West Frankfort Reservoir, Lake Calhoun, and Lake Springfield, respectively.

(553) RADAR-RAINFALL PROJECT.

(b) Laboratory project, cooperative with Signal Corps, Department of the Army.
(c) Mr. G. E. Stout, Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Field investigation; basic research.
(e) A radar installation is being used to track rain clouds, showing extent, movement, and intensity of each rain area. Four concentrated recording rain gage networks consisting of 9, 24, 26 and 50 rain gages each yield rainfall data which are correlated with photographic records of the radar PPI scopes. Precipitation particle-size data are being collected in a volume of one-third cubic meter using high-speed photography. These data will be correlated with radar echo-return. Twenty-one rain gages concentrated with 300 square feet are collecting data on the variability of precipitation within a very small area.
(g) Results ineicate that radar is capable of matching an equivalent rain gage spacing of at least the gage each 150 square miles.

(555) EVAPORATION IN ILLINOIS.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Illinois State Water Survey Division, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Measurements are being made of evaporation at three stations in northern, central, and southern Illinois. Vapor pressure gradients are obtained at Four-Mile Crib in Lake Michigan and at Urbana.
(g) One Year's record at Four-Mile Crib indicated 41.7 inches evaporation for a period Sept. 1950-Aug. 1951 incl. Equipment at Urbana being rebuilt after laboratory study.
(h) Report presented at joint meeting A.M.S. and A.G.U., Sept. 12, 1952.

(561) GROUND WATER INVESTIGATION IN THE EAST ST. LOUIS AREA.

(b) Laboratory project.
(c) Mr. Jack Bruin, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research.
(e) To evaluate the ground water resources of the American Bottom (E. St. Louis region). Ground water levels are measured continuously. Pumpage, river stage, and rainfall data are collected. Chemical quality of ground water is measured. Areas of infiltration are determined, and all data are correlated with consideration of local conditions. Statistical studies have been made of the service lines of municipal wells.
(g) Average daily ground water pumpage in the area is between 100 and 110 million gallons. Since 1941 there has been no recession of ground water except in areas of highly concentrated pumpage. The data indicate the water-bearing formations are being recharged by water from the Mississippi River, local rainfall, and upland drainage.
(h) "Preliminary report on the ground water resources of the American Bottom." Report of investigation No. 17, Illinois State Water Survey, 1952.

43) GROUND WATER RESOURCES IN JO DAVIESS, STEPHENSON, AND CARROLL COUNTIES.

(b) Laboratory project.
(c) Mr. H. F. Smith, Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Field investigation; applied research.
(e) To determine ground water resources of the area, water level contours of the sandstone aquifers, transmissibility and storage coefficients of the aquifers, quantity of water available were obtained.
(g) Data indicate that piezometric surface conforms generally with topography, with a 500-foot drop in about 30 miles with no apparent withdrawal. The sandstone aquifers are overlain with 100 to 300 feet and more of impervious limestone.

44) GROUND WATER RESOURCES IN CHAMPAIGN COUNTY.

(b) Laboratory project.
(c) Mr. H. F. Smith, Illinois State Water Survey Division, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) To determine ground water resources of the county, water level contours of two glacial aquifers. Pumping tests to determine transmissibility, rates of flow into heavily pumped areas.
(g) Data show little, if any, communication between two glacial aquifers. Withdrawal in heavily pumped area exceeds recharge by 30 percent.
(h) "Ground water resources in Champaign County." H. F. Smith, Report of Investigation No. 6, Illinois State Water Survey Division. (Available on request.)

092) HYDROLOGIC CYCLE EVALUATION.

(b) Laboratory project; cooperative with the U. S. Geological Survey.
(c) Mr. H. E. Hudson, Jr., Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research.
(e) Data from rain gage networks (gathered under Project 553) together with information from five stream-gaging stations and five ground water level recorders are being maintained. Data will be used in analyzing storm rainfall-runoff relationships on small watersheds and effect of runoff on water table.
(g) Analysis in progress.

336) DESIGN OF A 60-FOOT TILTING FLUME.

(b) Laboratory project.
(c) Dr. G. H. Nelson, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Experimental; design.
(e) Design of versatile flume for hydraulic laboratory.
(f) Design completed, awaiting fabrication.

337) DESIGN OF BUBBLER SYSTEM FOR MEASUREMENT OF WATER LEVELS IN WELLS.

(b) Laboratory project.
(c) Mr. G. H. Nelson, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Experimental; applied research.
(e) Development of accurate method of water level measurement with minimum opportunity for observer error. Tests of effect of field transport conditions and temperature variations on the accuracy of pressure recorder to be used with above project. Determination of accuracy obtainable by use of present methods of water level measurements.

339) FLOW THROUGH POROUS MEDIA.

(b) Laboratory project.
(c) Mr. H. E. Hudson, Jr., Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Applied research.
(e) A study of the application of Hatch's equation in the transition region.
(f) Completed.
(h) Report was presented before the Second Midwest Conference on Fluid Mechanics, Ohio State University, March 1952 for publication.

(1340) PHYSICAL PROPERTIES OF FLUIDS.

(b) Laboratory project.
(c) Mr. A. M. Buswell, Chief, Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Experimental.
(e) Investigations to determine if any measurable changes in physical properties occur in fluids during flow.

(1341) CORROSION STUDY.

(b) Laboratory project.
(c) Dr. T. E. Larson, Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Experimental.
(e) A basic study of corrosion occurring at the steel electrodes under flow through a twenty foot plastic tower.

(1342) STUDY OF CORROSION AND DEPOSITION RATES WITH DIFFERENT FLOW RATES.

(b) Laboratory project.
(c) Dr. T. E. Larson, Illinois State Water Survey Division, Box 232, Urbana, Ill.
(d) Experimental.
(e) One-half inch pipes made of different materials are in service. Changes in flow due to corrosion and at constant head are being measured.

(1588) RADAR AS A WEATHER FORECASTING AID.

(b) Bureau of Aeronautics, Department of the Navy.
(c) Mr. G. E. Stout, State Water Survey Division, Box 232, Urbana, Ill.
(d) Field investigation; basic and applied research.
(e) Three and 10-cm wavelength radar is being used to track rain clouds. Radar data are being correlated with surface weather when echoes occur at Weather Bureau stations within 150 miles of the radar station. Also correlations are being made between the movement of echoes produced by rain clouds and upper air winds as determined by Weather Bureau and Air Force winds-aloft stations in the area.
(g) Results indicate that radar will give accurate winds-aloft data in areas with echoes, and can aid in short-range forecasting of the time of wind and intensity of weather to be expected from a particular echo or area of echoes.

ILLINOIS STATE WATER SURVEY DIVISION, Peoria.

Inquiries concerning Projects Nos. 556 to 560, incl., 845, and 1335 should be addressed to Dr. Max Suter, Engineering Research Subdivision, Illinois State Water Survey Division, Box 717, Peoria, Ill.

(556) PERMEABILITY OF GRADED SAND MIXTURES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The permeabilities of known mixtures of graded sand are measured to determine functional changes.
(g) Sand mixtures containing 60 to 70 percent of fine material in 40 to 30 percent of coarser from 2 adjoining sieves of the $\sqrt{2}$ series have less permeability than the material of the fine screen alone.

(557)) TURBULENT FLOW THROUGH GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Critical flow is determined to define conditions under which turbulent flow occurs outside of well screens.

) In flow through granular media, the Reynolds number cannot be calculated from ordinary formulas. By assuming a critical Reynolds number as existing at the determined critical flow conditions, the corresponding pore size can be calculated. This has been done in preliminary tests, but further work is needed to get a correlation with screen analysis.

3) STUDY OF CAUSES AND PREVENTION OF SAND BOILS.

b) Laboratory project.
d) Field investigation; basic research.
e) Sand boils occurring during floods in levied districts are mapped, classified, and sampled. Also sampled are river and nearby well waters.
g) From chemical analyses and temperature measurements it was found that the water flowing in typical sand boils (those free from pipe connections towards the river) is different from the river water and similar to well water in neighboring wells. Such sand boils can be stopped from flowing by damming them up to a level that is below that of the river stage. They are not caused by leaks through the levee.

9) ARTIFICIAL RECHARGE OF GROUND WATER.

b) Laboratory project.
d) Experimental laboratory and field investigation; basic research.
e) Experimental pilot plant consists of river intake, control tower with chlorination and measuring devices, gravel pit with bottom 10 feet below river pool stage, sides and bottom covered with sand.
g) Pit only in operation in winter when the river water is cool and low in turbidity. Pit recharged 260 million gallons from October 1951 to May 1952. Many operating difficulties overcome. Flow conditions checked on a model of 1/8 sector of pit.
h) Paper on results presented before Amer. Geophys. Union, Chicago, Sept. 12, 1952.

0) GROUND WATER INVESTIGATION IN THE PEORIA, ILLINOIS, DISTRICT.

b) Laboratory project.
d) Field investigation; basic research.
e) To determine the ground water resources of the district, inventory of wells was made, including construction and logs of wells. Ground water levels are measured continuously, pumpage data collected, river stages and rainfall recorded, chemical analyses for changes in composition of ground water are made, areas of infiltration are determined, and all data are correlated with consideration of local ground conditions.
g) The existence of a recession was proved to be due to overpumpage and high local concentration of pumpage. Remedial measures have been recommended.

5) EXTENSION OF THEIS' NON-EQUILIBRIUM THEORY FOR VARIABLE FLOW.

b) Office project.
d) Theoretical; basic research.
e) Development of formulas that could be used for conditions of variable flow.
g) Formulas developed for most important types of variable flow, but the series obtained have not been calculated for wide ranges.

35) GROUND WATER INVESTIGATION IN THE CHICAGO AREA.

(b) Laboratory project.
(d) Field study on variations of natural resources. Investigation of artesian well field with wells 1200 to 2200 feet deep, locally heavily pumped. Study of ground water level recession, interferences, transmissibilities, effect of additional demands.
(g) Results determine recession and give good data for future prediction.
(h) Some data given in "Ground Water Reservoirs." International Congress on Hydrology, Bruxelles 1951, Vol. IV, p. 16.

UNIVERSITY OF ILLINOIS, Fluid Mechanics and Hydraulics Laboratory, Department of Theoretical ar Applied Mechanics.

Inquiries concerning Projects Nos. 1343 and 1589 should be addressed to Prof. W. M. Lansford, Department of Theoretical and Applied Mechanics, 214 Talbot Laboratory, Unive sity of Illinois, Urbana, Ill.

(1343) VELOCITY DISTRIBUTION STUDY IN A FLOOD-PLAIN CHANNEL.

(b) Laboratory project.
(d) Basic research.
(e) Data have been collected on quantities of flow varying from 1.59 cfs to 11.5 cfs in a flood plain channel, 160+ feet long.
(f) Data being analyzed.

(1589) OPEN CHANNEL METER.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Data are being collected on a meter which may be built in a sewer leading from a man hc after the sewer has been in service. Models in a 6-inch lucite pipe were tested.

UNIVERSITY OF ILLINOIS, Hydraulic Engineering Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 564, 1094 to 1098, incl., 1590, and 1591 should be addressed to Prof. J. J. Doland, University of Illinois, Urbana, Ill.

(564) HYDROLOGY OF URBAN AREAS.

(b) Laboratory project, cooperative with Illinois State Water Survey Division and U. S. Geological Survey.
(d) Experimental, theoretical, and field investigation; applied research and design.
(e) Fourteen recording rain gages, one evaporation station including recording dew-point device, one radar station, and two recording stream gaging stations are installed for observation of rainfall and runoff for an area of about eight square miles. Analytical investigation includes frequency analysis of rainfall intensity, area-depth relationshi for storms, ground-water depletion study, unit hydrograph analysis and consumptive use determination.
(h) "Hydrologic studies of urban watersheds, rainfall and runoff of Boneyard Creek Watershe Champaign-Urbana, Illinois." Ven Te Chow, Hydraulic Engineering Series No. 2, University of Illinois, Nov. 1, 1952.

(1094) STUDY OF HIGHWAY INLET BOXES AND DISCHARGE PIPE SHAPES.

(b) Laboratory project, cooperative with Illinois Division of Highways and U. S. Bureau of Public Roads.
(d) Experimental, basic research.
(e) Full scale inlet boxes of various sizes are being tested with C. I. bell, square, and rounded discharge pipe shapes. Velocity of approach to inlet box is varied to simulate different approach gutter grades.
(f) Inactive.
(h) Report in preparation.

(1095) SCALE MODEL STUDIES OF INLET BOXES.

(b) Laboratory project, cooperative with Illinois Division of Highways and U. S. Bureau of Public Roads.
(d) Experimental, applied research; field, design.

(e) Model tests of inlet boxes with the aim of utilizing kinetic energy of the falling jet to obtain higher velocity discharge in connecting pipes. Temperature studies are being conducted to determine the desirability of catch basins as heat reservoirs for winter grate operation.
(f) Inactive with exception of temperature study.

96) FULL SCALE GUTTER TESTS.

(b) Laboratory project, cooperative with the Illinois Division of Highways and U. S. Bureau of Public Roads.
(d) Experimental; applied research.
(e) Determination of roughness coefficients for very smooth concrete gutters.
(f) Completed.
(h) Report in preparation.

97) CORRECTION OF SCOUR BELOW TWO PIER HIGHWAY BRIDGE.

(b) Laboratory project, cooperative with Illinois Division of Highways.
(d) Experimental; applied research.
(e) A 1:50 scale model of an overflow bridge on flood plain of the Wabash River has been constructed as an aid in determining the cause of excessive scour just downstream from the bridge. Remedial dikes and topography changes have been tested in the model to determine their suitability.
(f) Completed.
(h) Report available.

98) RESERVOIR MODEL.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Model of triangular longitudinal section reservoir has been constructed with one entire side of lucite. Density current studies for various bottom slopes will be conducted. Work is primarily concerned with ability to repeat given underflows when considering certain relative densities.

590) FREQUENCY STUDY OF HYDROLOGIC DATA.

(b) Laboratory project, cooperative with the Illinois Division of Highways and U. S. Bureau of Public Roads.
(d) Theoretical; basic and applied research.
(e) To develop sound principles and practical procedures for the frequency analysis of hydrologic data. A comprehensive survey was made of available literature and theories in the field under investigation. Various existing statistical methods of hydrologic analysis were reviewed and an investigation on the suitability and deficiencies of data to be used in the analysis were made. The analyses of precipitation data for Chicago, Seattle, and Los Angeles, were taken as sample cases.
(g) Two new procedures of frequency analysis were developed. Procedures for the preparation of hydrologic data were recommended.
(h) Thirteen preliminary reports were produced. A final report entitled, "Frequency analysis of hydrologic data", by Ven Te Chow, will be published as technical bulletin by the Department of Civil Engineering, University of Illinois.

591) DETERMINATION OF WATERWAY AREAS.

(b) Laboratory project; cooperative with Illinois Division of Highways.
(d) Theoretical and field investigation; applied research and design.
(e) Investigation to determine the amount of water which will reach highway openings, such as bridges and culverts and provide a simple but scientific procedure for use of engineers in establishing the economical and adequate size of opening. Methods of investigation include a survey of existing structures, library study of literature, analyses of pertinent climatological and physical factors relating to the hydrologic and hydraulic features of the problem.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH, State University of Iowa.

Inquiries concerning Projects should be addressed to the following, all at State University of Iowa, Iowa City, Iowa:
Nos. 66, 299, 1108, 1592, 1593.................................. to Prof. J. W. Howe.
Nos. 69, 568, 1101, 1107, 1347, 1595, 1597................... to Mr. Emmett M. Laursen.
Nos. 72, 73, 851.. to Mr. Philip G. Hubbard.
Nos. 75, 302, 854, 1100, 1102................................. to Dr. Hunter Rouse.
Nos. 79, 81, 82, 298, 567, 1104, 1344, 1596.................... to Dr. John S. McNown.

(66) HYDROLOGIC STUDIES, RALSTON CREEK WATERSHED.

(b) Cooperative with Department of Agriculture and Geological Survey.
(d) Field investigation; applied research and Master's Thesis.
(e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 3-square-mile area measured by Geological Survey; rainfall records at five automatic recording stations collected by Soil Conservation Service. Continuous records since 1924 of precipitation, runoff, ground-water levels, and vegetal cover.
(g) Yearly records available for examination at Iowa Institute of Hydraulic Research.
(h) Reports prepared annually since 1924 available in files at the Iowa Institute of Hydraulic Research.

(67) COOPERATIVE SURFACE-WATER INVESTIGATIONS IN IOWA.

(b) Cooperative with Geological Survey.
(c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Field investigation; collection of basic stream-flow data.
(e) Stream-flow and sediment measuring stations maintained throughout the State of Iowa cooperatively on a continuous basis. Records collected by standard methods of Geological Survey.
(g) Records of stream flow and sediment discharge computed yearly.
(h) Records contained in Water-Supply Papers available through offices of the Geological Survey.

(68) HYDROLOGIC STUDIES, RAPID CREEK WATERSHED.

(b) Cooperative with Department of Agriculture and Geological Survey.
(c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Field investigation; applied research and Master's Thesis.
(e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 25-square-mile area measured and flood runoff on main sub-basins determined by Geological Survey; rainfall records at four automatic recording stations collected by Weather Bureau. Continuous records since 1941 of precipitation, runoff and ground-water levels.
(h) Rainfall records published in Weather Bureau Climatological Bulletins and surface runoff and ground-water levels published in Geological Survey Water Supply Papers.

(69) RELATION OF SEDIMENT CHARACTERISTICS TO BED EROSION.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental; for Doctor's Thesis.
(e) To evaluate general relations between geometric and kinematic parameters of flow and mean size and grading of bed sediments for an arbitrary condition of scour. Experiments conducted in glass-walled flume with a two-dimensional horizontal jet. Selected geometrical proportions kept constant during all runs, the variables being the rate of flow, the mean diameter and standard deviation of the sediment, and time and depth of scour.
(h) "Observations on the nature of scour." E. M. Laursen, Proc. Fifth Hydraulics Conference, State University of Iowa, June 1952. (Publication pending.)

ELECTRICAL ANALOGY OF THREE-DIMENSIONAL FLOW.

Cooperative with Office of Naval Research, Department of the Navy.
Experimental; basic research.
An entire system of elliptical transitions from a reservoir to two-dimensional, axisymmetric and square pipes has been constructed and tested to give the significant boundary pressures.
Experiments completed, results to be published.
Transitions based upon ellipses having major to minor axis ratios of 1, 1.5, and 3 have been constructed and tested for each of the pipes listed in (e) above, for a wide range of effective pipe diameters relative to the ellipse dimensions.

MEASUREMENT OF TURBULENCE IN FLOWING WATER.

Waterways Experiment Station, Corps of Engineers.
Experimental; development.
To develop practical instruments for the field measurement of turbulence in flowing water.
Instruments are planned to include a rigidly mounted unit for shallow water over a considerable velocity range, a unit to be suspended on a cable for deep water, and a tape recorder for evaluation of means and root-mean-squares of three velocity components.

DIFFUSION OF SUBMERGED JETS.

Cooperative with Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research and graduate theses.
To provide information as to distribution of velocity and turbulence in two- and three-dimensional submerged jets. The velocity distribution in an unbounded air jet was originally studied and the results were reduced to dimensionless relationships. The distribution of turbulence is being studied in a similar manner with special reference to the cavitation of submerged jets. The investigation is being extended to the diffusion of flow under various related boundary conditions, in particular the hydraulic jump.
"An investigation into the point of incipient cavitation of submerged jets." J. P. Whitehouse, Master's Thesis, State University of Iowa, Feb. 1952. (Available on loan.)
"Cavitation in mixing zone of a submerged jet." Hunter Rouse, Presented at Eighth International Cong. on Theor. and Appl. Mech., Istanbul, Turkey, Aug. 1952.

CAVITATION.

Cooperative with Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research and graduate theses.
Basic information is sought on cavitation for systematically varied boundary conditions.
Tests are conducted in two variable-pressure water tunnels and a special cavitation tank.
Studies are being conducted on high-velocity submerged jets, using underwater noise as a criterion, to determine cavitation parameters. Tests have been made to evaluate the relationship between the cavitation index and temperature, relative velocity, and nozzle geometry.
Determination is being made of the effect of relative spacing upon the pressure distribution around a grid of equidistant cylinders mounted perpendicular to a steady, uniform, two-dimensional flow. Pressure distributions are being measured in the water tunnel for two-dimensional flow at Reynolds numbers above the boundary-layer critical, and at various stages of cavitation.
Previous measurements of the pressure distribution around various rounded, ellipsoidal, and conical head forms have been extended to various angles of yaw.

MATHEMATICAL ANALYSIS OF PRESSURE DISTRIBUTION.

Office of Naval Research, Department of the Navy.
Theoretical; basic research.
Methods of applying irrotational-flow theory to problems of hydraulic design are being used to obtain information on specific problems. The pressure distributions around faired boundary forms are obtained mathematically, assuming that viscous effects are negligible.
Both exact and approximate methods are used, and wherever possible the results are compared with experimental measurements determined in other studies. A modification of the relaxation method is being used for analysis of flows with curved boundaries.

(82) HYDRAULICS OF MANIFOLDS.

(b) Laboratory project, originally sponsored by Committee on Hydraulic Research, Hydraulic Division, A.S.C.E.
(d) Experimental; for design and Master's Thesis.
(e) Divided and confluent flow have been studied in a 2-inch smooth brass pipe with a singl right-angle lateral to determine effect of discharge and diameter ratios on the change in pressure at the junction. The effect of spacing in multiple-lateral manifolds and t pattern of flow and pressure variation in the immediate vicinity of the junction were studied. Comparisons have been made with the results of mathematical analyses.
(f) Project completed with preparation of final report.
(h) "Mechanics of manifold flow." John S. McNown, Presented at Centennial meeting of A.S.C Sept. 1952. (Available as Convention Preprint No. 55.)

(298) FALL VELOCITY OF SEDIMENT.

(b) Laboratory project.
(d) Experimental; basic research and Masters' Theses.
(e) The effect of a cylindrical boundary and the particle shape on the fall velocity of inc vidual particles, and the effects on concentration on the rate of settlement of sedimer samples have been investigated. Various reports on these studies have been prepared ir cluding a summary of work done by many other investigators since the time of Stokes.
(h) "Effect of particle concentration on fall velocity." J. S. McNown and P. N. Lin. Proc 2nd Midwestern Conf. on Fluid Mechanics, March 1952. (Publication pending.)
"Particles in slow motion." John S. McNown, La Houille Blanche, Sept.-Oct. 1951, pp. 7 722.

(299) DETERMINATION OF PRESSURE DISTRIBUTION CAUSED BY FLOW OF AIR OVER A SERIES OF THREE-DIMENSIONAL BUILDING FORMS.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental; applied research and Master's Thesis.
(e) To determine pressure distributions on simple three-dimensional building forms of varic proportions, for winds of different orientations. Extensive investigation of block-typ buildings with gabled roofs, hangar-type buildings, and vertical walls completed. Mast Thesis on effect of parapets on pressure around flat-roofed buildings completed.
(f) Inactive.
(h) "Wind pressure on elementary building forms evaluated by model tests." J. W. Howe, Civ Engineering, Vol. 22, No. 5, May 1952.

(302) SEDIMENT SIZE ANALYSIS BY MEANS OF PRESSURE DIFFERENTIALS IN STRATIFIED SUSPENSION.

(b) Laboratory project.
(d) Experimental; doctoral dissertation.
(e) To develop a technique for rapid-size-frequency determination by measurement of pressur differentials during relative motion between sediment and suspending liquid. Sample is introduced at top of a water-filled tube containing a pervious piston which can be displaced along axis of tube. Piezometers at top of tube and just above piston permit dif ential pressure, and hence immersed weight of suspended sediment, to be recorded during traverse of tube by piston. Instrumentation has been completed.
(h) "An instrument for the rapid size-frequency analysis of sediment samples." D. W. Appel presented at Fifth Hydraulics Conference, State University of Iowa, June 1952. (Public tion pending.)

(567) A STUDY OF FLOW OVER LATERAL SPILLWAYS.

(b) Laboratory project; partially supported by A.S.C.E. through J. Waldo Smith award.
(d) Experimental; applied research and masters' theses.
(e) Flow over a sharp-crested weir in one side of a rectangular channel is being studied as function of the channel and weir dimensions, the channel depth, and the Froude number c the channel flow above the weir.
(f) Inactive.

) SCOUR AT BRIDGE PIERS AND ABUTMENTS.

) Iowa State Highway Commission and U. S. Bureau of Public Roads.
) Experimental; applied research.
) To investigate the effects of pier and abutment geometry, sediment properties, and stream-flow characteristics on the rate and pattern of scour, to the end of providing safe design criteria.
) Initial phase, the study of pier and abutment geometry, has been extended to various geometrical shapes. The second phase, the study of the effect of stream-flow characteristics, is continuing. The third phase, the study of sediment characteristics, has been initiated.
) "Progress report of model studies of scour around bridge piers and abutments." E. M. Laursen, Research Report 13-B, Highway Research Board 1951.
"Second progress report of model studies of scour around bridge piers and abutments." E. M. Laursen and A. Toch, Proceedings Thirty First Annual Meeting 1952, Highway Research Board.
"Observations on the nature of scour." E. M. Laursen, Proceedings Fifth Hydraulics Conference, State University of Iowa, June 1952. (Publication pending.)

) A CONSTANT-TEMPERATURE HOT-WIRE ANEMOMETER FOR THE MEASUREMENT OF TURBULENCE IN AIR.

b) Cooperative with Office of Naval Research, Department of the Navy.
d) Experimental; instrument design.
e) The anemometer was designed to measure fundamental properties of turbulence in a low-velocity air tunnel, with special emphasis on simple operational techniques and high sensitivity at low frequencies. The aims were accomplished by utilizing carefully designed electronic control circuits and maintenance of the wire temperature at a constant level, above that of the air stream.
g) Improvements have been made which led to greater stability and a more nearly linear response to the magnitude of the velocity. Complete new design now available.

) BOUNDARY-LAYER DEVELOPMENT ON SMOOTH AND ROUGH SURFACES.

b) Office of Naval Research, Department of the Navy.
d) Experimental and theoretical; basic research and graduate theses.
e) Preliminary experimental investigation of the drag of smooth and rough surfaces in the low-velocity air tunnel, including boundary-layer development, turbulence, and drag, has been followed by tests on surfaces roughened by abrasive cloth, screen, and arrangements of cubes and of transverse bars. Boundary-layer studies are being supplemented by studies of established flow in a channel over similar surfaces.
g) Investigations of the drag of smooth and rough surfaces has been completed.

) BOUNDARY-LAYER DEVELOPMENT ON STEEP SLOPES.

f) Completed.
h) "Development of the turbulent boundary layer on steep slopes." William J. Bauer, presented at ASCE Convention, Denver, Colo., June 1952. (Accepted for publication as an ASCE Proceedings Separate.)

) MOVEMENT OF SEDIMENT IN HIGHWAY DRAINAGE SYSTEMS.

(b) U. S. Bureau of Public Roads and Iowa State Highway Commission.
(d) Experimental; for basic research and graduate theses.
(e) Study of movement of sediment in pipes, including the pattern of sand transport and the accompanying hydraulic energy losses is being made for quasi-uniform flow in a circular conduit. Both full-pipe and free-surface flows have been studied.
(h) "The transportation of uniform sand in a smooth pipe." H. H. Ambrose, Doctoral dissertation, State University of Iowa, June 1952. (Available on loan.)

(1102) HISTORY OF HYDRAULICS.

(b) Laboratory project.
(d) Library research, as Institute project.
(e) To trace the historical development of the important theories of hydraulics, covering the fundamental ideas of the science, the critical periods of development, and the contribution of personalities of major importance to this development.
(g) History to end of Eighteenth Century completed, work continuing.
(h) "A history of hydraulics to the end of the Eighteenth Century." Simon Ince. Doctoral dissertation, State University of Iowa, Aug. 1952. (Available on loan.)

(1104) ACCELERATED MOTION OF A SPHERE.

(b) Laboratory project.
(d) Experimental; basic research and doctor's thesis.
(e) The force components on an accelerated sphere in a fluid medium have been studied by experimental means. For oscillatory motion, these force components were separated int the inertial effective force and dissipative shear force. The investigation is to be extended to include other shapes then the sphere and to obtain more detailed informati concerning the unsteady pattern of flow around submerged bodies. A study is also bein made of the acceleration of a sphere falling freely from rest to provide information concerning the diffusion characteristics of suspended sediment.
(h) "Accelerated motion of a spherical particle." M. R. Carstens, Trans. Amer. Geophys. Union, Oct. 1952, pp. 713-721.

(1107) TRANSPORTATION OF SEDIMENT AS SUSPENDED AND TOTAL LOAD.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) To determine the suspended and total load as a function of hydraulic and sediment parameters. Distribution of sediment, as well as total load, are measured. Effect of sediment transport on velocity distribution, energy loss, and other hydraulic characteristics will also be evaluated.

(1108) RELATION OF WATERSHED CHARACTERISTICS TO THE FORM OF THE UNIT HYDROGRAPH.

(b) Laboratory project.
(d) Analytical investigation; basic research, for master's thesis.
(e) A study was made of the relation of watershed characteristics of stream basins in Illir and unit hydrographs for those basins, recently developed by the Geological Survey in cooperation with the State of Illinois.
(f) Completed.
(g) The compactness coefficient of the drainage area proved to have a good correlation with the time base and the peak percentage of the distribution graph. The land slope is an important factor in estimating distribution graph properties for small watersheds.
(h) "A study of the relationship between watershed characteristics and distribution graph properties." Richard G. Warnock, Master's Thesis, State University of Iowa, Feb. 1952. (Available on loan.)

(1109) A STUDY OF MEANDERS.

(b) Department of Mechanics and Hydraulics State University of Iowa.
(c) Prof. C. J. Posey and Mr. M. C. Boyer, Engineering Building, Iowa City, Iowa.
(d) Field measurements and correlation of data to obtain relationships of significant variables. Master's Thesis.
(e) Additional data being gathered from meandering streams of a range of sizes.
(f) Reactivation of project completed in 1950.
(h) Discussion by Prof. C. J. Posey of "On the origin of river meanders", Trans. Amer. Geophys. Union, Oct. 1952, p. 771.

44) CALCULATION OF FREE-STREAMLINE FLOWS.

(b) Laboratory project; partially sponsored by the Office of Naval Research, Department of the Navy.
(d) Theoretical; applied research.
(e) Calculations are being made of various two-dimensional flows using the classical Helmholz-Kirchhoff method. Manifold flow with free and constricted lateral efflux, curved inlets and pier profiles, and the deflection and division of jets by symmetrically and unsymmetrically placed vanes are being computed. The intended applications are to the design of pipe and lock manifolds, the selection of appropriate profiles for inlets and the upstream portion of streamlined piers, and the more precise definition of the behavior of Pelton wheel buckets.
(g) Excellent concordance in bulk characteristics has been found between results calculated for two-dimensional flow and those measured in pipe manifolds.

45) DESIGN OF HIGHWAY FILLS FOR SAFE OVERTOPPING BY FLOOD WATERS.

(b) Iowa Highway Research Council.
(c) Prof. C. J. Posey, Engineering Building, Iowa City, Iowa.
(d) Experimental; applied research pertaining to design.
(e) Studies on methods of protecting fine material from erosion are being conducted in a flume in which velocity, depth of flow, and vertical pressure gradients through the bed can be controlled and measured and which permits close observation of modes of failure. When the most economical method that gives promise of being effective has been determined, full-scale embankments will be constructed and tested in a large flume.
(g) Flume tests show that fine material can be protected by graded layers of crushed-rock or gravel meeting requirements of Terzughi-Vicksburg criteria.
(h) "Tests of graded riprap for protection of erodible material." Henry de Silva Manamperi, Master's Thesis, State University of Iowa, June 1952. (Available on loan.)

346) RESISTANCE COEFFICIENT OF PLASTIC PIPE.

(b) Yardley Plastics Company and Carlon Products Corporation.
(c) Dr. Walter Rand, State University of Iowa, Iowa City, Iowa.
(d) Experimental; applied research.
(e) Determination of the resistance coefficient as a function of the Reynolds number for plastic pipe of both rigid and flexible types.
(f) Completed.

347) MODEL STUDIES OF SAN JACINTO DAM.

(b) Ambursen Engineering Corporation and City of Houston, Texas.
(d) Experimental; for investigation of design.
(e) Spillway discharge coefficients for free and submerged flow and efficiency of the stilling basin have been determined from a 1:15 model of one bay.
(f) Completed.

592) THE EFFECT OF OVERTOPPING OF STILLING BASIN SIDE WALLS UPON THE FORMATION OF THE HYDRAULIC JUMP.

(b) Laboratory project.
(d) Experimental; basic investigation for Master's Thesis.
(e) Overtopping of side walls and return flow falling on the water upstream from the jump, reduces momentum and required downstream depth of the jump. A particular geometry has been investigated in a msster's thesis and other geometric variations are now being studied in a second thesis.
(g) Substantial reductions in depth below jump have been observed. This indicates that stilling basin floor can be raised and side walls lowered, both leading to a reduction in cost of stiliing basin.
(h) "Effect of the submergence of the stilling basin sidewalls on the hydraulic jump." Stavros Nicolaou, Master's Thesis, State University of Iowa, Aug. 1952. (Available on loan.)

(1593) PRESSURE CONDITIONS AT THE OUTLET OF A PIPE.

(b) Laboratory project.
(d) Experimental; basic investigation for master's thesis.
(e) Location of the line of piezometric head just upstream from the outlet of a pipe in relation to the Froude number.
(g) Head line apparently slopes toward the center of the pipe outlet but falls below this point considerably within a distance of one diameter from the end.

(1594) UNSTEADY PHENOMENA IN FLUID FLOW AND IN HEAT TRANSFER.

(b) Laboratory project.
(c) Chia-Shun Yih, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Theoretical.
(e) To study certain unsteady phenomena in fluid flow and in heat transfer. Unsteady boundary conditions and internal heat sources are treated by a technique similar to the Duhamel principle of heat conduction. This technique is applicable to a wide variety of problems in the field of lubrication.

(1595) MODEL STUDY FOR STEAM POWER PLANT, WILL COUNTY, ILLINOIS.

(b) Public Service Company of Northern Illinois.
(d) Experimental; for investigation of design.
(e) Flow conditions in Chicago Sanitary and Ship Canal with diversion for condenser cooling water up to 100 percent of canal flow are being studied in relation to effect on barge traffic. Recirculation of heated water due to density current formation is being checked.

(1596) INITIATION OF BED LOAD MOVEMENT.

(b) Laboratory project.
(d) Experimental; for basic research and graduate theses.
(e) A study is being made of the transport of bed load by a standing wave in rectangular basin. Various types of sand and various velocities are used in investigating the beginning and early stages of motion.
(f) Inactive.
(g) Preliminary indications have been obtained.
(h) "Initial bed-load movement caused by a system of standing waves." J. M. F. Rogers, Master's Thesis, State University of Iowa, Aug. 1952. (Available on loan.)

(1597) A STUDY OF THE EFFICIENCY OF SAND TRAPS.

(b) U. S. Bureau of Public Roads and Iowa State Highway Commission.
(d) Experimental; for master's thesis.
(e) A study of the effects on the efficiency of sand traps of the geometry of the trap and the ratio of velocity of flow to settling velocity of particles. Various trap proportions, sand sizes and rates of both sediment and water transport have been varied.
(g) Experiments on two-dimensional traps of rectangular shape are essentially completed.

(1598) A STUDY OF THE EFFECT OF LIP ANGLE ON FLOW UNDER A TAINTER GATE.

(b) Laboratory project.
(c) Professor D. E. Metzler, State University of Iowa, Iowa City, Iowa.
(d) Experimental; for Master's Thesis.
(e) Experimental data was obtained on a model Tainter gate in a horizontal channel. The results, presented in three dimensionless diagrams, show the discharge coefficient as a function of the ratios of headwater elevation to gate radius, tailwater elevation to gate radius, gate opening to gate radius, and trunnion height to gate radius.

TE UNIVERSITY OF IOWA, College of Engineering.

99) PLUMBING RESEARCH.

(b) Laboratory project, cooperative with the National Association of Master Plumbers.
(c) Dean F. M. Dawson, College of Engineering, State University of Iowa, Iowa City, Iowa.
(d) Experimental; applied research.
(e) We have been investigating: (1) circuit and loop venting, (2) domestic hot water system, (3) back siphonage, (4) noise in the plumbing system, (5) use of substitute materials, and (6) special appliances.
(f) The work on circuit and loop venting is essentially completed.
(g) Results have been communicated to the Research Committee of the National Association of Master Plumbers but are not yet available for distribution.

JOHNS HOPKINS UNIVERSITY, Applied Physics Laboratory.

00) DEVELOPMENT OF A MINIATURE STRAIN-GAGE PRESSURE PICK-UP.

(b) Bureau of Ordnance, Department of the Navy.
(c) Applied Physics Laboratory, The Johns Hopkins University, Care of Chief, Bureau of Ordnance, Department of the Navy, Washington 25, D. C.
(d) Experimental.
(e) Construction of small strain-gage pressure pick-up cells, approximately one inch long and 1/8" in diameter, for incorporation in hydraulic transfer valve pistons to measure transient pressures on the face of the metering lands and throughout the hydraulic circuit.
(g) Laboratory models have given satisfactory performance.
(h) Report in preparation.

JOHNS HOPKINS UNIVERSITY, Institute of Cooperative Research.

Inquiries concerning Projects Nos. 855, 856, and 1111 should be addressed to Dr. John C. Geyer, The Johns Hopkins University, Baltimore 18, Maryland.

855) HYDRAULIC BEHAVIOR OF STORM SEWER INLETS.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Experimental; basic research and design.
(e) Model tests of curb, gutter, and combination inlets of various designs for inflow changes with street dimensions of grade, crown, and roughness. The design of the inlet itself, of the inlet depression, and of deflectors at the inlet are all under study. Structural design of inlet grates with longitudinal bars only is in progress.
(g) To previous results from tests of curb and combination inlets has been added information concerning the capacity of alley inlets using various number of grates in tandem.
(h) "Report on the storm drainage research project." J. C. Geyer and B. C. Goodell. (Available on loan.)

856) HYDROLOGY OF STORM DRAINAGE SYSTEMS IN URBAN AREAS.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Field investigation; basic research and design.
(e) Study of rainfall and runoff relationship as affected by physical parameters of the watershed. In addition to the 8 urban areas which have been gaged for rainfall and runoff, 5 inlet areas are also being gaged. For the inlet areas, runoffs are measured by inlet weirs and rainfall is measured by a tipping bucket raingage all connected to a single recording instrument. A feature of this instrumentation is that all events can be timed to the nearest fifteen seconds.

(1111) DEVELOPMENT OF A FLOW GAGE FOR STREAM SEWER DISCHARGES.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Experimental; applied research.
(e) The development of gages for measuring both depth and velocity of debris-laden shooting flow commonly found in storm sewers. The development of instrumentation for measuring the flow into an inlet box. The search is for methods generally adaptable to existing storm sewers and inlet boxes that do not require extensive alterations.
(g) Development of an electrical system to record the rotation of a "Pygmy" type cup (Price) current meter is in progress. Laboratory tests have been completed for a system to measure depth of flow in sewers. This system consists essentially of a pressure chamber mounted in the invert of the sewer connected pneumatically to a bellows system which drives a moveable arm across a wire-wound resistor. The resulting electric current is recorded on a moving chart. Field tests are to follow. Instrumentation to measure flow into an inlet box is in the field. The system consists of a baffle plate located under the inlet grates to divert the flow into the weir pool. Flow over a trapezoidal weir built into existing inlet box is measured by a float mechanism connected to a depth-sensing device. Head is measured in increments of 0.02 feet. Five installations of this type have been in operation for 5 months.
(h) "Storm runoff in urban areas." B. C. Goodell, Master's Thesis, in preparation.

THE JAMES LEFFEL AND COMPANY.

(1601) TURBINE DEVELOPMENT.

(b) Laboratory project.
(c) Mr. J. Robert Groff, The James Leffel and Company, 426 East St., Springfield, Ohio.
(d) Experimental; basic and applied research for development, design and operation.
(e) Additional development of low and medium specific speed Francis turbines for the higher head range of installations. Determinations of thrust of Francis turbines. Tests of certain propeller type turbines to obtain more complete information on characteristics. Testing of turbine models for contractual work.

LEHIGH UNIVERSITY, Fritz Engineering Laboratory.

Inquiries concerning Projects Nos. 90, 1113, and 1602 to 1604, incl., should be addressed to Prof. M. B. McPherson, Department of Civil Engineering and Mechanics, Lehigh University, Bethlehem, Pa.

(90) STUDIES OF PRESSURE VARIATIONS CAUSED BY BOUNDARY MISALIGNMENT IN THEIR RELATION TO CAVITATION IN HYDRAULIC STRUCTURES.

(b) A.S.C.E Subcommittee on Cavitation and the Lehigh Institute of Research.
(d) Experimental; basic research; Master's Thesis.
(e) Determination of pressure variation as a function of approach velocity and head, and magnitude of misalignment. Study of pressure distribution along one surface of both a rectangular open channel and a closed conduit in which a transverse step of variable height has been placed, with the object of defining misalignment tolerances for hydraulic structures.
(g) Studies of open and closed conduits have yielded distinct relationships between difference in piezometric head, velocity head and height of misalignment.
(h) "Study of misalignments in an open channel and a closed conduit." John C. Williams, Jr., Master's Thesis, Lehigh University, May 1952. (Available on loan.)

A STUDY OF SHARP-CRESTED CIRCULAR WEIRS.

Laboratory project.
Experimental; undergraduate thesis.
Study of the effects of variations in head, approach depths and diameter. Weirs are circular in plan, radial in approach.
Experiments concluded.
"Experimental determination of circular weir characteristics." Gerald M. Brey, undergraduate special problem, May 1951. Report for publication under preparation.

PRESSURE DISTRIBUTION IN CONDUIT BENDS.

) Laboratory project.
) Experimental; applied research, for professional degree thesis and undergraduate special problem.
) An investigation of minimum pressure has been made for bends of both rectangular and circular cross-section. At present an attempt is being made to define characteristics of 90-degree "Elbow Meters" or "Flow Bends". Results to date appear satisfactory.
) "The design of bends for hydraulic structures." M. B. McPherson, thesis for professional degree, Bucknell University, April 1952. (Available on loan.)

) BUTTERFLY VALVE STUDY.

) Fluid Controls Company, Inc., Philadelphia, Pa.
) Experimental; applied research; Master's Thesis.
) Fundamental butterfly valve characteristics are being investigated. Details are presently confidential but results eventually will be submitted for publication.
) Specific tests preceding this study are included in the following unpublished reports:
"Report on tests of butterfly valves discharging into a model discharge chamber and flume." J. C. Williams, Jr. and H. S. Straussser, June 1952.
"Tests of a six-inch butterfly valve discharging unsubmerged." J. C. Williams, Jr., Aug. 1952.

) MODEL STUDY OF FIRST FORK DAM, PENNSYLVANIA.

) Gannett, Fleming, Corddry and Carpenter, Inc., Harrisburg, Pa.
) Experimental; for design.
) The 1:32 model included a forebay structure, intake, gate chamber (for two gates), transition, circular conduit and stilling basin. Tests were performed with both a circular and rectangular conduit exit. Extensive stilling basin tests were made.
) Completed.
) "Tests of a 1:32 model of a proposed outlet structure for First Fork (Sinnemahoning) Dam." M. B. McPherson and H. S. Strausser, Oct. 1952.

SIANA STATE UNIVERSITY AND A AND M COLLEGE, School of Hydraulic Engineering.

Inquiries concerning Projects Nos. 860, 863, 1352, 1605, and 1606 should be addressed to Prof. T. M. Lowe, School of Hydraulic Engineering, Louisiana State University and A and M College, Baton Rouge 3, La.

0) THE EFFECT OF THE ADDITION OF SODIUM CHLORIDE UPON THE FLOW OF WATER THROUGH A STANDARD OTTAWA SAND.

b) Cooperative with the Geological Survey.
d) Experimental; basic research for Master's Thesis.
e) Salt water of varying concentration was run through permeameters containing Standard Ottawa Sand.
f) Completed.
h) "An investigation of the effect of density and viscosity on the flow of water through porous media." James W. Midkiff, Jr., Master's Thesis, Louisiana State University and A and M College. (Available on interlibrary loan.)

(863) THE EFFECT OF VISCOSITY ON WEIR DISCHARGE COEFFICIENTS.

(b) Laboratory project in conjunction with engineers of Waterways Experiment Station.
(d) Experimental; applied research for Master's Thesis.
(e) Tests were conducted on a twelve inch crest rectangular suppressed ogee type. Variati of viscosity was procuced by use of Methocel and heating.
(f) Completed.
(g) Good except for scattering of points at low head.
(h) "The effect of viscosity on the discharge coefficient of a model ogee weir." John R. Manning, Master's Thesis, Louisiana State University and A and M College, June, 1952. (Available on interlibrary loan.)

(1352) INVESTIGATION OF FLOW THROUGH VERTICAL RECTANGULAR OPENINGS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Investigation of flow through deep notches.
(f) Completed.
(g) Results not considered too conclusive but should prove of value to other investigators
(h) "An investigation of flow through rectangular deep notches." Charlton K. Miller, Loui ana State University and A and M College, August, 1952. (Available on interlibrary lo

(1605) THE EFFECT OF LENGTH ON THE EFFICIENCY OF A DIFFUSER.

(b) Laboratory project.
(d) Experimental; basic research for Master's Thesis.
(e) Tests were made on two-dimensional rectangular and square diffusers of variable length to determine efficiency. This study was a continuation of project No. 859, "Effect of length on performance characteristics of diffusers."
(f) Completed.
(h) "The effect of length on the efficiency of a diffuser." Alfred W. Schoeffler, Master' Thesis, Louisiana State University and A and M College. (Thesis available on interlibrary loan.)

(1606) AN INVESTIGATION OF FLOW CHARACTERISTICS IN THE TRANSITION RANGE IN A POROUS MEDIUM.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Tests are to be conducted on flow through standard Ottawa Sand confined in a 3" diamet glass cylinder to determine at what point the flow changes from streamline to turbulen

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UNIVERSITY OF MARYLAND, Glenn L. Martin College of Engineering and Aeronautical Sciences.

Inquiries concerning Projects Nos. 1353 and 1606 should be addressed to Prof. J. B. Cournyn, University of Maryland, College Park, Md.

(1353) HYDRAULICS OF MANIFOLDS.

(b) Laboratory project.
(d) Experimental; for design and for masters' theses.
(e) Equipment is being built for the systematic investigation of several phases of the phenomena of divided flow in pipes in view of developing hydraulic laws for divided fl
(f) Suspended.

(1607) HYDRAULIC MODEL INVESTIGATION OF TRIANGULAR CONTROL SILLS.

(b) The Hydrology Division of the Soil Conservation Service.
(d) Experimental for design and development; Masters' Theses.

The purpose is to establish a hydraulic control, by model analysis, so that the quantity of runoff from a watershed can be uniquely determined at a particular cross section for a given elevation of the water surface. An unusual and desirable feature of the control selected for this study is that consistent and stable rating characteristics with little maintenance can be expected. The control consists of two triangular-shaped sills placed on the floor of a drainage structure. A throat between the sills prevents the accumulation of sediment and debris.
Completed.
"Hydraulic model investigation of triangular control sills." Joseph T. Gay, Jr., M. S. Thesis, June 1952.

CHUSETTS INSTITUTE OF TECHNOLOGY, Department of Civil and Sanitary Engineering, Hydrodyna- Laboratory.

Inquiries concerning Projects Nos. 306, 307, 311, 577 to 580, incl., 869, 1354, 1355, and 1608 to 1612, incl., should be addressed to Dr. Arthur T. Ippen, Professor of Hydraulics, Hydrodynamics Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.

SCOUR AROUND BRIDGE PIERS.

Laboratory project.
Experimental; graduate research.
Qualitative study of scour patterns for various goometric arrangements of pile groups. Quantitative comparison of scour for single piles under various conditions of uniform sediment sizes. Plastic sediments in various colors and sizes are used to trace history of scour.
Inactive.
Systematic studies for various pile groups have been completed. A series of scour measurements with different bed materials and flow conditions are available which, however, need further extension with respect to grain size and hydraulic conditions. General conclusions not possible so far.

STABILITY OF FLOW STRATIFIED DUE TO DENSITY DIFFERENCES.

Laboratory project.
Theoretical and experimental; graduate research.
Theoretical analysis of instability at interface of density flow. Laboratory studies of criteria for mixing.
Inactive.
Comprehensive analysis of density flows on basis of gravity and inertia forces was compiled. Experimental study of underflow in reservoirs at equilibrium of gravity and viscous forces was carried out in a glass-walled tank. Velocity distributions in reservoir and density current were determined. Critical state of flow beyond which mixing occurs was determined for a range of characteristic parameters. Shape of initial surge and its celerity were measured. Work to be continued with a wider reservoir to reduce wall effects.
"Steady state characteristics of subsurface flow." Arthur T. Ippen and Donald R. Harleman. Gravity Waves, National Bureau of Standards, Circular 521, 287 pp. 1952. (Superintendent of Documents, Washington 25, D. C., $1.75 per copy.)

HYDRAULIC ANALOGY TO SUPERSONIC FLOW OF GASES.

U. S. Air Force.
Experimental; basic research.
Experiments in a high velocity water channel on airfoils, wedges and related shapes are conducted to explore the validity of the hydraulic analogy in the transonic and supersonic regions.

(g) In addition to the previous experiments with stationary models in the completely super sonic range, present program is concerned with the transonic range for both steady and accelerated motions. Models are towed in stationary water and data is obtained by var ious photographic devices including stereo methods. Pressure distribution, local Mach number variation and shock detachment have been studied, and reasonable agreement with air data have been obtained.

(h) "Studies on the validity of the hydraulic analogy to supersonic flow." Part IV, Feb. 1952, Part V, Dec. 1952. D. R. F. Harleman and H. E. Crossley, Jr., Air Force Technical Report No. 5985.
"Certain quantitative results on the hydraulic analogy to supersonic flow." A. T. Ipp and D. R. F. Harleman, Second Midwestern Conference on Fluid Mechanics, Ohio State Uni sity, March 1952. (To be published.)

(577) CHARACTERISTICS OF SOLITARY WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research for Doctor's thesis.
(e) (1) Experimental investigation of solitary wave characteristics in a horizontal channe Measurements of attenuation for various bottom roughnesses. (2) Investigation of defo mation and resulting characteristics of a solitary wave in shoaling water and on a she
(g) Phase 1 of program is essentially complete. Wave celerity, shape and internal particl motions have been measured and compared with various analytical results. Measurements the gradual damping of the wave for different bottom roughnesses have been obtained.
(h) "Characteristics of the solitary wave." J. W. Daily and S. C. Stephan, Jr., Proc. A.S.C.E., Vol. 77, Separate No. 107, Dec. 1951.
"The solitary wave: its celerity, profile, internal velocities and amplitude attenuati J. W. Daily and S. C. Stephan, Jr., Tech. Report No. 8, M. I. T. Hydrodynamics Laborat June 1952.

(578) TURBULENCE MEASUREMENTS WITH A PITOT TUBE-PRESSURE CELL COMBINATION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; development of instrumentation.
(e) Studies of turbulence characteristics in open channel flow.
(g) A turbulence measuring instrument consisting of a Pitot tube and an electric capacitan pressure cell is employed for turbulence investigations in an open channel. The distr bution of root mean square velocity fluctuations and the growth of a turbulent boundar layer have already been investigated. An instrument, in the form of an electrodynamom has been designed for use with the pressure cell and can be arranged to yield root mea square velocities as well as auto- and cross-correlation factors from continuous turbu lence data. It has been demonstrated that power density spectra can also be obtained.
(h) "An electrodynamometer for correlation." D. L. Favin, S. M. Thesis, June 1952.
"Reduction of turbulence data with an electrodynamometer." J. P. Lawrence, S. M. Thes Dec. 1952.

(579) INVESTIGATION OF FLUID FRICTION IN UNSTEADY MOTION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research and development of instrumentation.
(e) Investigation of the influence of unsteady motion on the flow in conduits and past sub merged bodies in a specially developed water tunnel.
(g) High frequency response electronic cells were developed for direct measurement of tran ient pressure differentials, and employed in experiments to determine loss of head in one-inch pipe during unsteady flows with accelerations up to 40 ft/sec/sec. A servo-mechanism has been developed to regulate the pressures governing the acceleration rate Experiments are being continued to extend the range of velocities and accelerations an to further verify initial findings regarding friction in unsteady flow. Experiments i volving separation will constitute the next phase of the program.
(h) "Fluid friction due to unsteady flow in conduits." K. C. Deemer, Sc.D. Thesis, June 1
"Measurements of fluid friction with steady and unsteady motion." J. W. Daily and K. Deemer, Tech. Report No. 9, M. I. T. Hydrodynamics Laboratory.

30) FUNDAMENTAL RESEARCH ON METHODS OF AIR DISPERSION IN AERATION PROCESSES.

(b) U. S. Public Health Service.
(d) Experimental; basic research.
(e) Study of the mechanics of oxygen absorption by water with the purpose of increasing the efficiency of aeration processes.
(g) Both air and oxygen are systematically dispersed by means of diffusor nozzles through water de-aerated to low concentrations of oxygen. Bubble size, frequency and concentration are varied in a vertical lucite test column of 5-1/2 in. diameter. The rate of oxygen absorption by the water is recorded continuously by a polarographic instrument, and values of the absorption coefficients are obtained in relation to the above variables. Additional tests are to determine mixing coefficients and associated turbulence induced by the bubble motion.
(h) "Determination of oxygen absorption in aeration processes." A. T. Ippen, L. G. Campbell, and C. E. Carver, Jr., Tech. Report No. 7, M. I. T. Hydrodynamics Laboratory, May 1952.

59) TRANSIENT PROBLEMS IN HYDRODYNAMICS AND HYDRAULIC ENGINEERING.

(b) Laboratory project; previously sponsored by Research Corporation, New York.
(d) Theoretical and experimental.
(e) To develop methods of analysis for transient problems which are applicable to a wide variety of non-linear systems. An electronic analog computer is being used in the analysis of transient phenomena.
(g) Current work includes analysis and electronic computation as well as laboratory work and use of field data on the hydraulic and governing stability of hydro units.
(h) "Methods and results from M. I. T. studies in unsteady flow." H. M. Paynter, J. Boston Society of Civil Engineers, Vol. XXXIX, No. 2, April 1952.
"Electrical analogies and electronic computers; surge and water hammer problems." H. M. Paynter, Proc. A.S.C.E. Vol. 78, Separate No. 146, Aug. 1952.
"Transient analysis and operating stability of surge tanks in hydro-electric plants." H. M. Paynter, Tech. Report No. 10, M. I. T. Hydrodynamics Laboratory.

54) THE MOTION OF DISCRETE PARTICLES ALONG THE BED OF A TURBULENT STREAM.

(b) Laboratory project.
(d) Experimental; graduate research.
(e) To establish a more rational basis for the analysis of some of the complex bed-load phenomena. By use of discrete particles on beds of varying roughness the variables entering the experimental analysis are reduced to distinct sediment and stream characteristics for which analytical concepts can be postulated.
(g) An analytical expression for incipient particle motion has been obtained in terms of the physical characteristics of the sediment, bed and hydrodynamic forces on the particle. Additional experiments to widen the range of the tests are proposed.

55) CAVITATION INCEPTION FOR STEADY MOTION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Cavitation inception for steady motion is to be studied for systematic variations in boundary layer development and in the turbulence level for the zone of minimum pressure.
(g) A closed-jet water tunnel with a rectangular test section is being developed for these studies. The working section is arranged so that the boundary layer growth is controlled by a systematic change of its shape. Provision is also made for control of turbulence level and pressure intensity.

08) FLOW CHARACTERISTICS OF SWING AND BALL CHECK VALVES.

(b) Atomic Energy Commission.
(d) Experimental; development.
(e) Head loss of swing and ball check valves under varying flow conditions are to be determined, also pressure transients during sudden closure.

(g) Test circuit consists of 8-inch pipe with associated flow metering and pressure measuring equipment. Special attention devoted to head loss at extremely low rates of flow and to amount of flow necessary to cause closure of the valve when flow is in the reverse direction. Transient pressures due to rapid closure at high rates of flow also to be measured utilizing electric pressure cells previously developed in this laboratory (See project 579.)

(1609) EXPERIMENTAL STUDY OF THE SORTING OF BEACH SEDIMENTS BY WAVE ACTION.

(b) Beach Erosion Board, U. S. Army Corps of Engineers.
(d) Experimental; basic research.
(e) Quantitative study of the sorting action and selective transport of beach material by shallow water waves moving on a granular beach.
(g) Equipment to be used consists of a wave channel with a variable wave generating mechanis Beaches consist of graded materials of selected sizes and variable physical properties. The results of the sediment transport and sorting studies are to be related systematically to the various wave characteristics such as shape, celerity, frequency, and internal velocities.

(1610) WATER TABLE EXPERIMENTS FOR THE STUDY OF BLAST EFFECT ON STRUCTURES.

(b) U. S. Air Force.
(d) Experimental; basic research.
(e) Investigation of water table techniques as a means of simulating and providing basic information for supplementing available shock tube and wind tunnel data.
(g) A water table with surface area of 50 $ft.^2$ with glass bottom is used. Moving shock wave of variable intensity are created by a surge generator. As the shock impinges on variou obstacles, the depth-time relationships at designated points are obtained by various photographic and electrical methods.

(1611) DIRECT DRAG MEASUREMENTS ON BAFFLE PIERS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Investigation of the effect of baffle piers on the stabilization and energy dissipation associated with hydraulic jumps.
(g) Direct measurements of drag exerted on baffle piers by flow is made possible by the use of an isolated plate in the floor of a glass-walled flume. Small displacements of the plate, to which the piers are attached, are measured by electronic methods and related to drag force. Major variables are initial Froude number, depth, and position of the jump with respect to the piers.

(1612) COMPLETE CHARACTERISTICS OF A 10" KAPLAN TURBINE AND A 12" ADJUSTABLE BLADE PROPELLOR PUMP.

(b) Laboratory project.
(d) Experimental; research for master's thesis.
(e) Study of pump and turbine characteristics for a wide range of operating conditions including energy dissipation and flow reversal.
(g) The test circuit provided by the S. Morgan Smith Company consists of a adjustable blade pump, a Kaplan turbine, draft tube pressure tank, Venturi meter, and dynamometers.

HUSETTS INSTITUTE OF TECHNOLOGY, Department of Mechanical Engineering.

Inquiries concerning Projects should be addressed to the following, all at Massachusetts Institute of Technology, Cambridge 39, Massachusetts:
Nos. 880, 1361.. to Prof. Joseph Kaye
Nos. 1357, 1359, 1360, 1616, 1621................................ to Prof. A. H. Shapiro
Nos. 1366, 1613, 1615, 1618...................................... to Prof. J. L. Shearer
Nos. 1118, 1374, 1375, 1622...................................... to Prof. E. S. Taylor

RECOVERY FACTORS AND HEAT-TRANSFER COEFFICIENTS FOR AIR FLOWING AT SUPERSONIC VELOCITIES IN A TUBE.

Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research involving M. I. T. Differential Analyzer.
The objective is to obtain reliable data for recovery factors, friction coefficients, and heat-transfer coefficients in a field where few are available, namely for supersonic flow of air.
"Measurement of recovery factors and friction coefficients for supersonic flow of air in a tube, Part I - apparatus, data and results based on a simple one-dimensional flow model." J. Kaye, J. H. Keenan, K. K. Klingensmith, G. M. Ketchum, and T. Y. Toong, J. Applied Mech., Vol. 19, No. 1, pp 77-96, March 1952.
"Measurement of recovery factors and friction coefficients for supersonic flow of air in a tube, Part II - results based on a two-dimensional flow model for entrance region." J. Kaye, T. Y. Toong, and R. H. Shoulberg, J. Appl. Mech., Vol. 19, No. 2, pp 185-194, June 1952.

RESEARCH ON CASCADES OF AIRFOILS.

General Electric Company and Westinghouse Electric Corporation.
Experimental and theoretical.
Cascade investigation of secondary flow phenomenon aimed towards application in the design of axial compressors and turbines.
"Loss coefficients in turbine passages." N. Van Le, Project reports Nos. 1 through 8, 2006, Gas Turbine Laboratory, 1952.

EFFECT OF COOLING ON TRANSITION OF GAS BOUNDARY LAYERS.

National Advisory Committee for Aeronautics.
Experimental; basic research for Doctor's Thesis.
Measurements were made of the apparent friction factor near the entrance of a round tube to establish whether cooling of the air stream would lead to the theoretical delay in transition from a laminar to a turbulent boundary layer.
Accurate friction measurements are available for short pipes. No significant effect of cooling on transition was found.
Report submitted to sponsor.

EFFECT OF HEATING ON TRANSITION OF WATER BOUNDARY LAYERS.

Office of Naval Research, Department of the Navy.
Experimental; basic research for Doctoral Thesis.
Measurements are being made of the apparent friction factor near the entrance of a round tube to establish whether heating of the water stream will lead to the theoretical delay in transition from a laminar to a turbulent boundary layer.

ATOMIZATION OF WATER IN HIGH-SPEED AIR STREAMS.

Office of Naval Research, Department of the Navy.
Experimental; applied research.
Measurements are being made of the dispersion pattern and droplet size for water sprays atomized by high-velocity air streams.

(1361) SUPERSONIC HEAT TRANSFER TO A FLAT PLATE.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental basic research and theoretical work involving M. I. T. Differential Analy
(e) The experimental program for determining recovery factors and heat-transfer coefficie for supersonic flow over a flat plate, at Mach numbers ranging from 1.9 to 3.2, is bei carried on in the large Naval supersonic wind tunnel at M. I. T. This basic research problem is used for thesis work by students for the Masters' and the Doctors' degrees

(1366) STUDY OF LATERAL FORCES ON HYDRAULIC PISTONS CAUSED BY AXIAL LEAKAGE FLOWS.

(h) "Contributions to hydraulic control - IV lateral forces on hydraulic pistons." J. F. Blackburn, Research Engineer, DACL, M. I. T., ASME Paper No. 52-A-44.

(1374) SHEAR FLOW IN BENDS.

(b) Office of Naval Research, Department of the Navy.
(d) Investigation of secondary flow in fluid passages employed in fluid machinery.
(e) Previously, investigation of secondary flow in a simple bend; now, investigation of secondary flow in rotating machinery.
(h) Report No. 6792-I, March, 1951. W. R. Hawthorne and H. Eichenberger.
"Shear flow in bends." H. Eichenberger, April, 1952.

(1375) EFFECT OF INLET PIPE GEOMETRY ON VOLUMETRIC EFFICIENCY OF A FOUR-STROKE INTERNAL-COMBU TION ENGINE.

(b) The Texas Company.
(d) Experimental and theoretical.
(e) Study of dynamic effects due to fluid inertia and pressure waves in inlet pipe. Flow measurements and pressure-time records in pipe and cylinder. Variables are length an diameter of pipe, speed of engine, valve flow capacity, and valve timing.
A theoretical study has been made by means of the Whirlwind Digital Computer. Result from the computations agree quite well with results of actual tests.
(f) Completed.
(g) Comparisons are given showing volumetric efficiency as a function of inlet pipe lengt inlet pipe diameter, engine speed, valve timing, valve flow capacity, and inlet port geometry.
Inlet pipe length and diameter have important effects on volumetric efficiency. These effects are largely attributable to the inertia and the kinetic energy of the inlet a column.

(1613) DYNAMIC CHARACTERISTICS OF COMPRESSIBLE FLUID SERVOMOTORS.

(b) Bureau of Ordnance, Department of the Navy.
(d) Theoretical and experimental; fundamental research.
(e) Theoretical and experimental methods are being used to seek a thorough understanding the behavior of a valve-controlled ram when compressed air is employed as the working fluid.
(g) Satisfactory performance is attainable with compressible fluid servomotor with certai load conditions.

(1614) A STUDY OF PERFORMANCE COEFFICIENTS OF POSITIVE DISPLACEMENT HYDRAULIC PUMPS AND MOTO

(b) Bureau or Ordnance, Department of the Navy.
(c) Mr. G. Reethof, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; basic and applied research.
(e) An investigation to determine the parameters that effect the performance of positive displacement pumps and motors and to compare the relationships with the performance equations proposed by previous investigations.
(f) Completed.

g) Performance equations used at the present time are only valid for gear and vane machinery. Piston type pumps and motors because of variations in the operating clearances do not follow such simple relationships as prescribed. A new set of performance equations is proposed to take such variations in the clearances into account.
h) "A study of performance coefficients of positive displacement hydraulic pumps and motors." Donald K. Crockett, M. S. Thesis, Dept. of Mechanical Engineering, M. I. T. - 137 pp. Aug. 1, 1952.

5) STEADY STATE COMPRESSIBLE FLOW CHARACTERISTICS OF 4-WAY VALVES.

b) Bureau of Ordnance, Department of the Navy.
d) Theoretical and experimental; fundamental research.
e) Load pressure vs. load velocity curves for various valve openings have been derived for some valve-and-ram systems. Experimental verification has been qualitatively made for a few conditions of operation.
g) Valve characteristics are affected by the ratio of upstream to downstream port width, although they are similar to the incompressible flow characteristics.

16) EFFICIENCY OF DIFFUSION OF DROPLET-LADEN AIR STREAMS.

b) Office of Naval Research, Department of the Navy.
d) Experimental and theoretical; applied research; Master's Thesis.
e) Measurements are being made to determine the effect of entrained liquid droplets on the efficiency of an air diffuser.

17) CALIBRATION OF SMALL DIAMETER SHARP-EDGED ORIFICES.

(b) General Electric Company.
(c) Prof. Wm. A. Wilson, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental.
(e) A series of eight orifices varying from 1/32 to 1/2 inch in diameter were installed successively in a one inch pipe and calibrated with air and with dibutylphthalate. The Reynolds number range was roughly 1000 to 100,000. Pressure ratios as low as .40 were impressed on some of the orifices.
(f) Completed.
(g) Results substantially confirm those of other investigators. In particular, compressibility effects are found to be the same as those reported by I. G. Cunningham -- Trans. A.S.M.E., July 1951, Vol. 73, No. 5, p. 625.
(h) "Flow coefficients for eight sharp-edge orifices in a one inch I. D. pipe." Charles Kojabashian.

18) INCOMPRESSIBLE FLOW CHARACTERISTICS OF 4-WAY VALVES.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental and theoretical; fundamental research.
(e) The characteristics of several types of 4-way flow-control valves have been derived without making linearizing assumptions. These characteristics are plotted as load flow vs. load pressure, in a manner analogous to the plate characteristics of a vacuum tube. Several differential coefficients have been derived and tabulated, and the valves are compared from the standpoint of linearity, sensitivity, power output, and losses. Some experimental work has been done to check the theoretical work.
(g) Good correspondence between experiment and theory.
(h) "Contributions to hydraulic control - III pressure - flow relationships for 4-way valves." J. F. Blackburn, Research Engineer, DACL, M. I. T. A.S.M.E. Paper No. 52-A-42.

19) A FAST RESPONSE TRUE MASS RATE FLOWMETER.

(b) Laboratory project.
(c) Dr. Y. T. Li, and Prof. S. Y. Lee, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Basic research.

(e) To develop a new type of flowmeter that will measure true mass rate of flow of any material. The basic principle of operation is based on measuring the torque or force produced in a flow-sensing tube through which the fluid is pumped. This flow-sensing tube is rotated about an axis perpendicular to the axis of the tube itself. It can be proved theoretically that the mass rate of flow through the tube is a linear function of the torque produced.
(f) Completed.
(g) This type flowmeter has many attractions: (1) it is a true mass rate flowmeter, (2) linear output, (3) it can be used to measure the flow of any substance whether liquid or gas or mixture. The accuracy is not dependent on the physical properties of the fluid to be measured, (4) the relationship between the torque and flow is exact. No calibration is required, and (5) fast response.
(h) "A fast response true mass rate flowmeter." Y. T. Li and S. Y. Lee, presented at the annual Convention of ASME, Dec. 3, 1952.

(1620) ROTARY PLATE SERVO VALVE.

(b) Dynamic Analysis and Control Laboratory, M. I. T.
(c) Prof. S. Y Lee, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Design and development research.
(e) The purpose is to develop an accurate but inexpensive servo valve for the control of fluid power. This research leads to a comparatively inexpensive way of manufacturing high precision four way valves. Research is being done on the flow force compensation, stability and other problems of this valve design.
(h) Preliminary report on a rotary-plate servo valve for hydraulic and pneumatic control systems. Shih-Ying Lee and Thomas C. Searle, DACL Research Memorandum No. R.M. 6387-1. Above report can be obtained by writing to Director, Dynamic Analysis and Control Lab. M. I. T., Cambridge, Mass.

(1621) DISCHARGE COEFFICIENT OF BORDA NOZZLE FOR COMPRESSIBLE FLUIDS.

(b) Laboratory project.
(d) Experimental and theoretical; basic research; Bachelor's Thesis.
(e) Measurements are being made of the flow coefficient of Borda mouthpieces through which flows air at high subsonic speeds.

(1622) REFRIGERATION TURBINE.

(b) Air Material Command.
(d) Experimental; development.
(e) Development of a radial flow turbine of small size, high efficiency, for use in low temperature refrigeration. Two turbines have been designed and are ready for test.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Naval Architecture and Marine Engineering.

Inquiries concerning Projects Nos. 1623 to 1627, incl., should be addressed to Prof. F. M. Lewis, Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.

(1623) CHARACTERISTICS OF A SERIES OF CONTROLLABLE PITCH PROPELLERS.

(b) Office of Naval Research, Department of the Navy.
(d) For design.
(e) To make available for the marine designer data for a controllable-pitch propeller series

(1624) VIRTUAL WATER INERTIA ASSOCIATED WITH A TORSIONALLY OSCILLATING PROPELLER.

(b) Laboratory project.
(d) For Master's Thesis.

5) CAVITATION PROPERTIES OF PROPELLERS.

b) Laboratory project.
d) Development.
e) To fix the properties of propellers having minimum cavitation.
f) Temporarily suspended.

6) MANUFACTURE OF MODEL PROPELLERS.

b) Laboratory project.
d) Development.
e) An extensive investigation of the procedure for casting model propellers so that higher accuracy can be obtained at reasonable cost.

7) VIRTUAL MASS OF A CYLINDER VIBRATING IN WATER.

b) Laboratory project.
d) Master's Thesis.
e) The work bears on the vibration characteristics of submarines with a view to their behavior in underwater explosions.

ERSITY OF MICHIGAN, Experimental Naval Tank.

Inquiries concerning Projects Nos. 585, 1127 to 1129, incl., and 1378 should be addressed to Prof. L. A. Baier, 326 West Engineering Building, University of Michigan, Ann Arbor, Mich.

35) RESISTANCE OF BARGE TOWS.

(b) Corps of Engineers, Department of the Army.
(d) Experimental; design.
(e) To determine resistance of several formations of certain barge types relative to non-restricted straight channels and to selected channels restricted in width and depth. Each run will consist of movement of one model formation, at one draft and one depth of water for a given channel condition through a range of velocities sufficient to define a curve of functions of resistance versus velocity.

27) TRANSOM IMMERSION ON HIGH-SPEED MOTORBOATS.

(b) Laboratory project.
(d) Research; design.
(e) Tests are being conducted to determine the most efficient transom immersion for various high speed hull forms.

28) COMMERCIAL VESSELS, 150 to 250 FEET IN LENGTH.

(b) Fairbanks, Morse and Company.
(d) Experimental; design.
(e) A large family of hull forms is being tested in order to provide design data for the future design of commercial vessels, 150 to 250 feet in length.

29) BARGE DESIGN AND FLOTILLA ARRANGEMENTS.

(b) Army Transportation Corps.
(d) Experimental; design.
(e) Barge tests are being conducted to determine the most efficient flotilla arrangements for various operating requirements.

(1378) VIBRATION ELIMINATION.

(b) Laboratory project.
(d) Experimental.
(e) Design and testing of fins fitted to both single and multiple screw hulls in way of propeller aperture in order to eliminate fantail vibration.
(h) Paper No. 1, Spring Meeting, Soc. of Nav. Architects and Marine Engineers.

UNIVERSITY OF MICHIGAN, Lake Hydraulics Laboratory.

Inquiries concerning Projects Nos. 1623 to 1625, incl., should be addressed to Prof. E. Brater, 230 West Engineering Bldg., University of Michigan, Ann Arbor, Mich.

(1377) INSTANTANEOUS CREATION OF ARTIFICIAL HARBOR ROADSTEADS ON SANDY COASTAL AREAS.

(b) The Horace H. Rackham School of Graduate Studies.
(c) Dr. V. Merkys, 322 West Engineering Building, Ann Arbor, Mich.
(d) Experimental; applied research.
(e) To study methods of temporarily decreasing the height of waves over limited coast areas.

(1628) MODEL STUDY OF MILWAUKEE OUTER HARBOR.

(b) Board of Harbor Commissioners, Milwaukee, Wisc.
(d) Experimental; applied research.
(e) To determine methods of alleviating or preventing damaging wave conditions in one of the harbor slips, and to study wave conditions in a proposed new slip.
(f) Completed.
(g) Several practical answers were found.
(h) "Model study of Milwaukee Outer Harbor." University of Michigan, Tech. Report No. 5, 19

(1629) STUDY OF SHORE PROTECTION METHODS FOR THE GREAT LAKES.

(b) Michigan Department of Conservation and Michigan Water Resources Commission.
(d) Field investigations; applied research.
(e) To evaluate the effectiveness and durability of inexpensive methods of shore protection.
(g) Preliminary results have been reported.
(h) "Low cost shore protection for the Great Lakes." Univ. of Michigan Research Publication No. 3, 1952.

(1630) MODEL STUDY OF OFF-SHORE DRILLING PLATFORM.

(b) Bethlehem Steel Co.
(d) Experimental; applied research.
(e) To study the effect of wave action on a pile-supported structure.

MISSISSIPPI STATE COLLEGE, Engineering and Industrial Research Station.

Inquiries concerning Projects Nos. 4 and 1631 should be addressed to Dr. Harold Flinsch, Box 365, State College, Miss.

(4) THE EFFECT OF WIND ON WAVES (FORMERLY DEVELOPMENT OF SURFACE WAVES BY WIND).

(b) Laboratory project.
(d) Experimental, theoretical and field investigation; basic research.
(e) Measurements of wave characteristics in wind-wave tunnel in laboratory, measurement of wind and waves in field (Gulf of Mexico and Atlantic), theoretical analysis.
(g) Off-shore wave height measurements in Gulf of Mexico, with recording apparatus.
(h) Report in preparation.

THE EFFECT OF WAVES ON BEACHES.

Laboratory project.
Experimental and theoretical investigation; basic research.
Waves are generated in a wave tank, and their effect on a sand beach is studied and analyzed.
Report in preparation.

JRI SCHOOL OF MINES AND METALLURGY, Department of Civil Engineering.

Inquiries concerning Projects should be addressed to the following, all at the Missouri School of Mines and Metallurgy, Rolla, Mo.
Nos. 116, 117, 586 .... Prof. J. B. Butler.
Nos. 319, 588, 1627, 1628 .... Prof. E. W. Carlton.
Nos. 317, 318, 587 .... Prof. V. A. C. Gevecker.

) FLOW THROUGH SMALL LOW HEAD SIPHONS.

) Laboratory project.
) Experimental; for student demonstration.
) Tests have been made on siphons of various materials, noting discharge, friction loss, and peak suctions.
) Temporarily discontinued.

) STUDY OF SUCTION IN TUBES AND SMALL HYDRAULIC APPLIANCES ESPECIALLY AS LIMITED OR AFFECTED BY ADHESION AND COHESION OF WATER.

) Laboratory project.
) Experimental; for student demonstration.
) Tests have been made on several small suction devices noting effect of adhesion and cohesion of water.
) Temporarily discontinued.

7) VELOCITY STUDIES IN A VERTICAL PIPE FLOWING FULL.

b) Laboratory project.
d) Experimental basic research; for Master's Thesis.
e) Tests were conducted on vertical flow in the 1/2 inch hard-drawn copper pipe approximately 35 feet in length, installed in a vertical position. Object was to investigate type of flow with pipe flowing full with gravity assisting in line pressure.
g) Studies for the above outlined experiment have been completed together with equations, graphs, and conclusions. Further studies using definite pipe diameters in pipes of other materials are contemplated.

8) FLOW THROUGH PIPE TRANSITIONS.

b) Laboratory project.
d) Experimental; basic research.
e) Tests on various shaped transitions were made, noting discharge and friction loss.
f) Suspended.

9) WEIR STUDIES.

b) Laboratory project.
d) Experimental basic research; for Master's Thesis.
e) Tests on several rectangular weirs were made to determine what effect the velocity of approach would have upon the relation between crest depth and critical depth of an imaginary open channel having the same dimensions as the weir opening.

(g) Study produced a simple, accurate and quick solution for the plotting of the M functio By means of a log-log graph plot a straight line relationship between the M function a the critical depth is obtained. Laborious tabulation and the errors inherent in fitti a curve are eliminated. This greatly simplifies the determination of critical flow wh the critical depth is known or the critical depth where the flow is known. A relation ship exists between the M function of channels of the same geometric shape but of diff ent dimensions when plotted on log-log graph paper. It was also established that the velocity of approach does not affect the relationship between physical depth and crest depth.

(586) FLUID FLOW IN PIPES.

(b) Laboratory project.
(d) Library research; basic research for Master's Thesis.
(e) A study of the various formulas for solution of problems on fluid flow in pipes is bei made. A correlation of the categories of roughness recommended by Prof. E. W. Schoder of Cornell University for use in the "exact type" exponential formula with the relativ roughness curves of Nikuradse used in determining the Reynolds number - friction facto relationship is being undertaken.
(g) A selected bibliography has been assembled.

(587) CROSS-SECTIONAL STREAM VELOCITY IN PIPES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) For studying velocity distribution in pipes, data are obtained by a Pitot tube for a w range of velocity heads. The equation for the velocity profile is determined for each overall velocity head and then compared with equations for other velocity heads. The parameters of the equations are also compared.

(588) SMALL AUGER TYPE TURBINES OPERATING OVER A LARGE RANGE OF HEADS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Using a 6-inch Auger type runner designed for a 12-foot head and having adjustable bla the efficiency, specific speed, and horsepower output are being studied for each head a setting of the blades. The application of small water turbines in the local streams around Rolla is being studied and necessitates a knowledge of the practicability of usi one model of a water turbine for all installations for small output.

(1632) EFFECT OF FLUID INTRODUCTION ON VENTURI TUBE CHARACTERISTICS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Study of liquid flow and gas flow in Venturi tubes with the introduction of fluid at th negative pressure point. The actual operating characteristics are determined for this condition, using a 2-inch Venturi tube for water with the introduction of water. The characteristics of a 6-inch Venturi tube with air as the medium are being obtained.

(1633) FLOOD CONTROL WITH RETARDING BASIN TYPE RESERVOIRS.

(b) Laboratory project.
(d) Library research; Master's Thesis.
(e) Studies of retarding basin type reservoirs for flood control in the Meramec Basin of Missouri.
(f) Completed.
(g) Further studies contemplated.
(h) Report written.

RT NEWS SHIPBUILDING AND DRY DOCK COMPANY.

Inquiries concerning Projects Nos. 123, 124, 896, 901, 1132, 1133, 1134, 1136, 1137, and 1634 should be addressed to Mr. C. H. Hancock, Hydraulic Laboratory, Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

) HYDRAULIC TURBINE TESTS.

) Laboratory project.
) Experimental; for design data.
) Scale model turbines, using either Francis or propeller type runners, are tested for power and efficiency at various speeds.

) METER CALIBRATION TESTS.

) Laboratory project.
) Experimental.
) To establish calibration curve for determining correction factors for various rates of flow. Meters are tested at various heads and rates of flow by weighing tank method. Time is recorded electrically by chronograph.

) VANE MOMENT TESTS ON ADJUSTABLE BLADE RUNNERS.

) Laboratory project.
) Experimental; for design data.
) Tests are to determine vane moment diagrams. The turbine load is applied by an electrical dynamometer and the gate openings are controlled by a governor. The blades adjust automatically and the blade moment is measured by a spring dynamometer.

) SHIP MODEL RESISTANCE TESTS.

) Laboratory project.
) Experimental; for design data.
) Scale ship models are towed to determine the effective horsepower, bare hull, required by the ship. Because of their small size, several models may be towed in a short period of time thus allowing much preliminary work to be done on the choice of lines. The final lines are checked by the David Taylor Model Basin. To eliminate a large portion of this preliminary testing, a schedule of systematic models was arranged in which the beam-draft ratio, the displacement-length ratio, and the prismatic coefficient are varied over a wide range. Towing of this set of models is continuing and when completed will provide design data for a standard offset series covering a wide range.

2) HYDRAULIC PUMP TESTS.

b) Laboratory project.
d) Experimental; for design data.
e) Scale model pumps, centrifugal and propeller types, are tested at constant speeds for head developed, power consumption, and efficiency at various rates of discharge. Cavitation tests are sometimes conducted by lowering the suction head to a point where the developed head and efficiency break down.

3) CAVITATION TESTS OF HYDRAULIC TURBINE MODELS.

b) Laboratory project.
d) Experimental; for design data.
e) Scale model turbines are tested on cavitation stand to determine sigma at which cavitation starts.

4) CAVITATION TESTS ON MODEL SHIP PROPELLERS.

b) Laboratory project.
d) Experimental; for design data.

(e) A water tunnel with a 42-inch test section is under construction. An electric dynamometer has been built to measure the propeller torque and thrust. Propellers up to 8-in diameter will be tested and a suction head approaching 33 feet will be available.

(1136) WAVE TESTS ON SHIP MODELS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Ship models are tested with scaled waves to determine the speed reduction in waves for the pull required for various still water speeds. Pitching periods and angles are determined from light trace photographs.

(1137) IMPACT TEST ON SHIP MODELS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental.
(e) Ship models were tested in waves to determine the impact and slamming forces on ships with light draft, encountered in heavy seas.
(f) Completed.
(h) "A brief investigation of impact forces on ships." Available from the Office of Naval Research, Department of the Navy.

(1634) RESEARCH AND TEST OF MAIN INJECTION SCOOPS AND OVERBOARD DISCHARGE.

(b) Bureau of Ships, Department of the Navy.
(d) Experimental.
(e) To determine the principal criteria governing the flow in ship circulating systems and to obtain some design data on the various circulating system components. Model components are tested separately in a water channel. Dynamic similarity is enhanced by modeling the boundary layer thickness and shape to scale. Stagnation, secondary flow, etc. are observed through transparent plastic models.

NEW YORK UNIVERSITY, Department of Chemical Engineering.

Inquiries concerning Projects Nos. 590, 1138, 1379, and 1635 should be addressed to Prof. John Happel, Department of Chemical Engineering, New York University, Bronx 53, N. Y.

(590) PRESSURE DROP DUE TO FLUID FLOW THROUGH ASSEMBLAGES OF SPHERES.

(b) Laboratory project.
(d) Experimental and theoretical; for two doctoral theses.
(e) Rigid assemblages of uniform spheres of various fractional void volumes in cubical assemblages were constructed, and the effect on pressure drop of passing a viscous liq through these assemblages was measured. The effect of particle size graduation and ro ness on pressure drop is being determined. A theoretical approach to the effect of fr tional void volume on pressure drop has also been derived and the validity of the deri expressions is being determined.
(g) Completed results for viscous flow indicate the existence of two different flow patter which converge at a voidage of approximately 90%.

(1138) EFFECT OF VARIATION OF SOLID TO FLUID DENSITY RATIO ON FLUIDIZATION CHARACTERISTICS.

(b) Laboratory project.
(d) Experimental; for one Doctoral and one Master's Thesis.
(e) Screened particles of very light solid substances will be fluidized in a 2-inch glass tube and the fluidization characteristics observed. The primary objective will be the determination of the optimum ratio of solid to gas density for smooth fluidization.

9) EFFECT OF SOLID-SOLID FRICTION ON PRESSURE DROP IN FLUIDIZED SYSTEMS.

b) Laboratory project.
d) Experimental; for Master's Thesis.
e) Unsupported beds of uniform smooth spheres were fluidized and the resulting pressure drop measurements were compared to the pressure drops through rigid assemblages of Project No. 590 in order to discover the effect of solid-solid friction.
f) Completed.
g) Qualitative results indicated that the presence of adhesional effects, entrance and exit effects and wall effects were of a greater magnitude than the solid-solid frictional effects on pressure drop.
h) "The study of the fluidization of uniform particles in a liquid medium." John Happel and Irwin L. Adler, Master's Thesis, New York University.

35) A CRITICAL STUDY OF THE PRIME VARIABLES IN A FLUIDIZED BED.

b) Laboratory project.
d) Experimental; for Doctoral Thesis.
e) A continuation of Project No. 1379. The parabolic flow pattern will be converted to a uniform flow pattern by means of a properly constructed bed screen support, and the velocity profile will be measured with a pitot tube. The effect of flow pattern and height of column to diamter ratio on the variables in a fluidized bed will be analyzed in order to separate and determine the effect of the various variables present on fluidization tendencies and pressure drop.

VERSITY OF NORTH CAROLINA, North Carolina State College of Agriculture and Engineering.

93) DYNAMIC SIMILARITY OF SMALL HYDRAULIC MODELS.

(b) Laboratory project.
(c) Prof. L. W. Long, Department of Engineering Mechanics, North Carolina State College, Raleigh, N. C.
(d) Experimental and theoretical; basic research.
(e) To make a theoretical study of dynamic similarity of small hydraulic models and at large scale ratios.
(h) To be published by the Department of Engineering Research, North Carolina State College.

36) RAINFALL INTENSITY DURATION-FREQUENCY CURVES FOR NORTH CAROLINA.

(b) Laboratory project.
(c) Prof. Charles Smallwood, Jr., Civil Engineering Department, North Carolina State College, Raleigh, N. C.
(d) Experimental; applied research.
(e) The collection and analysis of data pertaining to intensity, durability, and frequency of rainfall in North Carolina.

THWESTERN UNIVERSITY, The Technological Institute.

Inquiries concerning Projects Nos. 905, 906, and 1141 should be addressed to Prof. D. A. Dahlstrom, Projects Nos. 326 and 1637 to Prof. W. S. Hamilton, and Projects Nos. 127 and 904 to Prof. M. B. Gamet, Northwestern Technological Institute, Evanston, Ill.

27) RELIEF FROM WATER HAMMER BY MECHANICAL-PNEUMATIC SURGE SUPPRESSORS.

(b) Laboratory project.
(d) Experimental; for design.

(e) To determine extent to which surge pressures in pipe lines may be relieved by a preloaded, gas-filled, compression chamber in which the gas is separated from the liquid in the pipes by a stainless steel bellows.
(g) Present work has shown this type of unit to be free from fatigue failure and capable of protecting pipe systems from severe shock. Field tests are now being conducted in pipe lines in oil fields, distilleries, fuel supply lines for railroads, and test stations for jet engines. An improved pressure-time recorder of mechanical rather than electronic type is in use. Design of stainless steel unit preloaded at 125 psig, with useful volume of 10,000 cu in. has been completed, and is under test.

(326) CAVITATION DAMAGES UNDER CONTROLLED CONDITIONS.

(b) Laboratory project.
(d) Experimental; basic research; for theses and staff papers.
(e) The pressure in a vertical column of liquid is caused to fluctuate by a motor-operated piston and bellows arrangement, thereby forming and releasing a cavity at the top of the column. The amount of damage to various materials will be related to size of cavity, static load, dissolved air content, and proximity of material to point of cavity collapse
(g) Pits have been caused in brass, lucite, and mortar. An elastic-tube strain gage has been constructed for pressure measurements. Tests on mortar samples have begun.

(904) BULK MODULUS OF PETROLEUM PRODUCTS, INCLUDING CRUDE OILS AND GASOLINE.

(b) Laboratory project.
(d) Experimental; basic research for design.
(e) Tests have been conducted on three crude oils, one gasoline, and on distilled water at temperatures from 60° F. to 130° F. and at pressures ranging from 0 to 1500 psig. Further tests will be made on other oils and gasolines, tap water, and a variety of chemical Specific gravities and viscosities will be determined over the ranges of temperature and pressure indicated above.
(g) Tests indicate high modulus with low temperature and rapidly increasing modulus at low pressures after which a leveling off takes place with nearly constant modulus above 1000 psig.

(905) THE LIQUID-SOLID CYCLONE.

(b) Laboratory project.
(d) Experimental and field investigations; basic and applied research, for design and operation.
(e) Application of centrifugal fields as obtained in the liquid-solid cyclone to the rapid classification, beneficiation, separation, and desliming of coal and minerals.
(g) Experimental and field investigations on theory and operation of the liquid-solid cyclone have been completed, making it possible to design equipment for any capacity and efficiency desired. Investigations have indicated that it is easily possible to deslime minerals and coal of minus 200 refuse, and design and operation methods have been published. New additions are being made to the cyclone to permit addition of fresh water for maximum separation of fine solids from coarse. Field tests have already been conducted indicating less water is required than in conventional equipment.
(h) "High-efficiency desliming by use of hydraulic water additions to the liquid-solid cyclone." D. A. Dahlstrom, Mining Engineering, Aug. 1952.

(906) SEPARATION OF FINE-SIZED CLOSE GRAVITY SOLIDS BY CENTRIFUGAL FORCE AS OBTAINED IN THE LIQUID-SOLID CYCLONE.

(b) Laboratory project.
(d) Theoretical and experimental; basic and applied research for design and operation.
(e) Separation of close gravity solids by liquids and the application of centrifugal fields as obtained in the liquid-solid cyclone is being investigated.

(g) Economical separation and recovery of materials differing by as little as 0.01 in specific gravity and as small as 100 mesh in size have been obtained. A small pilot plant has been constructed, which can be used on any material to obtain necessary design data. Methods for predicting industrial design and operation have been advanced. Two industrial installations have been made within the past year and three more are being installed. Actual results conform quite closely with predicted values.
(h) "Application of low cost, high-capacity classification to thickening and separation of solids in the food industry." D. A. Dahlstrom, Food Technology, to appear early 1953. "Fine-size, close-specific-gravity solid separation with the liquid-solid cyclone." J. J. Moder, D. A. Dahlstrom, Chemical Engineering Progress, Feb. 1952.

1) HIGH SPEED SEPARATION OF CLOSE SPECIFIC GRAVITY LIQUIDS IN THE CYCLONE.

(b) Laboratory project.
(d) Theoretical and experimental; basic and applied research for design and operation.
(e) Rapid separation of close specific gravity liquids by use of centrifugal fields as obtained in the cyclone is being investigated. Preliminary tests indicate that recovery of either liquid phase will be a function of feed and overflow diameters, cyclone included angle, pressure drop across cyclone, volume split between overflow and underflow, specific gravity difference between liquid phases, free composition and interfacial tension between liquids. Liquid-liquid separation work will be especially important for liquid-liquid extraction applications.
(g) It has been proven that separation of the two liquid phases can be obtained at a probable cost and simplicity far surpassing that experienced in most liquid-liquid extraction applications to date. Correlations have been obtained for recovery of the various liquid phases as a function of volume split, feed composition and pressure drop across the cyclone. Basic data indicate that liquid-liquid separation is possible and predictable. A pilot plant is now being constructed to obtain actual operative data on liquid-liquid separation and extract.
(h) "Separation of two immiscible liquids in a liquid-liquid cyclone." R. R. Ellefson, Master's Thesis, Northwestern University, Aug. 1952.

37) SPRAY FORMATION.

(b) Bureau of Aeronautics, Department of the Navy.
(d) Theoretical and experimental; for design.
(e) The effects of different variables in causing a jet of water to break up into spray is to be investigated.

VERSITY OF NOTRE DAME, College of Engineering.

Inquiries concerning Projects Nos. 1638 and 1640 should be addressed to Dr. A. G. Strandhagen, Department of Engineering Mechanics, and Projects Nos. 1641 to 1646, incl., to Dr. Steponas Kolupaila, Hydraulics Laboratory, University of Notre Dame, Notre Dame, Ind.

638) THE EFFECT OF BOUNDARY LAYER ON COMPUTED WAVE RESISTANCE.

(b) Laboratory project.
(d) Theoretical; basic research.
(e) The research is concerned with the form and shape of a laminar and turbulent boundary layer and its effect on producing a virtual modification to the lines of the ship.
(f) Completed.
(g) It was found that for a selected form of ship, virtual modifications of the lines were necessary for speeds below a particular speed and that modifications were not necessary for speeds above a particular speed.
(h) Report in preparation.

(1639) DEVELOPMENT OF FREE SURFACE VARIABLE PRESSURE WATER TUNNEL.

(b) Laboratory project.
(c) Dr. K. E. Schoenherr, Department of Mechanics, University of Notre Dame, Notre Dame, Ind
(d) Theoretical and experimental.
(e) Study of flow conditions and energy losses in a 1/6 scale model.
(g) Feasibility of project has been proved.

(1640) STABILITY OF TOWED SHIPS.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical; basic research.
(e) The hydrodynamic forces and moments are in the process of evaluation for the case of two ships in tandem moving in a sea at rest and in a regular seaway.

(1641) THE KINETIC ENERGY FACTOR FOR THE TRUE VELOCITY HEAD.

(b) Laboratory project.
(d) Theoretical; field investigation.
(e) The Coriolis coefficient developed for a pipe, open channel and channel under ice conditions, using two different graphical methods.
(f) Completed.
(g) Some standard values suggested.
(h) Report in preparation.

(1642) COMPUTATION OF EMPIRICAL DISCHARGE CURVES.

(b) Laboratory project.
(d) Applied research and design.
(e) A convenient determination of the exponent of empirical parabolas.
(f) Completed.
(g) A nomogram for direct reading of the exponent.
(h) Report in preparation.

(1643) BIBLIOGRAPHY ON WATER MEASUREMENTS.

(b) Laboratory project.
(d) Bibliographical.
(e) Titles of the hydrometric literature in more than 20 languages.
(f) Completed.
(g) Classified lists and card-index.
(h) First list published 1921, second (partly) 1948.

(1644) BASIC HYDROLOGIC DATA FOR THE WORLD'S RIVERS.

(b) Laboratory project.
(d) Applied research.
(e) Collection and calculation of lengths, basin areas, water discharges.
(h) Report in preparation.

(1645) ACCURACY OF THE MISSISSIPPI RIVER RUNOFF DETERMINATION.

(b) Laboratory project.
(d) Experimental research.
(e) Different methods of computation of the daily discharge at Vicksburg, Mississippi, applied and compared. Methods of stream gaging discussed and investigated. Comparison of results obtained by two federal agencies.
(h) Report in preparation.

PULSATION IN A PENSTOCK.

Laboratory project.
Field investigation.
Velocity fluctuations observed simultaneously wtth 25 current meters in a large penstock.
Suspended.
Three-dimensional diagram for one set of observations constructed.

STATE UNIVERSITY, Robinson Laboratory.

Inquiries concerning Projects Nos. 598, 910, 1143, 1144, 1380, 1381, 1382, and 1647 should be addressed to Prof. S. R. Beitler, Robinson Laboratory, Ohio State University, Columbus 10, Ohio.

) COEFFICIENTS OF DISCHARGE FOR ECCENTRIC AND SEGMENTAL ORIFICES.

) American Society of Mechanical Engineers and American Gas Association.
) Experimental; applied research.
) Coefficients of discharge are being obtained for eccentric and segmental orifices in 4-inch, 6-inch, 10-inch, and 14-inch pipe lines. It is desired to publish curves from which coefficients for commercial use may be chosen for a large range of Reynolds numbers, diameter ratios, and pipe sizes.
) Completed.
) To be published as ASME paper in December, 1953.

) CALIBRATION OF ORIFICES, VENTURIS, AND FLOW NOZZLES.

) Manufacturers and users of flow meters.
) Experimental; calibration for use.
) Many primary metering elements for flow measurement are being calibrated individually for accurate measurements.
) Results indicate that published data on orifices and nozzles are satisfactory, but that material for venturi tubes is not complete.

) STUDY OF SUDDEN EXPANSION IN PIPE LINES.

b) Laboratory project.
d) Experimental; basic research for masters' theses.
e) A study of pressure and velocity changes with flow through sudden enlargements for both compressible and incompressible fluids.
g) Theoretical analysis has been completed.

) A STUDY OF FLOW IN BENDS AND ELBOWS IN SMALL PIPE LINE.

b) Laboratory project.
d) Experimental; basic research.
e) A study of variation of pressure and velocity around bends of different radius smooth tubes of 1.5 inch diameter and less.
g) Considerable work completed and additional work in progress.

) STUDY OF THE EFFECT OF ROUNDING OF ENTRANCE EDGE ON THE COEFFICIENT OF ORIFICES.

b) Laboratory project.
d) Experimental; research for masters' theses.
e) To study the effect of different radii of rounding on the coefficient of discharge of orifice plates in a 2-inch pipe line.
g) First project completed.
h) Theses are available for reproduction.

(1381) STUDY OF THE EFFECT OF CHANGING THE ANGLE OF THE THROAT OF ORIFICE PLATES ON THEIR COEFFICIENTS OF DISCHARGE.

(b) Laboratory project.
(d) Experimental; research for masters' theses.
(e) Orifices for use in 2-inch lines are to be constructed with the bored portion conical rather then cylindrical. The face of the truncated cone is to be upstream. It is hoped to develop a more stable primary measuring device.
(g) First project completed.
(h) Theses are available for reproduction.

(1382) STUDY OF THE EFFECT OF INLET VELOCITY PROFILE ON THE FLOW AND DIFFERENTIAL PRESSURE OF PRIMARY METERING ELEMENTS.

(b) Laboratory project.
(d) Experimental; research for masters' theses.
(e) It is planned to set up various disturbances in the inlet section of a metering device, measure the velocity traverse ahead of the primary metering element and the differentia across it and attempt to correlate the results to determine the optimum locations for flow straighteners, etc.
(g) First project completed.
(h) Theses are available for reproduction.

(1647) LEAKAGE THROUGH CLEARANCES IN ROTARY PUMPS.

(b) Laboratory project.
(d) Basic research.
(e) To determine the effect of viscosity surface speed and clearance on the leakage past th ends of teeth on gear pumps.

OKLAHOMA A AND M COLLEGE, Civil Engineering Department, Hydraulic Laboratory.

Inquiries concerning Projects Nos. 911, 913, and 1648 to 1653, incl., should be addressed to Prof. John H. Dawson, School of Civil Engineering, Oklahoma A and M College, Stillwater, Oklahoma.

(911) THE EFFECT OF SURGES ON CARRYING CAPACITY OF DRILLING MUD.

(b) Laboratory project.
(d) Experimental and theoretical; for Master's Thesis and applied research.
(e) To determine whether surges such as produced by centrifugal or piston pumps have any effect on the slip velocity of particles in the stream and to obtain a measure of the effect.
(f) Laboratory investigations completed. Tests are now needed on actual well drilling rotary rigs.
(g) Surges increase slip velocity. Experiments check theory.
(h) Master's Thesis available on loan.

(913) THE EFFECT OF SURGES ON THE EFFICIENCY OF A PISTON PUMP.

(b) Laboratory project.
(d) Experimental.
(e) To determine the effect of surges on pump action and efficiency, and to determine the required size of an airdome or desurger and the savings that might be obtained through the elimination of pressure surges on the discharge side of the pump.
(f) Suspended.
(g) Savings of up to 35% in efficiency.
(h) See World Oil Magazine, Nov. 1952. Master's Thesis, E. A. Fitch. (Available on loan.)

8) WATER HAMMER ALLEVIATOR.

b) Laboratory project.
d) Theoretical; design and development.
e) A new type of valve and controller is being designed which may be installed on any pipeline that will prevent the pressure from going above any set amount and yet provide for closure of the valve in an absolute minimum of time. This is done without air chambers, bypasses, or accumulators.
f) Theoretical work completed. Attempt being made to interest manufacturers or consumers so experimental verification may be carried out.

9) SURGES IN LONG PIPELINES.

b) Laboratory project.
d) Experimental and theoretical; for general information.
e) Various types of positive displacement pumps are being installed so as to discharge into a variable length pipeline. A recording is being made of the instantaneous pressure versus time by means of electronic equipment for various surge frequencies. Methods of eliminating these surges are being investigated and compared. High speed aircraft type pumps have serious surge problems. Removal or surge decreases noise.

0) EFFECT OF PRESSURE ON PIPES.

b) Laboratory research.
d) Theoretical and experimental.
e) Various sections of sizes and types of pipes are subjected to external and internal pressure to determine the effects of pressure on length, diameter, and position of pipe.

51) DESIGN AND CONSTRUCTION OF LABORATORY EQUIPMENT.

b) Laboratory project.
d) Demonstration and applied research for improvement of teaching and thesis.
e) Equipment suitable for student demonstration, operation, instruction, and construction is being designed and built in a systematic manner for mass production.
g) Twenty sets of basic equipment plus student laboratory manual suitable for any laboratory have been prepared. Total cost for entire laboratory equipment in operating condition is less than $10,000.
h) Laboratory manual and photographs of equipment available.

52) DEVELOPMENT OF TEACHING AIDS.

(b) Laboratory project; cooperative with American Society for Sanitary Engineering.
(d) Experimental; for development and instruction.
(e) Design and construction of exhibits to show back siphonage, venting, pipe friction, and loss through valves and fittings for short courses, plumbing groups, and students.
(g) Plans completed for these units. Two have been built. Cost per unit less than $100.00.
(h) Information and plans available.

53) WIND PRESSURE DISTRIBUTION ON BUILDINGS.

(b) Laboratory project.
(d) Theoretical and experimental for demonstration.
(e) Portable wind tunnel with capacity of 100 fps through one square foot - throat area has been constructed. Models of buildings are installed and pressure distribution measured with manometers. To aid in constructing Oklahoma Farm fitted structures.

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OREGON STATE COLLEGE, Department of Civil Engineering.

(918) RELATION BETWEEN RAINFALL AND RUNOFF FROM SMALL WATERSHED IN WESTERN OREGON.

(b) Laboratory project.
(c) Dr. C. A. Mockmore, Oregon State College, Corvallis, Ore.
(d) Field investigation; basic research.
(e) Watershed 7.34 sq mi partly wooded, partly farmed; automatic recording rain gages and flow recording gages on loan from Weather Bureau and U. S. Geological Survey. Planned as 10-year project, 3 years completed.

(1383) MODEL STUDIES OF TAPERED INLETS FOR BOX CULVERTS ON STEEP GRADES.

(b) Cooperative with Oregon State Highway Department and Bureau of Public Roads.
(c) Mr. Roy H. Shoemaker, Jr., Oregon State College, Corvallis, Ore.
(d) Experimental; design.
(e) Scale models of inlets tested with culvert on steep grades to improve discharge characteristics of box culverts.
(f) Completed.
(g) Simple modification to existing culvert design permits culvert to flow full under low head.
(h) Final report in preparation.

(1654) MODEL INVESTIGATION OF FISH LADDERS IN BOX CULVERTS.

(b) Cooperative with Oregon State Highway Department and Bureau of Public Roads.
(c) Mr. Roy H. Shoemaker, Jr., Oregon State College, Corvallis, Ore.
(d) Experimental; design.
(e) Scale model of box culvert with fish ladders installed to determine discharge characteristics of culvert.

(1655) OREGON CITY SIPHON SPILLWAYS.

(b) Stevens and Thompson, Consulting Engineers.
(c) Mr. E. F. Rice, University of Alaska, Fairbanks, Alaska.
(d) Experimental; design.
(e) A 1:30 scale model of proposed spillway was constructed to study pressure variations, priming characteristics, and discharge characteristics.
(f) Completed.
(h) Report submitted to sponsor.

PELTON WATER WHEEL COMPANY.

Inquiries concerning Projects Nos. 1146, 1385, and 1656 should be addressed to Mr. R. M. Bacchi, Pelton Water Wheel Company, 2929 19th Street, San Francisco 10, Calif.

(1146) HEAD EFFECT ON IMPULSE TURBINE MODEL TESTING.

(b) Laboratory project; sponsored by the Mountain Laboratory Group.
(d) Experimental; applied research.
(e) To establish model law for testing impulse turbines under various operating pressures, tests are being made under heads between 100 and 2000 ft. The effect of housing size and shape is under study.
(f) Temporarily suspended for further housing changes.
(g) Initial tests have been completed.

ADJUSTABLE BLADE PROPELLER TYPE TURBINE MODEL. EFFICIENCY AND HORSEPOWER TESTS.

Laboratory project.
Experimental; applied research.
An 11-inch model turbine was built and tested to study the effect of using an existing casing - draft tube combination on a reoonstruction project.

FOUR NOZZLE VERTICAL SHAFT IMPULSE TURBINE MODEL. EFFICIENCY AND HORSEPOWER TESTS.

Laboratory project.
Experimental; applied research.
A 14-7/8 inch P.D. wheel impulse turbine has been built with a vertical shaft, four-nozzle arrangement to study effect of bucket size and shape on this configuration.

LVANIA STATE COLLEGE, Ordnance Research Laboratory.

Inquiries concerning Projects Nos. 605, 1150, 1151, 1152, 1386, and 1389 should be addressed to Dr. J. M. Robertson; Projects Nos. 920, 921 and 1387 to Mr. B. W. McCormick; and Project No. 1388 to Mr. Donald Ross; Ordnance Research Laboratory, P. O. Box 30, State College, Pa.

FLOW PAST SLOTS IN SURFACES.

Laboratory project.
Experimental; applied research.
Studies were made on the pressure and flow conditions near slots in surfaces, as affected by relative boundary layer thickness and contour of slot corners.
Inactive.
The boundary layer thickness, slot width in the direction of flow, and rounding of downstream edge were found to govern the magnitude of the pressure dip following the slot.

FUNDAMENTALS OF SURFACE CAVITATION.

Bureau of Ordnance, Department of the Navy.
Experimental; basic research.
A laboratory-size eggbeater apparatus is used in which the noise inception point and noise output is to be correlated with the composition and nature of the liquid and the surface of the propeller.
Being reactivated.
Effects of air content and fluid properties on cavitation inception were investigated for one simple propeller shape.

ELECTROMAGNETIC ANALOGY FOR PROPELLERS.

Completed.
"The application of an electro-magnetic analogy to the determination of induced camber correction for wide-bladed propellers." B. W. McCormick, 1952 Heat Transfer and Fluid Mechanics Institute, Preprints of Papers, Stanford University Press, 1952, p. 111.

PROPELLERS FOR OPERATION IN SYMMETRIC WAKES.

b) Bureau of Ordnance, Department of the Navy.
d) Theoretical and experimental; applied research.
e) The problem is the design of optimum-efficiency and cavitation-free propellers for operation behind bodies of revolution. It is being attacked through consideration of the physics of propeller action. Design methods resulting from the theory are being tested by experiment on an 8-inch diameter model torpedo in the 48-inch Water Tunnel.
h) "Optimum single propellers in radially varying, incompressible inflow." Frank Lane, Jour. of Applied Mechanics, Trans. ASME, Vol. 19, No. 3, Sept. 1952, pp 252-256.

(1150) HYDRODYNAMIC PERFORMANCE OF 48-INCH WATER TUNNEL.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental; applied research.
(e) Velocity distributions and pressures are being measured in all portions of the 48-inch Water Tunnel at velocities up to 80 fps.
(g) The initial testing program indicated the need of a honeycomb and possibly screens to straighten the flow. A honeycomb was installed and the testing program is being repeat

(1151) DESIGN AND CONSTRUCTION OF 12-INCH WATER TUNNEL.

(b) Bureau of Ordnance, Department of the Navy.
(d) Design.
(e) Tunnel is planned for general supplementary research; interchangeable working sections have been designed. One circular closed jet 12 inch diameter, one circular open jet 12 inch diameter, one 4 1/2 inch x 20 inch rectangular closed; maximum design velocity 70 fps. Tunnel shell and rectangular working section erected in the fall of 1952.
(h) "New hydrodynamic research facilities at the Ordnance Research Laboratory." A. F. Lehman, Paper prepared for Ninth Underwater Ballistics Conference, July 1952, Ordnance Research Laboratory, The Pennsylvania State College, State College, Pa.

(1152) DESIGN AND CONSTRUCTION OF 48-INCH AIR TUNNEL.

(b) Bureau of Ordnance, Department of the Navy.
(d) Design.
(e) Closed circuit tunnel planned for supplementary research; working section 48-inch octagon, 16 feet long; maximum design velocity including honeycomb and screens, 200 fps A fifth scale model of the nozzle has been constructed for testing suitability of proposed design.
(h) "New hydrodynamic research facilities at the Ordnance Research Laboratory." A. F. Lehman, Paper prepared for Ninth Underwater Ballistics Conference, July 1952, Ordnance Research Laboratory, The Pennsylvania State College, State College, Pa.

(1386) CAVITATION STUDIES.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental; basic research.
(e) Cavitation inception as noted visually and acoustically on bodies is being correlated with the magnitude and location of the minimum pressure coefficient as a function of scale, i.e. Reynold's number and Weber's number. The nature and shapes of cavities behind bodies are also being studied.

(1387) STUDY OF TIP VORTEX CAVITATION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Attempt to correlate such factors as vortex core size, vortex strength, and Reynold's number through studies of an elliptic wing in the 48-inch water tunnel.

(1388) TURBULENT BOUNDARY LAYERS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) A new empirical method for calculating two-dimensional, turbulent, boundary-layer flows in adverse pressure gradients is being developed by correlating existing data for a wid variety of flows. Experimental measurements are being made in a conical diffuser with various entrance conditions.
(g) Division of the boundary layer into inner and outer turbulent regions has made possible an analysis which does not depend upon the assumption of a single parameter family of profiles.

REDUCTION OF STRUT WAKE.

Bureau of Ordnance, Department of the Navy.
Theoretical and experimental; applied research.
The model torpedo supporting strut in the 48-inch water tunnel (see Project 921) exerts an asymmetric effect on the velocity distribution at the plane of the propeller. A method of filling in the wake flux deficiency by an external pumping apparatus has been tried to alleviate this condition.
It was found possible to reduce the strut wake by filling; however, this did not eliminate the interference of the strut on the boundary layer of the body.
"Reduction of a strut wake." Master's Thesis, J. H. McGinley, Dept. Aeronautical Engineering, Graduate School, The Pennsylvania State College, Aug. 1952. (Available on loan.)

ILVANIA WATER AND POWER COMPANY.

Inquiries concerning Projects Nos. 1154 to 1158, incl., should be addressed to Dr. S. K. Waldorf, 405 Fulton Bank Building, Lancaster, Pa.; and Projects Nos. 1657 and 1658 to Mr. Carroll F. Merriam, Pennsylvania Water and Power Company, Lexington Building, Baltimore 3, Maryland.

) MEASUREMENT OF WATER VELOCITIES WITH ULTRASONICS.

) Laboratory project.
) Experimental; applied research.
) To develop an improved method of measuring large quantities of water, particularly the discharge of large hydroelectric units having short intake conduits with large rectangular cross-sections. An ultrasonic transducer rod is placed at each of two parallel opposite walls of the rectangular duct in which water velocity is to be measured. The transducers are displaced from each other along the principal axis of flow. The phase angle between the transmitted and received ultrasonic signals is a measure of the water velocity.
) Water velocities up to ten feet per second have been measured with an error of one-half percent in a rectangular duct five inches by nine inches.

) CORRELATION OF ANNUAL TREE GROWTH WITH PRECIPITATION AND RIVER FLOW.

) Laboratory project.
) Field investigation; applied research.
) Cross-sections of trees from Juniata River drainage area above Huntingdon, Pa. were measured for correlation with flow records at Huntingdon, and precipitation and temperatures at several other stations.
) Completed.
) Good correlation not found.
) Report in Company files.

) AIR BUBBLER SYSTEM TO MAINTAIN OPEN CHANNEL IN SHEET ICE.

) Laboratory project.
) Field investigation; applied research.
) Three experimental 1000-foot and one 1500-foot lengths of galvanized steel pipe, with holes at intervals for discharging compressed air, are laid on the reservoir bottom perpendicular to the dam. The warmer water caused to rise with the bubbles maintains an open channel in the reservoir sheet ice. The pipes are widely spaced to avoid interaction and are placed so that open channels will direct the movement of pack ice over the dam at selected gates. If successful, a system of such pipes extended farther upstream is expected to reduce the possibility of ice jams.
g) Results are encouraging, but not conclusive. Experiments with flexible tubing revealed some inherent difficulties with tubing which have not been overcome.
h) Minutes of Hydraulic Power Committee, Edison Electric Institute, 1950.

(1157) SEDIMENTATION IN RESERVOIR OF SAFE HARBOR HYDROELECTRIC STATION.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) With a U.S. D-43 sampler, suspended sediment in the Susquehanna River is measured at th head of the Safe Harbour Reservoir. The suspended sediment in the discharge of the reservoir is measured at the station discharge and dam overflow by special means appli- cable to turbulent water. The rate of silting in the reservoir is measured periodicall by fathometer soundings.

(1158) FOREWARNING OF FRAZIL ICE FORMATION.

(b) Laboratory project.
(d) Experimental; applied research.
(e) By means of a resistance thermometer and strip chart recorder, the temperature of the Susquehanna River is measured within 0.001° C at Safe Harbour and Holtwood hydroelectri stations for the prediction of frazil ice formation.
(g) A cooling rate in excess of 0.01° C per hour to the freezing point of the river water i followed by the formation of frazil ice rather than sheet ice.
(h) "Combatting frazil ice in hydroelectric stations." K. J. Granbois, American Institute Electrical Engineers Technical Paper 53-8, presented at 1953 AIEE Winter General Meetir

(1657) DETERMINATION OF MEAN ANNUAL FLOW OF SUSQUEHANNA RIVER.

(b) Laboratory project.
(d) Applied statistical research.
(e) Development of three independent time series reduced to common basis representing varia tions in river flow extending 24 years prior to beginning of stream gaging on the river One series is based on composite of four stream measurements near the mouth. The secor series used all of the stream flow data published by the U. S. Geological Survey for th Susquehanna drainage basin. The third series is estimated runoff derived from rainfall records since 1865.
(f) Completed.
(g) Series show possibility of interesting properties indicating that the data are not pure accidental variations having statistical distribution.
(h) Described in Company Engineering Reports 515 and 516.

(1658) RAINFALL IN SUSQUEHANNA DRAINAGE BASIN.

(b) Laboratory project.
(d) Applied research.
(e) Large scale application of double mass curve to all available rainfall data in Susque- hanna basin. Record of individual gages analyzed by double mass curve method in order to derive figure which appears to represent most reliably the long term mean for each gage. Weighted average taken to determine estimated variations in rainfall for 92 year
(g) Rainfall map appears to be sufficiently in detail to indicate some relationship between rainfall and topography.

PURDUE UNIVERSITY, School of Civil Engineering and Engineering Mechanics.

(1391) INVESTIGATION OF THE FUNDAMENTAL THEORIES OF SEDIMENTATION IN A TANK.

(b) Federal Security Agency, Public Health Service, and National Institutes of Health.
(c) Prof. Don E. Bloodgood, Purdue University, Lafayette, Ind.
(d) Experimental; for design and Masters' Theses.

e) Observing the sedimentation rate of finely divided solids suspended in water moving at various velocities. The effect of variation in depth and width and length of channel eventually will be observed. The sediment used in the first series of tests was finely ground coal. The sediment currently being investigated for a new series of tests is a diatomaceous silica.
h) "An investigation of the effect of varying the width and depth of a sedimentation tank." M.S.C.E. Thesis, C. E. Smith, Purdue University, Aug. 1952.

9) APPLICATION OF AIRPHOTO INTERPRETATION TECHNIQUES IN ESTIMATING RUNOFF FROM A SELECTED WATERSHED.

b) Joint Highway Research Project, Purdue University.
c) Prof. K. B. Woods, Purdue University, Lafayette, Indiana.
d) Experimental; basic and applied research; doctoral thesis.
e) All the characteristics of the watershed and the main channel of the selected 227 sq mi Busseron Creek watershed (tributary of the Wabash River) are determined exclusively from 1;20,000 scale uncorrected AAA airphotos by means of aerial photographic interpretation techniques and theories of photogrammetry. Inexpensive instruments such as "Abrams Contour Finder", "W. and T. Surveying Altimeter", etc. were employed in the study. Factors which affect the accuracy of the results are discussed at length.
f) Completed.
g) The results of the computed runoff for the storm of Feb. 13-15, 1948 were satisfactory. It indicates the adaptability of the airphoto interpretation method in runoff estimates.
h) "Application of airphoto interpretation techniques in estimating runoff from a selected watershed." P. T. Yeh, Doctoral Dissertation, Purdue University, Jan. 1953.

SELAER POLYTECHNIC INSTITUTE, Mechanical and Hydraulic Laboratory.

50) HIGH SPEED HYDRAULIC COMPONENTS.

b) Frankford Arsenal, Ordnance Corps, Department of the Army.
c) Assoc. Prof. Frederick J. Bordt, Mechanical Engineering Department, Rensselaer Polytechnic Institute, Troy, N. Y.
d) Experimental; applied research, development.
e) Investigation and development of a 24,000 RPM hydraulic torque conversion system including control. The system, with a constant speed input, is to have a variable torque and speed output.

KY MOUNTAIN HYDRAULIC LABORATORY.

Inquiries concerning Projects Nos. 332 and 1661, should be addressed to Prof. C. J. Posey, Engineering Building, State University of Iowa, Iowa City, Iowa.

32) TESTS OF SCOUR AROUND BRIDGE PIERS.

(b) Cooperative with Bureau of Public Roads.
(d) Experimental; development.
(e) Study of methods of protecting piers from scour.
(f) Active during summers.
(g) Methods so far developed gave model pier complete protection until entire bed had undergone severe degradation.

561) TESTS OF EROSION AROUND MODELS OF SUBMERSIBLE OIL-STORAGE AND WELL-DRILLING BARGES.

(b) Shipbuilding Division, Bethlehem Steel Company, Beaumont, Texas.
(d) Experimental; design.

(e) Drilling barges and storage barges used for off-shore oil pool development must be secur from underscour during windstorms, when high water velocities may be induced. Model tests were made in the 80-inch flume, using fine sand for the movable bed.
(f) Completed.
(g) Scour holes were recorded for tests of models of the various practicable designs under different degrees of exposure. Methods of obtaining protection from underscour were developed and tested.
(h) "Tests of erosion around models of submersible oil-storage and well-drilling barges." C. J. Posey, Rocky Mountain Hydraulic Laboratory, Oct. 1952.

RUTGERS UNIVERSITY, Department of Botany.

(1662) PINE REGION HYDROLOGICAL RESEARCH.

(b) Cooperative with U. S. Geological Survey, New Jersey Department of Conservation and Economic Development, and the U. S. Forest Service.
(c) Mr. Henry Barksdale, U. S. Geological Survey, Trenton, N. J.
(d) Field investigation; basic research.
(e) Study of water relations of watersheds, one of which will be burned according to recentl developed silvicultural practices, and the other will be left to natural forest succession.
(h) "Progress report on pine region hydrological research." May, 1952.
"Preliminary investigation of prescribed burning on soil water supplies in South Jersey. John Cantlon, Amer. Cranberry Growers Assoc. Proc. for 1951.
"The pine region hydrological research project of New Jersey." Jack McCormick Cranberries, the National Cranberries Magazine, 1952.

ST. ANTHONY FALLS HYDRAULIC LABORATORY, University of Minnesota.

Inquiries concerning Projects Nos. 100, 104, 105, 616, 924, 925, 1159, 1160, 1161, 1163, 1165, 1392, 1394, 1396, 1397, 1663 to 1672, incl., should be addressed to Dr. Lorenz G. Straub, Director, St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minn.

Inquiries concerning Projects Nos. 111, 114, 1168, and 1398, which are conducted in cooperation with the Soil Conservation Service, should be addressed to Mr. Fred W. Blaisdell, U. S. Soil Conservation Service, St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minn.

Inquiries concerning Projects Nos. 194, 412, 985, 1206, 1733, which are conducted in cooperation with the Corps of Engineers, should be addressed to the District Engineer, Corps of Engineers, Department of the Army, St. Paul District, St. Paul, Minnesota. (These projects are listed on pages 129 and 130.)

(100) AIR ENTRAINMENT RESEARCH.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic and applied research.
(e) Detailed study of the self-aeration of high velocity open-channel flows. Velocity distributions and air concentration distributions in the flows are being obtained with specially developed electrical instruments. Control and variation of flows afforded by laboratory channel built for purpose. Present phase concerns observation of flows when fully aerated.

"Velocity measurements of air-water mixtures." Lorenz G. Straub, John M. Killen, and Owen P. Lamb, March 1952, 28 pp., 15 ill., St. Anthony Falls Hydraulic Laboratory Technical Paper No. 10, Series B.
"An experimental channel for the study of air entrainment in high-velocity flow." Owen P. Lamb, Nov. 1952, 46 pp., 15 ill., St. Anthony Falls Hydraulic Laboratory Project Report No. 34.

) FLOW DIVERSION RESEARCH.

) Office of Naval Research, Department of the Navy.
) Theoretical and experimental; basic and applied research and design.
) Detailed study of flow processes in bends with main emphasis on guide vane bends. Two dimensional and secondary effects are to be separated so that the performance of a given bend geometry can be predicted.
) It has been shown that secondary flows have only a small influence upon the two-dimensional deflection in a guide vane bend, but increase the two-dimensional loss many fold. The relation of the secondary flow to the increased loss has been shown and formulas which check the experimental data reasonably well have been deduced. A result of practical importance is that a guide vane system of minimum loss can be obtained using thin plate vanes by selecting a two-dimensional cascade of such vanes having a small head-loss coefficient and using vanes of large chord length.
) Publication in preparation.

) WATER TUNNEL DESIGN STUDIES.

) David Taylor Model Basin, Department of the Navy.
) Applied research and experimental design.
) Tests were made on a 6-inch model of a 36-inch open-jet or closed-jet (with both cylindrical and diverging test section) variable pressure water tunnel with an air-bubble resorber.
) Completed.
) Power requirements and cavitation limits for the prototype tunnel were estimated. The resorber resulted in an even more uniform velocity profile in the test section and added no detectable pressure or velocity fluctuations there. A method of designing a diverging closed-jet test section with no axial pressure gradient was verified by model tests.
) "Model studies of a water tunnel with an air-bubble resorber." Reuben M. Olson, St. Anthony Falls Hydraulic Laboratory Project Report No. 29, Feb. 1952.
"Model studies of a water tunnel with an air-bubble resorber; A diverging closed-jet test section for a water tunnel." Reuben M. Olson.

) FLOW THROUGH GRANULAR MEDIA.

b) Laboratory project.
d) Experimental and theoretical; for master's thesis.
e) Tests have been made to determine head loss resulting from flow through uniform sized media of varying shapes, including sieved fractions of a sand sample, dimensionless numbers have been developed through consideration of forces and dimensions involved. An attempt has been made to determine effect of particle shape on the flow.
g) Resistance to flow through granular material is greater the more angular the particle.
h) "Fluid flow through porous media composed of regular-shaped particles. Clarence W. Carpenter, Jr., Master's Thesis, University of Minnesota, Jan. 1952. (Available on loan.)
"Fluid flow through sieved sand fractions of similar shape." Ian C. Everist, Master's Thesis, University of Minnesota, Aug. 1952. (Available on loan.)

3) ARCTIC AND SUBARCTIC DRAINAGE INVESTIGATIONS.

b) Department of the Army, Corps of Engineers, St. Paul District, St. Paul, Minn.
c) District Engineer, Corps of Engineers, St. Paul, Minn.
d) Field investigations and library research; design and operation.
e) The objection was to determine design, construction, and maintenance procedures suitable for the drainage of airfields located in arctic and subarctic areas and subject to potential military operations.

(f) Completed.
(h) "Construction on permafrost." Translation by Meir Pilch, St. Anthony Falls Hydraulic Laboratory Project Report No. 30, May 1952.

(924) FREE-JET WATER TUNNEL STUDIES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; applied research and design.
(e) The characteristics of the free-jet type of water tunnel, including the effect of the test stream boundary conditions on steady state cavity phenomena which are modeled within the stream, are being studied.

(925) EXPERIMENTAL STUDY OF A CYLINDRICAL, VERTICAL-FLOW SEDIMENTATION TANK.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) The effect of variations in Reynolds number upon the sediment retention characteristics of a 1:24 scale model of a proposed tank was investigated experimentally. Variations in discharge, sediment size, and to a limited extent, temperature were studied. The ratio of largest to smallest Reynolds number obtained was 10 to 1.
(f) Completed.
(g) Sediment retention was independent of Reynolds number for the range of test conditions covered. Retention was largely a function of the ratio V_f/V_s, where V_f is a typical flow velocity and V_s is the mean settling velocity of the sediment.
(h) "Experimental study of a cylindrical, vertical-flow sedimentation tank." B. B. Behari, Master's Thesis, University of Minnesota, May 1952. (Available for interlibrary loan.)

(1159) MISSISSIPPI RIVER REVETMENT STUDIES.

(b) Waterways Experiment Station and Mississippi River Commission.
(d) Experimental; applied research.
(e) The effect of pressure pulsations due to turbulence and of sand scour on the stability of a double layer of articulated concrete revetment were studied with full-scale revetment blocks in the laboratory's 9-foot testing channel.
(g) Pressures below the lower layer of revetment mattress remained essentially constant and thus the differential pressures across the double layer essentially followed the pulsating pressures above the top layer. No revetment settling occurred as a result of sand scour after 18.7 hours of test at a flow velocity of 5.5 fps, a similar test at 8.5 fps, and 1.2 hours at 10 fps.
(h) "Mississippi river revetment studies; tests on a double layer of articulated concrete mattress." Lorenz G. Straub and Reuben M. Olson, St. Anthony Falls Hydraulic Laboratory Project Report No. 28, May 1952.

(1160) EFFECT OF TUBE VIBRATIONS ON PRESSURE DROP OF FLOW IN TUBES.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic and applied research.
(e) This project arose in connection with the possibility that external tubing vibrations were producing excessive pressure drop or excessive phase lag in pressure in high pressure aircraft hydraulic lines. An experimental apparatus has been established to pump oil through tubing at pressures up to 3000 psi over a range of Reynolds numbers (based on tube diameter) from 1000 to 20,000 and to vibrate the tubing externally at various frequencies. As a conclusion from research by others, it is believed that vibrations contemplated will produce early transition in the tube when flow is in the lower Reynold number range; it is still to be determined whether vibration will have any effect on already turbulent flow.
(f) Completed.

(1161) ENTRANCE EFFECTS ON PART-FULL FLOW IN A MODEL CULVERT PIPE.

(b) Laboratory project.
(d) Experimental; master's thesis.

Tests were conducted on a 4-inch diameter culvert with a length of 35 feet; a square and a well-rounded inlet were used. Head-discharge relationships, pressures, and related data were obtained for variations in discharge and slope.
Completed.
For part-full flow on steep slopes with free outlet, control was at the entrance. With a square-edged inlet the required head-pool elevation was much higher than for a rounded inlet. Dependent upon the slope and discharge ratio, the required head (with respect to the invert at the inlet) was up to three times that of the rounded inlet. Analytical results based on critical depth, and weir and orifice formulae agreed well with experimental data.
"Entrance effects on part-full flow in a model culvert pipe." M. Manohar, Master's Thesis, University of Minnesota, July, 1952.

THE STUDY OF FLOW AT AN INTERFACE.

Laboratory project.
Experimental and theoretical; basic research.
Experiments are to be conducted in a six-inch channel with an immediate object to study the interfacial instability and to clarify flow conditions before and after mixing and to determine the characteristics of a flow of liquid with the density varying with depth and some facts in connection with bed-load movement, boundary-layer effect, shallow water-wave, etc. Photographic method will be employed to record flow patterns. Analytical and relaxational approaches will be carried in parallel with an attempt to solve some simple cases of incompressible flow with variable density.
Discontinued.

RIPPLE FORMATION AND ITS RELATION TO BED-LOAD MOVEMENT.

Laboratory project.
Theoretical and experimental; for doctor's thesis.
A basic research to investigate the phenomenon of bed-load movement of an alluvial stream. Analytical study on the items of mechanics of ripple-formation and frictional resistance of the channel of an alluvial stream. Criterion of ripple formation has been established by experiments. Frictional resistance of an alluvial channel based on analysis has been established by using data of various sources.

GENERAL WAVE STUDIES.

Laboratory project.
Experimental.
Preliminary study and evaluation of wave generators, filters, and related equipment, for the creation of waves in both still and moving waters.
Two generators have been developed which can create waves in both still and moving water.

MODEL STUDIES OF SEDIMENTATION BASINS.

Laboratory project.
Experimental; for master's thesis.
Tests are conducted on two similar models of different sizes to determine the degree of similarity attained by the use of the Reynolds law and the Froude law. Comparisons are made between the flow-through efficiency, as determined by the color method, and the sediment retention efficiency.
Completed.
Within the range of the present study, it is apparent that the sedimentation phenomena in a small-scale model can better be predicted for the prototype by operating the model in accordance with the Reynolds model law. In this instance it was assumed that the ratio of mean flow velocity to mean settling velocity would be the same for both model and prototype.

(1396) INVESTIGATION OF TRUE CRITICAL DEPTH FOR VERTICALLY CURVED FLOW.

(b) Laboratory project.
(d) Experimental and analytical; for master's thesis.
(e) Flow over weirs and a free overfall in an open channel were treated analytically. An abrupt change in grade of an open channel was studied experimentally. Changes in gra of 15°, 30°, and 45° were studied. Bed pressure, surface profile, and velocity distr bution were measured.
(f) Completed.
(g) The ratios of true critical depth to specific energy head were as follows: (1) weir 0 (2) free overfall 0.47, (3) abrupt change in grade: 45°--0.447, 30°--0.456, 15°--0.49
(h) "Investigation of true critical depth for curvilinear flow." Kao-Ling Chen, Master's Thesis, University of Minnesota, April, 1952.

(1397) PERFORATED PLATE ENTRANCE TO A FLOW-THROUGH SEDIMENTATION BASIN.

(b) Laboratory project.
(d) Experimental; for master's thesis.
(e) To determine the effect of perforated plate entrances upon sedimentation in a flow-through type basin. Three such entrances, each with a different size of perforation, will be studied over a range of discharges.
(h) Thesis in process.

(1663) MODEL STUDY OF BOX CANYON POWER PROJECT.

(b) Harza Engineering Company, Inc., Chicago, Ill.
(d) Experimental; design.
(e) Model study to examine flow in main channel and appurtenant works for various flow cor tions, study of spillway operation, and spillway calibration.

(1664) MISSOURI RIVER SEDIMENT STUDIES.

(b) Corps of Engineers, Missouri River Division.
(d) Experimental; applied research.
(e) Tests are being made to determine the transportation characteristics of Missouri River sediment under various flow conditions. Flow characteristics are measured for various rates of transportation and various combinations of slope, depth, and discharge for a given rate of transportation.
(f) Suspended.

(1665) LOW VELOCITY WIND MEASUREMENTS.

(b) Army Ordnance Corps, Ballistic Research Laboratories.
(d) Literature search leading to applied design recommendations.
(e) Survey of basic nature and limitations of existing systems or components intended or adaptable for the precision measurement of wind velocities in the range of 1 to 50 fee per second near the earth's surface.

(1666) EXPERIMENTAL STUDIES OF THE DEPRESSION OF THE FILAMENT OF MAXIMUM VELOCITY IN RECTANGU CHANNELS.

(b) Laboratory project.
(d) Experimental; for master's thesis.
(e) Tests were made in both a 1-foot width channel and a 9-foot width concrete channel.
(f) Completed.
(g) The depression of the filament of maximum velocity in a rectangular open channel has a definite variation as the depth-width ratio varies. This depression is caused by the secondary flow and effected by the mean velocity of flow. Since the maximum velocity occurred some distance below the water surface, the Keulegan equations for rectangular channel could not possibly apply to the entire velocity profile. The experiments show that the variation of velocities in the region between the point of maximum velocity a water surface also follows the logarithmic law.

ST. ANTHONY FALLS SPILLWAY MODEL STUDY.

Northern States Power Co., Minneapolis, Minn.
Experimental; design.
Model study to determine the design of a stilling basin to replace the present structure at St. Anthony Falls on the Mississippi River at Minneapolis, Minn.
Completed.
"Hydraulic model studies of St. Anthony Falls spillway." Sigurd H. Anderson, St. Anthony Falls Hydraulic Laboratory Project Report No. 33, Aug. 1952.

FLUID FLOW IN ROUGH TRIANGULAR CHANNELS.

Laboratory project.
Experimental; master's thesis.
To determine the characteristics of bulk flow in triangular channels having a definite boundary roughness and varied central angle. Experiments have been performed on a triangular open channel made up of two 6-inch structural aluminum channels placed back to back and so arranged that the angle between them may be varied. The turbulent flow regime is being studied with water as the testing fluid.

EXPERIMENTAL INVESTIGATION OF BASIC EQUIPMENT AND METHODS ASSOCIATED WITH LABORTORY WAVE STUDIES.

David Taylor Model Basin, Department of the Navy.
Experimental.
Conduct experimental studies of wave generators, filters, and absorbers for the purpose of (1) evaluating overall characteristics, (2) comparing experimental and analytical results, and (3) determining design requirements.

MISSOURI RIVER DIVERSION AT FORT RANDALL.

Western Contracting Corporation.
Experimental and analytical studies to assist in planning diversion of Missouri River at Fort Randall Dam for the purpose of making the closure of the dam. Design and construction procedures were developed based upon the principles of bed-load transportation by means of which the Missouri River could be diverted solely by means of an underwater hydraulic fill by dredge operations.
Completed.
The design developed proved to be exceptionally suitable although unprecedented for such large-scale operations for a river diversion.

CAVITATION TESTING IN WATER TUNNELS.

David Taylor Model Basin, Department of the Navy.
Experimental; basic and applied research.
To investigate the cavitation characteristics of body shapes which will be independent of the cavitation susceptibility of the test fluid. Consideration will be given the various parameters, such as the air content of the fluid, which have been found to affect cavitation.

SLOTTED-WALL TEST SECTION FOR WATER TUNNELS.

David Taylor Model Basin, Department of the Navy.
Experimental; design.
Studies will be made of a new type of test section for a water tunnel intended to combine the constant-pressure characteristics of a closed jet with the negligible wall interference effects obtained in an open-jet test section. This takes the form of an open jet with an inner slotted liner wall.

(111) DROP INLET CULVERT WITH PIPE CONDUIT.

(b) Division of Drainage and Water Control, Soil Conservation Service, in cooperation wit the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab atory.
(d) Experimental; applied research.
(e) Tests have been made on three different sizes of Lucite pipe set on slopes ranging fr 2.5 to 30 percent to verify the similarity relationships. Information on discharges, pressures, and flow conditions has been obtained. Future studies will be on the effe of different types of inlets on the flow conditions.
(g) Pipe drop inlet culverts laid on steep slopes will flow completely full even through the outlet discharges freely. Entrained air did not invalidate the Froude model law.
(h) "Hydraulics of drop-inlet pipe-conduit spillways." Fred W. Blaisdell, Professional Civil Engineer Thesis submitted to University of New Hampshire, April, 1950. (Availa on loan from University of New Hampshire.)

(114) DIVERGING TRANSITION FOR SUPERCRITICAL VELOCITIES.

(h) "Flow through diverging open channel transitions at supercritical velocities." Fred Blaisdell, U. S. Department of Agriculture, Soil Conservation Service, SCS-TP-76, pp April, 1949. (Progress report covering tests with straight sideqalls flaring 1 in 3 and 1% channel slope.)
"Flow in diverging transitions of rectangular open channels with supercritical veloci George N. Nomicos, Master's Thesis submitted to University of Minnesota, Sept. 1952. (Available on loan.) (Tests were made with sidewalls shaped to a hyperbolic curve wh form was theoretically derived so that wavelets emanating from the opposite wall woul not impinge on the near wall. The slope of the floor was that required to maintain normal flow in the approach channel.)

(1168) A STUDY OF CANTILEVERED OUTLETS.

(b) Division of Drainage and Water Control, Soil Conservation Service, in cooperation wit the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab atory.
(f) Suspended.

(1398) STRAIGHT DROP SPILLWAY.

(b) Division of Drainage and Water Control, Soil Conservation Service, in cooperation wit the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab atory.
(d) Experimental; applied research.
(e) Spillway is used as a grade control structure in ditches and streams. Study will res in general design rules for the spillway and outlet. Outlet will have floor blocks a end sill. Movable sand beds are used to evaluate the outlet performance.

S. MORGAN SMITH COMPANY.

Inquiries concerning Projects Nos. 1402, and 1673 to 1679, incl., should be addressed Mr. Emmert M. Lowry, Jr., S. Morgan Smith Company, York, Pa.

(1402) FIXED BLADE PROPELLER MODEL TURBINES.

(b) Laboratory project.
(d) Experimental; applied research.
(e) To improve the characteristics of fixed blade propeller turbines designed to replace l specific speed Francis turbines, several 12" models were tested complete with wheel c and draft tube for efficiency, power, cavitation, and runaway speed.
(g) Results are being used for prototype designs.

) ADJUSTABLE BLADE SMITH KAPLAN MODEL TESTS.

b) Laboratory project.
d) Experimental; applied research.
e) To improve performance and extend range of application, several adjustable blade Smith-Kaplan turbine models were designed and tested complete with wheel case and draft tube for efficiency, power, cavitation, and runaway speed.
g) Results are being used for prototype designs.

4) MODEL DRAFT TUBE TESTS.

b) Laboratory project.
d) Experimental; applied research.
e) To improve performance of both Francis and Smith-Kaplan turbines, various draft tube designs were tested with the models. Results were obtained from both 12" and 16" model turbines.
f) Completed.
g) Results substantiated the fact that draft tube design has a marked effect on turbine performance and were used for prototype designs.

5) IMPULSE TURBINE TESTS.

b) Laboratory project.
d) Experimental; applied research.
e) To improve performance characteristics, several 29" model impulse turbines were tested for power, efficiency, and runaway speed. The effects of various types of housings were also investigated.
g) Results are being used in prototype designs.

6) FRANCIS TURBINE MODEL TESTS.

b) Laboratory project.
d) Experimental; applied research.
e) To improve performance and extend range of application, various designs of Francis turbines were tested complete with wheel case and draft tube for efficiency, power, cavitation, and runaway speed.
f) Completed.
g) Results were used in prototype designs.

7) EVALUATION OF WEIR COEFFICIENTS.

b) Laboratory project.
d) Experimental; applied research.
e) To correlate results in two types of testing apparatus more accurately, a 7 foot and a 4 foot weir were calibrated by using calibrated Venturi meters as standards.
f) Completed.
g) Results were used to more accurately evaluate and correlate experimental results.

78) INTERMEDIATE SPEED FRANCIS TYPE TURBINE MODEL FOR LITTLETON PROJECT.

(b) Connecticut River Power Company.
(d) Experimental; applied research for design.
(e) A completely homologous model was tested complete with spiral case and draft tube for efficiency, power and runaway speed.
(f) Completed.
(g) Results were used in prototype design.

79) ELBOW DRAFT TUBE PERFORMANCE TESTS.

(b) Department of the Army, Corps of Engineers, Portland Oregon District.
(d) Experimental; applied research for design.

(e) 12" and 16" model Smith-Kaplan turbines were tested for power, efficiency, and cavitation with several model elbow draft tubes of various designs.
(f) Completed.
(g) Results used in final design of prototype.

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

(895) THE COMPILATION OF RESISTANCE AND PROPULSION DATA.

(b) Office of Naval Research, Department of the Navy.
(c) Captain W. N. Landers, Secretary, The Society of Naval Architects and Marine Engineers, 29 West 39th Street, New York 18, New York.
(d) The compilation of ship model resistance, propeller, and self-propulsion data presently available at the various model basins and in designing offices, and the presentation of these data in a readily usable form.
(e) A critical study and correlation of existing data on the wave-making resistance of ship hull models which have been tested by the several towing tanks of this country and abro[ad]. An analysis of these data, after correlation, to determine systematically the influence of differences of hull form on wave-making resistance and to establish the fundamentals of the subject.
(g) A standard form entitled "Model Resistance and Expanded Resistance Data" has been developed to record model data and test results, and for the expansion of the model test results to ship size. Explanatory notes defining the various dimensions, ratios, and coefficients used on the data sheets have been completed. Propeller data forms and self-propulsion data forms have been prepared. Model resistance and expanded resistance data sheets covering 150 models have been completed.
(h) "Model resistance and expanded resistance data sheets with explanatory notes."
For models 1-40 $4.00 per set to members, $5.00 to non-members.
For models 41-60 $2.00 per set to members, $3.00 to non-members.
For models 61-100 $4.00 per set to members, $5.00 to non-members.
For models 101-150 $5.00 per set to members, $7.50 to non-members.

STANFORD UNIVERSITY, Hydraulic Laboratory.

Inquiries concerning Projects Nos. 627, 628, 1171, and 1172 should be addressed to Prof. John K. Vennard, Stanford University, Stanford, Calif.

(627) STUDY OF TURBULENT BOUNDARY LAYERS.

(b) Laboratory project.
(d) Experimental; engineer theses.
(e) Pressure drops and velocity profiles downstream from sharp and bellmouth entrances in smooth pipes of various diameters.
(g) Thesis by S. M. Barnes completed, thesis by C. T. Chen about finished.

(628) EFFECT OF SHAPE OF PARTICLE ON SETTLING VELOCITY.

(f) Inactive.

(1171) STUDY OF MANIFOLD PORTS.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Measurement and interpretation of pressure variation near outlet ports in manifold pipes and obtaining hydraulic coefficients for various flow geometries.
(f) Experimental work completed; thesis delayed by Naval duty.

PERMEAMETER WALL EFFECT.

Inactive.

S INSTITUTE OF TECHNOLOGY, Experimental Towing Tank.

LANEOUS PROJECTS.

The Experimental Towing Tank carries out an extensive research program of a classified nature for the Bureau of Ships, Bureau of Ordnance, Office of Naval Research, and the Bureau of Aeronautics, Department of the Navy. A large number of projects involving commercial vessels of many different designs for private clients are also undertaken for the determination of effective horsepower, the resistance, directional stability of barges, the determination of shaft horsepower for river towboats and comparable vessels, resistances under sailing conditions of sailing yachts, and the hydrodynamic characteristics of flying boats and seaplane floats.

PLANING SURFACES.

Office of Naval Research, Department of the Navy.
Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
Experimental and basic research.
To investigate the fundamental factors affecting the performance of planing surfaces for application to seaplanes and planing type surface craft, and to investigate the wave shape formed in the wake of such surfaces.
Investigations will extend from elementary planing surfaces of several deadrises through warped surfaces, surfaces with the steps of Vee plan form, and the combinations of the forebody and the afterbody planing in its wake.

THE DEVELOPMENT OF A TEST TECHNIQUE FOR THE DETERMINATION OF SHIP MODEL RESISTANCE IN HEAD SEAS.

Laboratory project.
Mr. Randolph Ashton, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
Experimental and developmental.
Resistance tests in waves of ship models (commercial vessels and fast power boats) so that the models are about as free as possible to respond to the oncoming waves - in particular, to heave, pitch and surge fore and aft.
A method has been developed, termed the "gravity weight method", with extremely little friction in the system and no towbar, springs, or dashpot damping. It is currently being used for obtaining model resistances in head seas.
) Tech. Memo. in preparation.

) WAKE FRACTION STUDY.

) Laboratory project.
) Mr. Allan B. Murray, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
) Experimental and developmental.
) Self-propelled tests of a twin-screw hopper dredge model to compare the wake-fraction and thrust-deduction coefficients with two pairs of propellers - each pair having the same diameter but differing in other respects.
) Completed.
) Wake fraction and thrust-deduction coefficients vary little with the two pairs of propellers.
) "Study of wake and thrust deduction of a twin screw seagoing dredge model." Randolph Ashton and Edward V. Lewis, ETT Tech. Memo. No. 100.

(1405) IMPACT LOADS ON THE JR2F-1 FOR BOW LANDING CONDITIONS.

(b) Bureau of Aeronautics, Department of the Navy.
(c) Mr. Wilfred C. Hugli, Jr., Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
(d) Experimental; applied research for design.
(e) A 1/16 scale dynamic model of the JR2F-1 was catapulted at various bow down attitudes Two self-contained recording accelerometers measured the impact accelerations. Resul of the investigation are to be used in evaluating the validity of present design spec fications for loads experienced during bow landings in smooth water.
(g) Report in preparation.

(1406) TURBULENCE STIMULATION OF PLANING SURFACE MODELS.

(b) National Advisory Committee for Aeronautics.
(c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technol 711 Hudson St., Hoboken, N. J.
(d) Experimental and theoretical.
(e) Previous experimental and analytical material on the subject is being reviewed. Experiments are being made to test out theories.
(h) "Turbulence stimulation in the boundary layer of planing surfaces - Part I - Review o analytical and experimental aspects of subject." B. V. Korvin-Kroukovsky, Edward W. Ross and Daniel Savitsky, ETT Report No. 443, submitted to sponsor.
"Turbulence stimulation in the boundary layer of planing surfaces - Part II - Prelimi experimental investigation." Daniel Savitsky and Edward W. Ross, ETT Report No. 444, submitted to sponsor.

(1407) SEAWORTHINESS OF SHIPS.

(b) Society of Naval Architects and Marine Engineers.
(c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technol 711 Hudson St., Hoboken, N. J.
(d) Experimental; basic research.
(e) To determine the vertical forces and pitching moments acting on a restrained ship mod moving against head seas. This project supplements the project on seaworthiness mode tests conducted at David Taylor Model Basin and Massachusetts Institute of Technology
(g) The project is in the planning stage.

(1408) HYDRODYNAMIC COEFFICIENTS OF AN AIRSHIP.

(b) Bureau of Aeronautics, Department of the Navy.
(c) Mr. John B. Drisko, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
(d) Experimental.
(e) Experimental determination, utilizing the rotating arm of the static and hydrodynamic coefficients of a conventional airship form. Static (straight-line) values have been determined by wind-tunnel tests, and the principal reason for curvilinear tests is to determine the rotary (damping) coefficients.
(g) Partial data furnished client.

(1409) BENDING MOMENT OF SHIPS IN WAVES.

(b) Society of Naval Architects and Marine Engineers.
(c) Mr. Edward V. Lewis, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
(d) Experimental; to check calculations.
(e) Stress measurements of jointed model to determine external bending moment underway in waves, for comparison with calculated bending moment in "stationary" wave.
(g) Preliminary results are promising but not yet conclusive.

) SELF-PROPELLED MODEL TESTING.

) Laboratory project.
) Mr. E. V. Lewis, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St. Hoboken, N. J.
) Experimental; developmental research.
) To determine if successful self-propelled testing can be conducted using models of less than 12-foot length and to determine causes of scale effect in propulsion factors.
) Self-propelled tests of the motorship San Francisco and open-water tests of the model propeller have been completed. Tests of two self-propelled planks have thrown some light on wake scale effect. New open-water test apparatus is under construction, and a new instrument for measuring propellers has been built. Preparations have been made for tests of a 7-1/2-foot and a 9-foot Victory ship model and their propellers, coordinating with a series of models 9-foot and above being tested by the Netherlands Model Basin.

) PROPELLER MEASURING APPARATUS.

b) Society of Naval Architects and Marine Engineers.
c) Mr. Allan B. Murray, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
d) Design and construction.
e) Apparatus to enable the carrying out of open water tests of ship propeller models.
f) Completed.
g) Instrument has been giving very satisfactory results in measuring model propellers of 2-1/2 to 5-1/2 inches in diameter. Blade section offsets can be read to 0.001 - 0.002 inches.
h) Report in preparation.

2) DESIGN AND CONSTRUCTION OF PROPELLER BOAT.

b) Society of Naval Architects and Marine Engineers.
c) Mr. Allan B. Murray, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
d) Design and construction.
e) Apparatus to enable the carrying out of open-water tests of ship propeller models.
f) Completed.
g) Preliminary runs indicate satisfactory performance.
h) Report in preparation.

3) AN INVESTIGATION OF SHIP RESISTANCE USING STATISTICAL METHODS.

b) Office of Naval Research, Department of the Navy.
c) Mr. Milton Morrison, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
d) Applied research.
e) Approximately 60-single-screw displacement hulls (reduced to a common 400 foot LBP) have been selected to investigate the effects of shape and hull parameters on resistance. The statistical techniques will involve the applications of regression analysis and principal components.
g) Compilation of data complete. Calculation and analysis work in progress.

30) COMPUTATION OF WAVE RESISTANCE OF SHIPS.

b) Society of Naval Architects and Marine Engineers and Office of Naval Research, Department of the Navy.
c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
d) Theoretical; applied research.
e) To verify the applicability of methods and tables developed by R. Guilloton to the calculation of wave-making resistance of ships of practical shape. To verify validity of certain second order corrections.

(g) The preliminary stage of work under SNAME sponsorship indicated that computations for a idealized ship form based on Guilloton tables give results essentially identical with Havelock's method. A certain frequently proposed method of allowing for the boundary layer effects was shown to be fallacious.
(h) Report on the preliminary stage of investigation in preparation.

(1681) TO EVALUATE RESISTANCE AND MOTION IN STILL WATER AND IN WAVES WITH BULB VARIATIONS FROM 0% TO ABOUT 13% OF THE IMMERSED MIDSHIP AREA.

(b) U. S. Maritime Administration.
(c) Mr. Edward V. Lewis, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, N. J.
(d) Experimental; model testing.
(e) Resistances of various models being measured in smooth water and in head seas. Bow accelerations and bow pitching being measured in head seas.
(g) Test results being analyzed.
(h) Report in preparation.

UNIVERSITY OF TENNESSEE, Engineering Experiment Station.

(944) HYDRAULIC FRICTION.

(b) Laboratory project.
(c) Dr. Harry Ambrose, Engineering Experiment Station, University of Tennessee, Knoxville 1 Tenn.
(d) Experimental; basic research.
(e) A long term investigation to determine the relationship between character of roughness pipe surface and shape of transition curve for resistance coefficients in the range between smooth and rough turbulent flow. Tests are being made in a four inch lucite pipe which is roughened by the insertion of sleeves.
(h) Progress report in preparation.

TEXAS ENGINEERING EXPERIMENT STATION, A and M College of Texas.

(1682) FLOW CHARACTERISTICS OF INTERMEDIATE LENGTH CONDUITS AS A FUNCTION OF ENTRANCE DESIGN.

(b) Laboratory project.
(c) Mr. R. E. Schiller, Jr., Dept. of Civil Engineering, A and M College of Texas, College Station, Texas.
(d) Experimental; applied research.
(e) Scale model tests using cylindrical conduits with flared-wing, straight-wing, and parallel-wing walls have been completed. Tests with rectangular conduits are in progre
(g) Preliminary results appear to indicate that the type of entrance used has only limited effect on the flow characteristics.

UNIVERSITY OF TEXAS, Department of Civil Engineering.

Inquiries concerning Projects Nos. 948, and 1683 to 1685, incl., should be addressed to Dr. Walter L. Moore, Department of Civil Engineering, University of Texas, Austin, Texa

(948) DIFFUSION OF A TWO-DIMENSIONAL SUBMERGED JET.

(b) Laboratory project.
(d) Experimental.

) An experimental study of the diffusion of a water jet to determine the influence of a free surface and solid boundaries.

) Detailed measurements have been made and the mean-flow characteristics with a hydraulic jump occurring at an abrupt and at a beveled drop in the channel floor for a particular tail water condition. A check is now being made on the range of possible tail water conditions and the accompanying variation in the character of the jump.

) THE EQUIVALENT PIPE CONCEPT IN RELATION TO THE GENERAL RESISTANCE DIAGRAM.

) Laboratory project.
) Theoretical.
) An analytical study to clarify the conditions for the validity of the equivalent pipe concept and to modify the parameters of the conventional resistance diagram making it more convenient for problems with branching pipes, pipes in series, and pipe networks.
) The concepts are worked out and it remains to choose the best form of diagram and use the method on some typical problems.

) FLOW PATTERNS ASSOCIATED WITH THE VENTILATION OF A LARGE AREA.

) Laboratory project.
) Experimental; applied research.
) The flow patterns associated with a conventional plan for the ventilation of a large area will be studied by visual observations in a model of a portion of a large underground garage. Water will be used as the fluid and colored dye to trace the flow patterns. The effectiveness of alternative flow patterns will be investigated.

) THE INFLUENCE OF ENTRANCE CONDITIONS ON THE FLOW IN SPILLWAYS.

) Texas Board of Water Engineers.
) Experimental.
) Tests will be made on typical spillway designs to investigate the effect of unsymmetrical and curved channel entrance conditions on the flow in spillway channel.

STATE AGRICULTURAL COLLEGE, Agricultural Experiment Station.

1) LINING OF IRRIGATION CANALS AND DITCHES.

See U. S. Department of Agriculture, Soil Conservation Service, Division of Irrigation and Water Conservation, page 108.

) DRAINAGE OF IRRIGATED LANDS.

b) Laboratory project.
c) Dr. O. W. Israelsen, Irrigation Department, Utah State Agricultural College, Logan, Utah.
d) Field studies; applied research and masters' theses.
e) The major purposes are to find low cost, effective methods of drainage of arid-region waterlogged and alkali lands. Work has been concentrated on four Utah areas and one area in Canada in need of drainage; (1) the 10,000-acre area in Cache County, (2) the 1,000-acre area in Salt Lake County, designated respectively the Lewiston and the Draper areas, and (3) the Delta area in Millard County, and (4) the Logan-Cache County Airport area overlying an artesian aquifer. Basic studies of permeabilities of soils and hydraulics of wells are reported.
g) Use of piezometers for low cost development of ground water flow patterns has been helpful in all areas. Pumping from sand formations having permeabilities as low as 3×10^{-5} feet per second shows a measurable influence in lowering the ground water table. Project to be enlarged with special reference to regional aspects of research.
h) Bulletin reporting 6 years work will be published in 1953.

(1189) METHODS OF CONTROL AND DISTRIBUTION OF WATER.

See U. S. Department of Agriculture, Soil Conservation Service, Division of Irrigation and Water Conservation, page 110.

(1190) DISTRIBUTION OF WATER FROM PERFORATED PIPE.

See U. S. Department of Agriculture, Soil Conservation Service, Division of Irrigation and Water Conservation, page 110.

(1191) DETERMINATION OF THE DISCHARGE FROM HORIZONTAL PIPE BY THE COORDINATE METHOD.

See Utah State Agricultural College, Engineering Experiment Station, page 91.

(1192) FLOW THROUGH FLEXIBLE NON-ELASTIC PIPE.

(b) Cooperative with Soil Conservation Service, Division of Irrigation and Water Conservati and Irrigation Department of the Utah State Agricultural College.
(c) Dr. Vaughn E. Hansen, Soil Conservation Service, College Hill, Box 70, Logan, Utah.
(d) Experimental and theoretical; applied research, master's thesis.
(e) A light-weight, flexible, non-elastic pipe has recently been developed to convey water. As very little is known regarding the hydraulic properties of this material they are being studied.
(f) Inactive.

(1415) PERMEABILITY AND STABILITY OF SOIL AND SOIL MATERIAL.

See U. S. Department of Agriculture, Soil Conservation Service, Division of Irrigation and Water Conservation, page 110.

(1686) CONSUMPTIVE USE OF WATER AND IRRIGATION REQUIREMENTS.

(b) Laboratory project, cooperative with Soil Conservation Service, Division of Irrigation, and Geological Survey.
(c) Dr. Dean K. Fuhriman, Irrigation Department, Utah State Agricultural College, Logan, Utah.
(d) Field investigation; applied research.
(e) To obtain basic information regarding consumptive use of water by agricultural crops, pastures, and native vegetation; and to study methods of measurement of consumptive use of water.
(g) The study for the upper Colorado area has been completed. Work now concentrated in the Bonneville Basin in Utah.
(h) "Consumptive water use and requirements in the Colorado River Area of Utah." Willis C. Barrett and Cleve H. Milligan, to be published by the Utah Agricultural Experiment Station as Bulletin No. 361 in 1953.
"Unit consumptive use of water studies in the Ashley and Ferron Valleys of Utah for the 1950 growing season." James O. Henrie, Master's Thesis, Utah State Agricultural Colleg Logan, Utah, 1951.
"The consumptive use of water in Milford Valley, Utah." Terrel R. Tovey, Master's Thes Utah State Agricultural College, Logan, Utah, 1952.
"Consumptive water use and requirements." Wayne D. Criddle and Dean F. Peterson, Progress report (mimeographed) for Colorado River Area investigations in Utah, Soil Conser vation Service, 1949.
"Consumptive use of water in Colorado River Area of Utah." J. Y. Christiansen, Master' Thesis, Utah State Agricultural College, Logan, Utah, 1949.
"Consumptive use of water studies in the Ashley and Ferron Creek Areas of Utah." Elden E. Fisher, Master's Thesis, Utah State Agricultural College, Logan, Utah, 1950.

TATE AGRICULTURAL COLLEGE, Engineering Experiment Station.

DRAINAGE OF IRRIGATED LANDS.

See Utah State Agricultural College, Agricultural Experiment Station, page 89.

AN INVESTIGATION OF FRICTION LOSSES IN ALUMINUM TUBING AND COUPLINGS.

Cooperative with Aluminum Company of America.
Dean J. E. Christiansen, Engineering Experiment Station, Utah State Agricultural College, Logan, Utah.
Experimental; applied research and master's thesis.
To determine friction loss in aluminum tubing and losses at commercial couplings. Additional studies being made on aluminum irrigation pipe with deflection angles at couplings.
Experimental work completed.
Thesis by Lyman S. Willardson in process of preparation.

DETERMINATION OF THE DISCHARGE FROM HORIZONTAL PIPE BY THE COORDINATE METHOD.

Cooperative with Soil Conservation Service, Division of Irrigation and Water Conservation, and Utah Agricultural Experiment Station.
Dr. Vaughn E. Hansen, Irrigation Department, Utah State Agricultural College, Logan, Utah.
Experimental and theoretical; applidd research, master's thesis.
To determine the coefficient of discharge for the flow from a horizontal pipe as determined by the coordinate method. This coefficient has been assumed to be one, which is definitely not the case in the majority of problems encountered in the field. The tests were conducted so that the method may be applied with confidence to the measurements of water.
Inactive.
The discharge from a horizontal pipe is measured by the coordinate method. The result might be in considerable error unless the appropriate discharge coefficient is applied to the equation. The results of this study can be used with a fair degree of accuracy in predicting the actual discharge, however, further field studies will be made in order to further evaluate the method for field application.
"The discharge coefficient in the coordinate method for measuring pipe flow." Day L. Bassett, Master's Thesis, Utah State Agricultural College, Logan, Utah, 1952.

INFILTRATION IN FURROW IRRIGATION AS EFFECTED BY FURROW SHAPE, SIZE OF STREAM, AND MOISTURE LEVEL IN THE SOIL.

Agricultural Experiment Station and Irrigation Division, Soil Conservation Service.
Dr. Vaughn E. Hansen, Irrigation Department, Utah State Agricultural College, Logan, Utah.
Experimental; basic research.
(1) To determine the effect of size of stream, shape of furrow, and moisture level in the soil at the beginning of an irrigation upon the maximum infiltration rate of Greenville loam soil. (2) To test the following hypothesis; (a) size of stream (Q) has no effect on the maximum infiltration rate of a V-shaped furrow but the rate increases as the furrow departs from a V-shape; (b) shape of furrow and width-depth ratio are directly related to the infiltration rate; (c) the asymtotic rate of infiltration is independent of the moisture level at a six inch depth below the furrow; (d) the infiltration is reduced as time of season (days) advances. (3) An attempt will be made to establish the quantitative relationship of the three factors to the asymtotic rate of infiltration.

USE OF COMBINED ELECTRICAL AND MEMBRANE ANALOGIES TO INVESTIGATE UNCONFINED FLOW INTO WELLS.

Laboratory project; experimental work conducted at Colorado A and M College.
Dr. O. W. Israelsen, Irrigation Department, Utah State Agricultural College, Logan, Utah.
Experimental and theoretical; basic research.

(e) To define better the hydraulics of unconfined wells, and particularly free surface.
(f) Completed.
(h) "The use of combined electrical and membrane analogies to investigate unconfined flow into wells." Chong-Hung Zee, Ph.D. Dissertation, Utah State Agricultural College, Log Utah, 1952.

STATE COLLEGE OF WASHINGTON, Department of Civil Engineering and Division of Industrial Resear

(1689) STUDY OF FLUID FLOW IN PIPE NETWORKS.

(b) Laboratory project.
(c) Prof. Charles L. Barker, Hydraulic Engineer, Hydraulic Laboratory, Washington State College, Pullman, Washington.
(d) Experimental.
(e) Using the McIlroy flow network analyzer the following studies are to be made: (1) Effe of eliminating small pipes in a distribution system in the Handy Cross analysis, (2) effect of combining loads in a network, and (3) the effect of pipe roughness on pumpir costs on network flow.

(1690) PLACEMENT OF AIR VENTS IN IRRIGATION PIPELINES.

(b) Concrete Products Association of Washington.
(c) Mr. John A. Roberson, Hydraulic Laboratory, Washington State College, Pullman, Wash.
(d) Experimental; applied research for design.
(e) The minimum distance that an air vent is to be placed from the inlet of a pipeline (wh air enters the pipeline) is a function of the rise velocity of the air bubbles, the velocity of water in the pipe, and physical characteristics of the structure. An atte will be made to determine the rise velocity of bubbles as a function of bubble size, a Reynolds number.

(1691) PRESSURE RELIEF STRUCTURE.

(b) Concrete Products Association of Washington.
(c) Mr. John A. Roberson, Hydraulic Laboratory, Washington State College.
(d) Theoretical; for design.
(e) Former research has shown that air release from small vents in irrigation pipelines ma generate water hammer. An air dome used in conjunction with the small vent pipe will reduce the magnitude of pressure generation. Design dimensions of the air dome are be evaluated as a function of vent size, pressure reduction desired, size of main pipe, length of main pipe.

UNIVERSITY OF WASHINGTON, Department of Civil Engineering.

Inquiries concerning Projects should be addressed to the following, all at the Univers of Washington, Seattle 5, Washington.
Nos. 642, 644, 1416, 1417, 1694, 1705..............................to Prof. H. K. Mor
Nos. 1692, 1693.. to Prof. T. H. Campb
Nos. 1695, 1696, 1697...................................... to Lt. Comdr. Henry Mor
Nos. 1698, 1699, 1700, 1701................................ to Mr. Wm. H. Mil
Nos. 1702, 1703.. to Prof. H. H. Chenow

(642) A STUDY OF THE VALIDITY OF THE USE OF THE HYDRAULIC RADIUS AS A MEANS OF CORRELATING T RELATIONSHIPS OF FLOW IN CONDUITS OF DIFFERENT SHAPES.

(b) Laboratory project.
(d) Experimental; basic research.

A series of tests to determine the relationships of the flow functions to the hydraulic radius in channels of different shapes. The project is intended to correlate the work done on closed conduits of various shapes and that done on pipes. It is tributary to Project No. 644.
Suspended.
Data on closed conduits complete and being analyzed. No data on open conduits.

FLOW IN PIPES AND CHANNELS.

Suspended pending completion of several tributary investigations.

HYDRAULIC JUMP CHARACTERISTICS IN CIRCULAR CONDUITS.

Laboratory project.
Experimental.
Jump was provoked in circular conduits by restricting the entrance and gating the exit. Control elements included slope and quantity variation, and the size of the entrance restriction. Depth and average pressure head readings were observed by means of piezometers. The experiment was directed toward verification of the mathematical theory of the hydraulic jump based upon the law of conservation of momentum. It included a study of the jump characteristics, considering height, length, and factors which affect its stability. Research intended to extend results of Lane and Kindsvater. (Eng. News-Record, Dec. 29, 1928).
Completed.
Experiments on 2 1/4 inch lucite pipe with level invert agree closely with the momentum theory. Special attention was given to jump to less than full, since the investigation was primarily concerned with prediction of flow profiles occurring in sewers. Characteristics of moving jump were also studied.
Unpublished report is filed in library of the Hydraulics Laboratory.

STATIC HEAD REQUIRED TO PRODUCE A FULL FLOWING CONDUIT.

Laboratory project.
Theoretical and experimental.
Investigation of the ratio of headwater elevation to pipe diameter needed to develop an absolutely full flowing pipe. Rational analysis of the critical depth caused by an increasing static head loses continuity when the critical depth approaches the limit of the pipe diameter. Complete understanding of the transition from gravity flow to pressure flow is the intended goal.

PRESSURE MEASUREMENTS FOLLOWING ABRUPT EXPANSION.

Laboratory project.
Mr. J. E. Colcord, Department of Civil Engineering, University of Washington, Seattle 5, Wash.
Experimental and theoretical; basic research.
A study of the magnitude of the pressure rise following an abrupt expansion, comparing theory to the results from two and three-dimensional test expansions. A study will also be made of the eddy patterns in an abrupt expansion with the aid of plastic equipment, polarizing materials, and a bentonite suspension.

SHORT RANGE FORECASTS OF SNOW-MELT RUNOFF IN COLUMBIA RIVER BASIN.

Bonneville Power Administration, in cooperation with the Geological Survey, Tacoma, Wash.
Theoretical; applied research, for doctor's thesis.
To develop a prodedure whereby increased flow from snow melt can be forecast for periods of five to ten days from weather bureau records or from forecasts of weather in the Columbia River Basin.

(1693) SHORT RANGE FORECASTS OF RUNOFF FROM PRECIPITATION IN COLUMBIA RIVER BASIN.

(b) Bonneville Power Administration, in cooperation with the Geological Survey, Tacoma, Wa
(d) Theoretical; applied research.
(e) To develop a practicable procedure for estimating the flow of streams in the Columbia River Basin for periods of five to ten days in advance during periods of rainfall.

(1694) REDUCTION OF PRESSURE FROM HIGH TO LOW PRESSURE HEADER WITHOUT CAVITATION BY TANGENTIA NOZZLES.

(b) City of Tacoma Department of Public Utilities, Water Division.
(d) Experimental; applied research.
(e) Model studies with 4 1/4 lucite tubing to investigate cavitation and pressure and velc ity distribution in low pressure header receiving water tangentially from high pressur header through a number of nozzles.
(g) Eccentric air core vortex studied as to control and elimination.
(h) Unpublished preliminary report in library of Hydraulics Laboratory.

(1695) A STUDY OF FLOW THROUGH MULTIPLE ORIFICES CONTAINED WITHIN A PIPE.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Experimental verification of application of theory to predict flow through multiple orifices in an orifice plate in a pipe line, and to determine the resistance thereof. Also to find the influence of proximity of orifices to each other and to the pipe wall
(f) Completed.

(1696) FLOW OF WATER THROUGH WIRE REINFORCED RUBBER HOSE.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Investigation of the friction factors for wire reinforced rubber hose as used for suction connections to fire pumpers.
(f) Completed.
(h) Unpublished report in library of Hydraulics Laboratory.

(1697) A COMPARATIVE STUDY OF JETS FROM DIFFERENT TYPES OF FIRE NOZZLES.

(b) Laboratory project.
(d) Experimental; development, for master's thesis.
(e) Influence of various nozzle profiles and manner of acceleration upon the character and coefficients of the jets are determined, with study of velocity distribution traverse, and mechanism of jet propagation.

(1698) INVESTIGATION OF GRADUALLY VARIED FLOW IN CIRCULAR CONDUITS PARTLY FULL.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Approximately 50 feet of 3 inch glass piping connected by special fittings permits any combination of three slopes to be maintained. These are with respect to critical slop Profiles are measured, plotted and compared with those derived from one dimensional fl theory. Emphasis is placed on comparison between experimental depth and calculated critical depth at the break in grade from mild to steep slopes.

(1699) FLOW PROFILES IN SEWERS.

(b) Laboratory project.
(d) Theoretical and experimental; for master's thesis.
(e) Study of the principles underlying uniform, gradually varied, and rapidly varied flow. Five engineering techniques are discussed, correlated, and presented for use in prediction of flow profile in sewers, and are further employed to shed light on design of man hole transitions involving change in pipe size, and the action of moving jumps in sewe

) Completed.
) Unpublished thesis in University of Washington library.

) A STUDY OF SEWER OUTFALLS.

) Laboratory project.
) Experimental; applied research.
) Occurrence of a jump to pressure flow in a submerged sewer outfall can cause sufficient reduction in velocity to create deposition of settleable solids or collection of floating solids within the pipe. This action has been observed in a laboratory model, and velocities developing the undesirable collection were compared with those in a number of outfalls around the City of Seattle. Comparision disclosed that periodic collections of solids can occur and that ensuing septic conditions may be a cause of offensive odors. The study will conclude with recommendations for an economical flushing device.

) "TIDAL DRAINAGE" ANALYSIS.

b) Laboratory project.
d) Experimental; operation.
e) A process by which paralyzed human bladders are automatically discharged has been termed "Tidal Drainage" by the medical profession. The principle involved is that of a controlled siphon which eliminates need for any exertion on the part of the patient. The problem of proper adjustment to insure complete discharge during any one cycle of siphon operation has often troubled hospital technicians. Complete analysis of the apparatus has been made.
f) Completed.
g) Specifications for proper operation of the apparatus have been compiled and certain design refinements were recommended.
h) Unpublished report is in library of the Hydraulics Laboratory. "Tidal drainage analysis." William M. Miller, Trend, Vol. 5, 1953.

2) HYDRAULIC ACTION ON TUNA FISH TAGS.

b) U. S. Fish and Wildlife Service.
d) Experimental; applied research.
e) A venturi water tunnel with plastic windows was designed and built suitable for an average sized Tuna fish wherein frozen Albacore Tuna were mounted. Tags of different styles were attached at various locations on the fish, and tests run at different velocities in order to determine if retention could be accomplished.
f) Laboratory phase completed; ocean tag recovery in progress.
h) "Experimental testing of fish tags on Albacore in a water tunnel." D. L. Alverson and Harry H. Chenoweth, Commercial Fisheries Review, Vol. 13, No. 8, Aug. 1951.

3) HYDRAULIC FACTORS AFFECTING DESIGN OF SALMONOID REARING PONDS.

b) U. S. Fish and Wildlife Service.
d) Experimental and field investigation; applied research.
e) Hydraulic characteristics of some existing ponds were studied by models and verified in field. Hydraulic and biological conditions were correlated. Possible improvements in existing ponds and new type ponds will be studied by models in an attempt to produce healthier conditions for fish.

04) FRICTION IN PIPES WITH CONTROLLED ARTIFICIAL ROUGHNESS.

b) Laboratory project.
c) Dr. Joseph Kent, Hydraulics Laboratory, University of Washington, Seattle 5, Wash.
d) Experimental; basic research.
e) An experimental investigation of the effect upon the friction factor characteristics of controlled and varying roughness caused by numerous screws projecting various distances into the pipe wall.

(1705) A HYDROGRAPHIC SUMMARY OF THE STREAMS IN THE STATE OF WASHINGTON.

(b) State of Washington, Department of Fisheries.
(d) Field investigation; operation.
(e) Comparative hydrographic study of streams in the state on basis of high year, low year, and mean year.

UNIVERSITY OF WISCONSIN, Hydraulic Laboratory.

Inquiries concerning Projects Nos. 956, 957, 958, and 1181 should be addressed to Dr. J. R. Villemonte, and Projects Nos. 959, 1420, and 1706 to 1710, incl., to Dr. Arno T. Lenz, Hydraulic Laboratory, University of Wisconsin, Madison 6, Wis.

(956) HEAD LOSSES IN FLOW OF LIQUIDS IN PIPES UNDER HIGH LINE PRESSURES.

(b) Cooperative with Ladish Company, Cudahy, Wis.
(d) Experimental; for master's and doctoral theses.
(e) A circulating system of 2-inch seamless steel pipe with oil flowing contains a 20-foot section in which energy losses are measured by latest type strain gages. Line pressure vary from 100 to 2000 psi and show the effect of high line pressure on the friction factor for both laminar and turbulent flow.
(g) Tests have been completed on 1/4, 1/2, 1, and 2-inch seamless steel tubes over a Reynolds' number range of 100 to 15,000. Friction factor f is about 5 percent greater at 2000 psi during laminar flow and 2.8 percent greater at 2000 psi during turbulent flow.
(h) "Energy loss in liquid flow in straight pipes under high pressure." J. G. Slater, Ph.D Thesis, Aug. 1952. (Available on loan.)

(957) THE THERMODYNAMICS OF LIQUIDS.

(b) Laboratory project.
(d) Experimental; for doctoral, master's and bachelor theses.
(e) The effects of temperature (35-130° F) and pressure (0-2200 psig) on the viscosity of a wide variety of liquids are being observed by use of a new type falling-ball viscosimet
(g) Tests have been completed on five oils ranging in atmospheric viscosity at 100° F from 0.00004 to 0.0015 slugs per ft sec. A general correlation equation has been developed.
(h) "Pressure, temperature, viscosity relations of petroleum oils." V. N. Gunaji, Ph.D. Thesis, June 1952. (Available on loan.)
"The effect of temperature and pressure on the viscosity of petroleum oils." V. N. Gunaji and J. R. Villemonte, Proc. 3rd Midwest Conference on Fluid Mechanics, Universit of Minnesota (in press), 1953.

(958) HEAD LOSSES IN FLOW OF LIQUIDS IN WELDING PIPE FITTINGS AND VALVES.

(b) Cooperative with Ladish Company, Cudahy, Wis.
(d) Experimental; for master's and doctoral theses.
(e) Head losses over and above those in straight pipes are being observed for 1/4, 3/8, 1/2 3/4, 1, 1 1/4, 1 1/2, and 2-inch high pressure constriction type gate valves.
(g) Coefficients K, in equation $H = Kv^2/2g$, are as follows for 4-inch fittings (velocities 1-20 fps):

One-cut 90° miter bend	1.39
Two-cut 90° miter bend	0.61
90° Elbow, R/D = 1.0	0.37
90° Elbow, R/D = 1.5	0.25

The settling length for all fittings was 40 diameters at a velocity of 20 fps.

) HYDROLOGIC INVESTIGATION OF LAKE MENDOTA DRAINAGE BASIN.

) Part of a larger project entitled "Origin and quantities of algal fertilizers tributary to Lake Mendota." Cooperative study sponsored by University of Wisconsin, Madison 6, Wisconsin.
) Field investigation; applied research for M. S. thesis.
) Seven stream gaging stations have been installed to measure tributary inflow to Lake Mendota and Yahara River outflow. Precipitation records are being obtained from fourteen recording rain gages. Records are being analyzed for surface and groundwater recession characteristics, infiltration capacity, and unit hydrograph shapes.
) Two M. S. and six B. S. theses completed. (Available on loan.)

.) VORTEX FLOW FROM HORIZONTAL THIN-PLATE ORIFICES.

) Cooperative with Mr. J. C. Stevens, Portland, Ore.
d) Theoretical and experimental; for doctoral and master's theses.
) Existing fundamental considerations are being studied and a new practical approach has been developed. Initial vorticity can be completely controlled, and measurements of head, discharge, and surface profile can be made. Orifice diameters will vary from 3 to 12 inches.
g) Some tests have been completed on a 4-inch diameter sharp-edged orifice. The functional relation between head and vorticity and standard orifice discharge coefficient has been determined experimentally and represented as a three-dimensional plot. Vortex flow with free radial approach produced standard discharge coefficients for the orifices tested.

) FORECASTING SNOWMELT RUNOFF, BIG EAU PLEINE RIVER, WISCONSIN.

b) Wisconsin Valley Hydrologic Research Project.
d) Experimental for Ph.D. thesis.
e) Using readily available U. S. Geological Survey and Weather Bureau records a method was developed for forecasting the spring runoff volume caused by snowmelt.
g) Continued study is in progress to determine rates of snowmelt runoff as a function of convection, condensation, radiation, and rainfall.
h) "A method of forecasting volume of snowmelt runoff." D. K. Fuhriman and A. T. Lenz, presented at A. G. U. meeting in Chicago, Sept. 11, 1952. (Available on loan.) Revision for final publication in progress.
One Ph.D. Thesis completed, a second in preparation.

6) MODEL TEST OF YELLOWSTONE DAM.

b) Wisconsin Conservation Department.
d) Experimental; for B. S. thesis.
e) Various designs of gate structure have been tested in a 1:30 scale model of this dam to store water for recreation purposes.
f) Completed.
g) Erosion patterns and discharge calibrations were obtained.
h) "Model test of the Yellowstone dam." A. W. DeBlaise and E. E. Schultz, B. S. Thesis, June 1952. (Available on loan.)

7) PROBLEMS OF SCOUR AT BRIDGE AND CULVERT OPENINGS.

b) Consolidated's Civic Foundation, Inc.
d) Experimental; for M. S. and B. S. theses.
e) Hydraulic model studies are in progress to determine methods of estimating probable scour pattern for a proposed structure having certain physical site characteristics and conditions of flow. Remedial methods will also be studied so scour at existing structures will be reduced or eliminated.

(1708) MODEL STUDIES OF DRAFT TUBES FOR HYDRAULIC TURBINES.

(b) Allis Chalmers Mfg. Co.
(d) Experimental; for M. S. thesis.
(e) Two different draft tubes have been constructed with 4-inch inlet diameter. These are being tested to determine efficiency and flow characteristics with varying directions of inlet velocity vectors.

(1709) CALIBRATION OF V-NOTCH WEIRS AT ENDS OF CULVERTS.

(b) Wisconsin Culvert Company.
(d) Experimental; for B. S. thesis.
(e) A 90° V-Notch weir has been installed at the end of a 30-inch corrugated steel culvert and calibrated for flows up to and above the top of the weir plate. Mathematical interpretation of the flows as the summation of V-Notch and rectangular weir flows is in progress.

(1710) CALIBRATION OF NEW DESIGN OF HEAD SPILLWAY.

(b) Laboratory project.
(d) Experimental; for B. S. thesis.
(e) Hydraulic model studies are in progress to determine discharge coefficients for a 6-inch lucite head flume used for soil erosion control. This flume has sloping sides to confine the earth fill, but no flaring head walls. Various length, width, and depth ratios will be studied at various heads.

WORCESTER POLYTECHNIC INSTITUTE, Alden Hydraulic Laboratory.

Inquiries concerning Projects Nos. 961, 1423, and 1711 to 1713, incl., should be addressed to Prof. L. J. Hooper, Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester 2, Mass.

(961) VALVE TESTS.

(b) Chapman Valve Company.
(d) Experimental; for design.
(e) Head loss measurements for various discharges were made on a 24-inch disc type check valve. Closure time and pressure changes were determined photographically for various flows up to 45 cfs.
(f) Inactive; work will be continued.

(1423) WANETA POWER DEVELOPMENT.

(b) Stone and Webster Engineering Corporation.
(d) Experimental; for design.
(e) A 1:70 model including section of river gravity dam and powerhouse was constructed to study flow conditions on the apron of the spillway and in vicinity of powerhouse.

(1711) QUINAPOXET RESERVOIR SPILLWAY.

(b) Metcalf and Eddy Corporation.
(d) Experimental; for design.
(e) A 1:40 model of the chute spillway, discharge pool and adjacent highway bridge were constructed to study flow conditions in the chute and the formation of the hydraulic jump at the discharge pool.

CROMBY MOVEABLE BED MODEL.

Philadelphia Electric Company.
Experimental; for design.
A distorted model (1:15 vertical scale, 1:45 horizontal scale) was constructed of a section of the Schuylkill River including provision for heating water pumped through the condensers. Studies to be made of re-circulation of hot water discharged from condensers and also movement of silt in river bed.

LITTLETON HYDROELECTRIC DEVELOPMENT.

Connecticut River Power Company.
Experimental; for design.
A 1:60 model is being constructed of the chute spillway and section of the Connecticut River to study flow conditions in the chute and in the river adjacent to the chute.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING.

Agricultural Research Administration.

Inquiries concerning Projects Nos. 395, 396, and 397 should be addressed to Mr. M. H. Gallatin, Sub-Tropical Experiment Station, Route 2, Box 508, Homestead, Florida.

(395) CONSERVATION OF THE MARL LANDS OF THE HOMESTEAD AREA.

(b) Cooperative with the Sub-Tropical Experiment Station of the University of Florida, and Dade County Division of Water Control.
(d) Experimental; field investigation, basic research.
(e) Periodic sampling of lands adjoining canals in the Miami and Homestead areas with and without chloride barriers to study the effectiveness of these structures in control of the intrusion of chlorides. Studying the effect of pumping from deep rock ditches on the intrusion of chlorides on agricultural lands. Studying the effectiveness of diking to protect low-lying lands from tidal inundation. Determining the tolerance of crops to chlorides as they are affected not only by high concentration but also by cultural and tillage methods.
(g) Present study must be continued at least one more year for intrusion studies, and sever more years for the pumping, diking and tolerance studies. Present data indicates that removal of water from areas where ditches penetrate underlying the permeable rock remov the fresh water head and allows the chloride front to move into these areas. Some data are available on the tolerance of crops to chlorides.
(h) Monthly reports on existing conditions to sponsors. Annual progress report submitted t Director of Soils Management, Beltsville, Maryland.

(396) WATER CONTROL ON THE DEEP MARL LANDS OF SOUTH FLORIDA.

(b) Cooperative with the Sub-Tropical Experiment Station of the University of Florida.
(d) Experimental; field investigation, design, operation.
(e) Because rainfall was not excessive and stopped early, little or no pumping was necessar to get the plot area ready for plowing. No tests on pump efficiency were run. Preliminary tests on the control of weeds and grasses in drainage ditches were conducted during the past year. Such materials as T.C.A., CMU and Ammate were used. Additional work is now being set up covering these materials plus other materials.
(g) Work has not been in progress over a long enough period to complete any part of the project or make any definite conclusions.
(h) Yearly summary report submitted to the Director, Soil Management and Irrigation, Beltsville, Maryland.

(397) WATER CONSERVATION AND IRRIGATION STUDIES ON THE ROCKDALE SOILS OF THE HOMESTEAD AREA.

(b) Cooperative with the Sub-Tropical Experiment Station of the University of Florida.
(d) Experimental; field investigations.
(e) To determine cycle, rates of application and types of irrigation systems best suited to this area. Observations are made of (1) distribution and pattern of various types of irrigation systems in use; (2) effect of elevation of water table on irrigation cycle; (3) rates of application and their effect on the leaching of plant nutrients; (4) rate of application, moisture studies on limes and avacadoes to determine the irrigation cycle; (5) the responsiveness of the water table to rainfall; (6) the water table as affected by ground water conditions as they exist in the Everglades.
(g) Data to date shows definite correlation between water table and irrigation cycle. Rate of application are governed by maturity of grove, amount of organic matter, types of material and depth of scarification.
(h) Summary report submitted to Director of Soils Management and Irrigation, Bureau of Plan Industry, Soils, and Agricultural Engineering, Beltsville, Maryland.

Salinity Laboratory.

) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

See University of California, College of Agriculture, Division of Irrigation and Soils, page 7.

) PRINCIPLES UNDERLYING THE FLOW INTO AND THROUGH SOILS.

b) Laboratory project.
) Mr. Ronald C. Reeve, P. O. Box 672, Riverside, California.
) Experimental; basic research.
) To investigate the factors that influence the flow of water into and through soils. A method for evaluating the magnitude and effect of soil structure changes on water transmission properties of soils has been developed, and the effect of absorbed cations on soil structure changes is being studied.

5) CHARACTERISTICS OF FLOW THROUGH WELL CASINGS.

f) Suspended.

s Division.

4) STUDY OF THE PHYSICAL PROPERTIES OF SOILS USED IN THE DESIGN OF SUPPLEMENTAL IRRIGATION.

b) Cooperative with Alabama Agricultural Experiment Station.
c) Mr. Arthur W. Cooper, Agricultural Engineering Building, Auburn, Alabama.
d) Field and laboratory investigations; basic and applied research.
e) Purposes are: (1) to determine the infiltration rates and available water-holding capacities of soils as a basis for designing irrigation systems; and (2) to determine the factors affecting the intake rate of water by soils, such as surface condition and cover, texture, and hydraulic conductivity of each layer of the profile. Infiltration tests are made in the field with a modified type, portable FA infiltrometer. Soil moisture is determined from samples taken at 6-inch increments before and after each test, and the surface conditions are noted. The hydraulic conductivity is determined on samples from each different layer of the profile to a depth of 24 inches. Mechanical analyses, 1/3-atmosphere tension soil moisture (field capacity), 15-atmosphere tension soil moisture (wilting point), and volume weight are determined for each layer of the profile to 24 inches.
g) Results are being used as a basis for the design of irrigation systems.
h) Three years results will be reported by July 1, 1953.

Management Research.

4) A STUDY OF THE EFFECTS OF LAND-USE AND FARMING PRACTICES ON RUNOFF FROM SMALL WATERSHEDS.

b) Cooperative with Purdue University, Agricultural Experiment Station.
c) Mr. N. L. Stoltenberg, Agricultural Engineering Building, Purdue University, Lafayette, Indiana.
d) Experimental; for design information.
e) To study the effects of types of land-use and cultural practices as a means of reducing rates and amounts of surface runoff, for soil and moisture conservation and upstream flood control. Continuous time-rate records of rainfall and runoff are collected for 20 small watersheds. Twelve watersheds are used in the rotation crop experiments. Determinations are made of the seasonal amounts and periodic high rates of runoff under a present typical farming system and under a conservation system. The results are intended to be applicable for soil conditions, the climate, and a type of agriculture generally representative of a large part of the eastern section of the corn belt.
g) Analysis of runoff rate data for critical storms and seasonal runoff totals for several years indicate important correlations with the type of soil management (conservation vs prevailing practices), crop and specific soil conditions. Selective loss of plant nutrients by erosion appears to be due to energy limitations of the runoff. More extensive data are needed for quantitative estimating of the expectancies of runoff rates and amounts within entirely practical fiducial limits.

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U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, California Forest and Range Experiment Station.

(261) WATERSHED MANAGEMENT RESEARCH, CALIFORNIA.

(b) Laboratory project.
(c) Mr. Stephen N. Wyckoff, California Forest and Range Experiment Station, P. O. Box 245, Berkeley 1, Calif.
(d) Experimental; field investigation; basic and applied research.
(e) Purposes are: (1) to study the disposition of rainfall as influenced by watershed conditions, including vegetation, soils, geology, and topography; and (2) to develop methods of watershed management, including the treatment of areas denuded by fire, to assure maximum yield of usable water, and satisfactory regulation of flood runoff and erosion. Major work center is the San Dimas Experimental Forest located in the San Gabriel Mountains of southern California. Rainfall, runoff, and erosion are measured on two main drainage areas, on ten large and seven small watersheds within these areas, and on twenty-one experimental plots. During 1952, studies on nine of the experimental plots were expanded to obtain more detailed information on the total disposition of rainfall from grass and mature brush. Three new plots were also established to obtain comparable information for a 25-year-old pine plantation. Twenty-six large lysimeters furnish comparisons of the use of water by various species of shrubs, one species of pine, and a bunch grass association. Climatic data are obtained from several meteorological stations. Studies of runoff and erosion as influenced by fire and the revegetation of large burns are in progress elsewhere in California. Studies in the improvement of vegetation cover density for increase of soil stability are in progress in the Los Angeles River watershed and at Pasadena in cooperation with the California Institute of Technology.
(g) A daily record of streamflow from each of the ten large and seven small watersheds comprising the San Dimas Experimental Forest has been computed and tabulated from 1935 to 1952 except for a few gaps in the record which still need to be interpolated. Soil moisture records from the lysimeters show that Coulter pine and several chapparal shrub species can survive for several months even though there is no available moisture in the soil.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Intermountain Forest and Range Experiment Station.

Inquiries concerning Projects Nos. 652 to 655, incl., should be addreseed to the Directo Intermountain Forest and Range Experiment Station, Ogden, Utah.

(652) SOIL RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

(b) Branch of Research, Forest Service, U. S. Department of Agriculture.
(d) Experimental and field investigation; basic and applied research.
(e) Tests on plots and small watersheds of the effects of forest, brush, and herbaceous plant cover in natural, depleted, and restored condition on the infiltration, storage, fertility, biology and stability of forest and range land soils; to determine land use practices for stabilizing eroding watershed soils and for maintaining soil stability under the impact of grazing, logging, and other wild land uses. Studies are under way on coarse, granitic soils of southwest Idaho; various soils on steep slopes of Wasatch Mountains in northern Utah; and on heavy limestone soils on the Wasatch Plateau in central Utah.
(g) On steep granitic soils of southwestern Idaho, infiltrometer tests showed artificial soil disturbance simulating the trampling of livestock decreased ground cover and increased the size of bare soil openings between plants and litter resulting in more storm runoff and erosion than on undisturbed range sites. Report completed on 15 years of runoff and erosion records from aspen, herbaceous, and bare plots at Wasatch Experimental Forest near Farmington, Utah. Completed 35 years of runoff and erosion measurements from two 10-acre subalpine watersheds at Great Basin Research Center near Ephraim, Utah.

"Effects of trampling disturbance on watershed conditions, runoff and erosion." Paul E. Packer. In press, Journal of Forestry.
"Ground cover requirements for summer storm runoff control on aspen sites in northern Utah." Jour. Forestry 50(4):303-307, April.

WATER RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

Branch of Research, Forest Service, U. S. Department of Agriculture.
Experimental and field investigation; basic and applied research.
Tests on watersheds of the effects of forest, brush, and herbaceous plant cover, and of mechanical soil stabilization structures, on runoff characteristics of mountain watersheds; to determine land use treatments required for flood control and for maximum yields of useable streamflow.
Long-range streamflow studies are under way on experimental watersheds at Great Basin Research Center near Ephraium Utah and Wasatch Research Center, Farmington, Utah.
"Visitors guide to the Wasatch Experimental Forest, Davis County, Utah." Intermountain Forest and Range Experiment Station, Ogden, Utah, 9 pp. Mimeographed, 1952.

PLANT RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

Branch of Research, Forest Service, U. S. Department oa Agriculture.
Experimental and field investigation; basic and applied research.
Tests on plots and watersheds of the effects of forest, brush, and herbaceous cover on interception and evapo-transpiration losses; to determine the kind of plant cover required for producing maximum yields of useful runoff from watersheds. Principal effort now limited to study of evapo-transpiration loss from herbaceous cover on Wasatch Mountains, northern Utah.
Completed report on three-year study of evapo-transpiration losses on aspen, herbaceous, and bare soil sites at Wasatch Experimental Forest near Farmington, Utah.
"Evapo-transpiration and other water losses on some aspen forest sites in Utah in relation to water available for streamflow." A. R. Croft and L. V. Monninger. In press, American Geophysical Union.

CLIMATIC RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

Branch of Research, Forest Service, U. S. Department of Agriculture.
Experimental and field investigation; basic and applied research.
Maasurements and studies of climatic factors including precipitation, temperature, wind, etc., that have a bearing on the hydrologic behavior of forest and range watersheds lands. These studies are confined to experimental watershed areas at the Boise Research Center near Idaho City, Idaho; Wasatch Research Center, Farmington, Utah, and Great Basin Research Center, near Ephraim, Utah.
Snow water content during the 1951-52 winter season exceeded previous 15-year record at Wasatch Experimental Forest near Farmington, Utah and previous 30-year record at Great Basin Research Center near Ephraim, Utah. Experimental Watersheds at Great Basin Research Center experienced a summer storm in 1952 in which rainfall sites exceeded previous maximum of record over a 35-year period.
"Snow accumulation and retention on ponderosa pine lands in Idaho." H. F. Haupt, Jour. Forestry 49(12):869-871, December.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Northeastern Forest Experiment Station.

Inquiries concerning Projects Nos. 656, 966, 1187, and 1188 should be addressed to Dr. Ralph W. Marquis, Director, Northeastern Forest Experiment Station, 102 Motors Ave Upper Darby, Pa.

(656) FOREST INFLUENCES INVESTIGATION (WATERSHED MANAGEMENT).

(b) Cooperative with the Pennsylvania Department of Forests and Waters and U. S. Geologica Survey.
(d) Field investigation; basic and applied research.
(e) Studies on the Delaware-Lehigh Experimental Forest, Monroe County, Pa., to determine tl water economy for a watershed covered with scrub oak. Afterwards, the cover will be converted by planting and fire protection to a commercially valuable type, and the eff on water relations will be measured. Installations have been established to evaluate all components of a water balance equation for the watershed.
(h) "Forest and water research project." Herbert C. Storey, Pennsylvania Department of Forests and Waters, 44 pages illus., 1951.
"Distant earthquakes affect local ground-water levels." Nedavia Bethlahmy, Northeaste Forest Experiment Station Research Note No. 9, pp. 1-3, Oct. 1951.
"Why do plants wilt in cold weather?" Nedavia Bethlahmy, Ecology 33:301-303, Illus., 1952.

(966) FOREST INFLUENCES INVESTIGATION (WATERSHED MANAGEMENT).

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) Studies on the Pocono Experimental Forest, Wayne County, Pa., to determine effects of forest management practices and logging operations upon the quantity and quality of water yielded by a small watershed. Installations have been established to measure pre cipitation, streamflow and rainfall interception.

(1187) FROST STUDIES IN THE NORTHEASTERN UNITED STATES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To determine the effect of land use and condition upon type and depth of frost formati Periodic observations of frost type and depth, snow depth, and water content are made upon a large number of plots in New England, New York, and northern Pennsylvania, selected to sample a variety of land uses and conditions within certain land use classes. A system of 186 plots was established and observations made thereon during the winters 1950-51 and 1951-52. Data are now being analyzed.

(1188) FOREST INFLUENCES INVESTIGATION (WATERSHED MANAGEMENT).

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) Studies on the Fernow Experimental Forest, Tucker County, W. Va., to determine the effect of different levels of cutting practices and different logging methods upon water quantity and quality. Five watersheds have been equipped with streamgaging stations and raingages. No logging will be done during a calibration period. Measurements being made on areas adjacent to the gaged watersheds to determine erosion rates on logging roads as influenced by length and steepness of grade and various erosion control measures.
(h) "Skid road erosion can be reduced." Sidney Weitzman and G. R. Trimble, Jr., Jour. of Soil and Water Conservation 7:122-124, illus., 1952.
"Design and lay-out of logging roads in mountain areas." Sidney Weitzman, West Virgini Conservation 16(3):16-21, 1952.

DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Northern Rocky Mountain Forest and Range ment Station.

FOREST INFLUENCES INVESTIGATIONS.

Laboratory project.
Mr. George M. Jemison, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Mont.
Field investigation; applied research.
To develop a detailed hydrological analysis for a small timbered watershed. Also to determine effect of forest cover and other site factors on accumulation of snowfall, rate of snow melt, and movement of snow-melt water. Work under way at Priest River Experimental Forest, Idaho.
Suspended.

DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Pacific Northwest Forest and Range Experiment on.

EFFECT OF LOGGING AND OTHER FOREST OPERATIONS ON STREAM FLOW.

Experiment Station project.
Mr. R. W. Cowlin, Director, Pacific Northwest Forest and Range Experiment Station, 423 U. S. Court House, Portland 5, Ore.
) Field investigation; basic research.
) Blue River Experimental Forest, in the McKenzie River drainage of west central Oregon (reported in preceding years). Two precipitation intensity recording gages installed, three trapezoidal flume stream gages installed in small study watersheds; observations for calibrating period under way, no studies begun, no watershed treatments applied.
) "A progress report on suspended sediment sampling in several Western Oregon and Western Washington streams." Manes Barton, Pacific Northwest Forest and Range Experiment Station Research Note No. 75, Nov. 1951.

DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Rocky Mountain Forest and Range Experiment on.

) FOREST INFLUENCES RESEARCH, MANITOU EXPERIMENTAL FOREST.

) Laboratory project.
) Dr. L. D. Love, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
) Field investigation; applied research.
) Studies of the influence of grazing, timber cutting, and revegetation of depleted watershed lands upon water supplies, and upon erosion and sedimentation, to solve problems in watershed management for the forest and range-covered watershed lands of the Rocky Mountain Front Range.
) The recording of rainfall, runoff, and erosion from plots and watersheds representing different complexes of soil, vegetation, and treatment have been continued in conformance with the long-term nature of the study.
) "Trees, grass, and water." 1951 Annual Report, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, March 1952.
"Manitou Experimental Forest: its work and aims." Station Paper No. 7, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, April 1952.

7) FOREST INFLUENCES RESEARCH, FRASER EXPERIMENTAL FOREST.

b) Laboratory project.
c) Dr. L. D. Love, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
d) Field investigation; applied research.

(e) To determine influence of lodgepole pine and spruce fir forests and of cutting on factors associated with yield of water, largely from stored snow. The aim is to solve problems in watershed management for forested watersheds of the Continental Divide zon of the Central Rockies.

(g) Analytical techniques developed which make possible the prediction with useful accurac the peak of river flow resulting from snow melt. Basic information consists of weathe observations and the recession curve of the particular river. Strong evidence that ocular mapping of snow cover during the spring melt period can yield reliable predictions of total snow-water run-off is also found.

(h) "Trees, grass, and water." 1951 Annual Report, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, March 1952.
"Progress in snowmelt investigations at the Fraser Experimental Forest." Report No. 3 Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and Bureau of Reclamation, Branch of Project Planning, Federal Center, Denver, Colorado, Sept. 19
"Watershed-management aspects of thinned young lodgepole pine stands." B. C. Goodell, Jour. of Forestry, 50(5):374-378. May 1952.
"A method for comparing the flow from a pair of experimental watersheds." B. C. Goode American Geophysical Union Trans. 32(6): 927-930, Dec. 1951.
"Fraser Experimental Forest: its work and aims." Station Paper No. 8, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, May 1952. 27 pp.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Southeastern Forest Experiment Station.

(380) FOREST INFLUENCES INVESTIGATIONS - WATER RESOURCES AND WATERSHED MANAGEMENT RESEARCH.

(b) Laboratory project.

(c) Mr. E. L. Demmon, Director, Southeastern Forest Experiment Station, U. S. Forest Servi P. O. Box 2570, Asheville, N. C.

(d) General and complete investigation of forest influences in southeastern United States. Includes fundamental hydrologic research and applied research in water resource and watershed management.

(e) To determine the effect of vegetation on the phases of the hydrologic cycle. To find out the effect of land use and land management practices on water yield and water quality. To develop standards and methods of watershed management so as to derive the greatest benefit from the land and water resources in the southeastern United States. Most of the actual research experiments and hydrologic data collection is carried out the 5600-acre Coweeta Hydrologic Laboratory which is located in the zone of maximum precipitation in the eastern United States (Nantahala Range of the Southern Appalachia Mountains). Within this experimental are approximately 35 individual watersheds whose stream flow is being continuously gaged and which are either being treated experimenta or being used as control checks. In addition to the stream flow gaging, there are 13 recording and 80 non-recording (standard) rain gages, 21 recording and 19 non-recordin ground water wells, 8 recording hygrothermographs, 2 recording anemometers, and one eva poration pan. Water samples for quality analysis are collected on a weekly and storm period basis from selected experimental watersheds.
The Calhoun Experimental Forest near Union, South Carolina, has been established and is doing basic research on how piedmont soils influence water resources and plant growth. Studies include measurement of infiltration, daily changes in field moisture, and runo from several small watersheds. Research projects include determination of effects of (1) permanent complete removal of all major vegetation; (2) temporary complete removal of all major vegetation; (3) removal of riparian vegetation; (4) removal of laurel and rhododendron shrub vegetation; (5) local logging practices; (6) mountain agriculture; (7) woodland grazing; (8) forest fires on water yield and quality; (9) improved techniques for removing wood products and retaining high quality water value on mountain watersheds.

(g) Land use studies on woodland grazing and mountain farming have shown changes in soil du to trampling are reflected in infiltration, permeability total porosity, increases in storm peaks, surface drainage characteristics, changes in time of watershed concentrati during storm periods and stream turbidities.

Data analyzed this year increased our knowledge for controlling water yields. A 40 acre coppice forest watershed 11 years after clear cutting shows diminishing stream flow as the trees grow older and as transpiration increases. The laurel and rhododendron understory on a 70 acre watershed was cut and increases in water field for the first 2 years after cutting was 3.6 inches. Exploratory studies indicate that the use of sulphur dioxide gas to defoliate trees during drought periods is a rapid, economical, and efficient method of increasing water yields.
The average annual percent of precipitation intercepted by Southern Appalachian Forest canopies varies from 11 to 17 percent. This is the equivalent of 8 to 12 inches of rainfall annually depending on the number and type of storm.
Piedmont studies are showing how various plant species influence restoration of fertility and water storage capacities to eroded soils.

h) "Weight and nitrogen and calcium content of the annual litter fall of forests in the South Carolina Piedmont." L. J. Metz, Soil Science Society of America Proc. 16(1):38-40, Jan. 1952.
"Effect of farm woodland grazing on watershed values in the southern Appalachian Mountains." E. A. Johnson, Journal of Forestry, Vol. 50, No. 2, Feb. 1952.
"Changes in vegetation, surface soil, and surface runoff characteristics of a watershed brought about by forest cutting and subsequent mountain farming." Robert E. Dils, Ph.D. Thesis, 1952, Michigan State College, East Lansing, Mich.
"Water and timber management." M. D. Hoover, Journal of Soil and Water Conservation, 7(2) 75-78, April 1952.
"Mountain water." E. Merrick and E. A. Johnson, American Forests, Vol. 58, No. 10, 30-32, 38. October 1952.

. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Southwestern Forest and Range Experiment ion.

7) FOREST INFLUENCES INVESTIGATIONS AND WATERSHED MANAGEMENT.

b) Laboratory project.
c) Mr. Raymond Price, Southwestern Forest and Range Experiment Station, Box 951, Tucson, Ariz.
d) Experimental; basic and applied research.
e) Purpose is: (1) to study the disposition of rainfall as influenced by watershed vegetation, and (2) to determine the influence of various types and densities of natural vegetation as well as vegetation modified by cultural treatment such as grazing and timber harvest, on stream flow, water uses, water losses, and erosion and sediment yields. One research center is at Sierra Ancha Experimental Watersheds in central Arizona. Rainfall, runoff, and erosion are measured on three watersheds in the pine-fir vegetation types at high elevation, on two watersheds in the ponderosa-chapparal type and four watersheds in the grassland-chapparal type at intermediate elevation, and on nine small watersheds in the semidesert chaparrel type at low elevations. Water use by different types of plants in different soils is studied on 11 large lysimeters. Another research center has recently been established in the Upper Rio Grande area of northern New Mexico. Studies are being initiated on infiltration rates on varying types of plant cover and the effect of reseeding range lands on water and sediment yields.
(g) Soil losses from old burn still high after 10 years. One hundred acres of an experimental watershed were burned on July 7, 1942. The vegetation and timber along with the litter and duff were completely burned. Profiles across the burn were measured in 1942, 1943, and in 1951 to determine soil losses. The average rate of soil loss for the 9-year period 1943-1951 was much lower than for the first year, but soil losses and soil movement continued. This indicates a disturbance factor is still present after 9 years, even though the over-all soil loss from the area may now be small, and indicates that natural recovery of vegetation following a fire is a long, slow process and is accompanied by large soil losses.
(h) Annual Report, 1951.
Sierra Ancha Experimental Watershed (in process of being printed).

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Division of Irrigation Engineering and Water Conservation.

(53) SAND TRAPS AND SLUICEWAYS.

See Colorado A and M College, page 16.

(55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.

See Colorado A and M College, page 17.

(151) LINING OF IRRIGATION CANALS AND DITCHES.

(b) Laboratory project; cooperative with Utah State Agricultural College and Bureau of Reclamation.
(c) Dr. C. W. Lauritzen, Soil Conservation Service, Box 179, College Hill, Logan, Utah.
(d) Experimental; basic and applied research.
(e) Linings for irrigation canals and ditches are being tested to develop more effective and lower cost methods of reducing conveyance losses in irrigation systems. The investigation includes: (1) evaluation of the physical properties of canal lining materials; (2) model testing of linings in an outdoor laboratory; and (3) field testing at selecte sites to determine relative durability under varying subgrade and climatic conditions.
(g) There is increasing evidence that both earth and asphaltic membrane linings are not low cost linings for canals in most areas. Generally, the installation can be made for les but the lower installation cost is offset by higher maintenance costs and early replacement compared to other linings.
(h) "Lining canals and reservoirs to reduce seepage losses." C. W. Lauritzen, O. W. Israelson, and Warren W. Rasmussen, Utah Agricultural Experiment Station Circular 129, 1952.

(287) PERFORMANCE TESTS OF WELL SCREENS.

See Colorado A and M College, page 17.

(386) DETERMINATION OF THE CHARACTERISTICS OF THE SUSPENDED SILT LOAD OF TEXAS STREAMS.

(b) Laboratory project; Texas Board of Water Engineers.
(c) Dean W. Bloodgood, Soil Conservation Service, 302 West 15th Street, Austin, Texas.
(d) Experimental; basic and applied research.
(e) (1) To determine the relationship between the suspended silt load and the discharge of Texas streams; (2) to establish criteria for planning surface reservoir storage based on suspended silt to be handled; (3) to determine the characteristics of silt deposited in reservoirs for use in evaluation of the life of a given reservoir; (4) to secure dat necessary to determine the effect of silt load on the cost of preparing water for domestic and industrial use; and (5) to determine the relationship between silt load and the management of the tributary watersheds.

(387) HYDROLOGY OF SNOW AND STREAM FLOW IN RELATION TO IRRIGATION IN THE NORTHWEST.

(b) Laboratory project; Oregon Agricultural Experiment Station.
(c) Mr. Robert A. Work, Soil Conservation Service, P. O. Box 1149, Medford, Ore.
(d) Experimental; applied research.
(e) (1) To develop from snow surveys and related data advance knowledge of the amount and distribution of the water supply available for each stream basin each season for agricultural use; and (2) to determine the factors which influence amount and distribution of water supplied to irrigated areas. Characteristics of stream flow and ground waters in principal stream basins are being studied in relation to occurrence, distribution, utilization, and efficiency of use.
(g) Research projects are being conducted in several states in cooperation with State Agricultural Experiment Stations to determine methods of developing and applying general forecasting principles to local conditions.

EVALUATION OF FACTORS AFFECTING WATER YIELDS FROM HIGH WATERSHEDS IN UTAH.

Laboratory project; Utah State Engineer, Utah Agricultural Experiment Station.
Mr. Gregory L. Pearson, Soil Conservation Service, College Hill, Box D, Logan, Utah.
Experimental; basic research.
(1) To determine the effect of deviation from normal of late fall and early spring precipitation on the established snow cover runoff relationship for Utah streams; (2) to determine the effect of temperature and other climatic factors upon the quantity and distribution of runoff from Utah's snow-fed streams.

STORAGE OF WATER UNDERGROUND FOR IRRIGATION IN CALIFORNIA.

Laboratory project; Kern County.
Dean C. Muckel, Soil Conservation Service, 222 P. O. Building, Berkeley, Calif.
Experimental; applied research.
To determine the factors affecting the percolation rate on water-spreading areas, and to devise ways and means to increase the percolation rate. In some soils the percolation rate decreases during spreading, and the objectives are to determine the cause of the decrease and to find practical methods of maintaining the high initial rates. Field tests are being made on test ponds and strips.
"Report on cooperative water spreading study with emphasis on laboratory phases, Bakersfield, California." E. S. Bliss, C. E. Johnson, and Leonard Schiff, Soil Conservation Service, Berkeley, Calif., Dec. 1950.
"Some developments in water spreading." Leonard Schiff, Soil Conservation Service, Berkeley, Calif., Sept. 1952.

IMPERIAL VALLEY DRAINAGE INVESTIGATIONS.

Laboratory project; Imperial Irrigation District.
Mr. William W. Donnan, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
Field investigation; applied research.
To establish criteria by which the feasibility of drainage in Imperial Valley may be determined and to develop methods of designing and installing drainage facilities.
Completed.
As a result of these investigations it is now possible to determine which lands are feasible to drain, how to design tile systems, their depth and spacing and how to leach out harmful mineral elements and reclaim water logged lands. Many basic principles and methods of analysis relating to the drainage of irrigated land have been developed and have been found applicable to other irrigated areas. Approximately 100,000 acres of land in Imperial Valley have been reclaimed to date using these techniques.
"Report on drainage investigations in irrigated areas of Imperial Valley, California." William W. Donnan, V. S. Aronovici and Harry F. Blaney, Soil Conservation Service, Los Angeles, Calif., Jan. 1947.
"Drainage investigations in Imperial Valley, California, a 10 year summary." William W. Donnan, George B. Bradshaw and Harry F. Blaney, Soil Conservation Service, Los Angeles, Calif., Oct. 1951.

IRRIGATION AND SOIL LOSS CHARACTERISTICS OF CONTOUR AND DOWNSLOPE IRRIGATION.

Laboratory project; Washington Agricultural Experiment Station.
Mr. Stephen J. Mech, Soil Conservation Service, P. O. Bo 590, Prosser, Wash.
Experimental; applied research.
A study of the irrigation and erosion characteristics of different size irrigation streams as they are influenced by furrow grade, crop and crop sequence, tillage, and soil moisture. Application and runoff measured by automatic water level recorders on type HS flumes. Detailed soil moisture determinations made with soil tube.
"1951 wheat-alfalfa irrigation experiments." Progress report by Stephen J. Mech and Donald M. Lowe, (mimeographed), available from Prosser, Wash.

(658) INFILTRATION OF WATER INTO AND PERMEABILITY OF SOILS IN AN IRRIGATED AREA OF THE SOUTH-WEST.

(b) Laboratory project; Arizona Agricultural Experiment Station.
(c) Mr. Karl Harris, Soil Conservation Service, Room 24, P. O. Bldg., Phoenix, Ariz.
(d) Experimental; applied research.
(e) To segregate, define, and evaluate the factors which affect water infiltration and permeability of soils; to determine cultural practices for optimum infiltration and percolation; and to develop methods of application of water most effective for given infiltration and permeability characteristics.
(g) Tillage is more important than soil amendments in increasing water intake rates. Clay soil properly handled will have a faster intake rate than sandy loam with poor tillage practices.
(h) Progress report; Harris and Peterson.

(820) THE STUDY OF SEEPAGE LOSSES FROM IRRIGATION CHANNELS.

See Colorado A and M College, page 18.

(1189) METHODS OF CONTROL AND DISTRIBUTION OF WATER.

(b) Laboratory project; Utah State Agricultural Experiment Station, BPISAE.
(c) Mr. George D. Clyde, Soil Conservation Service, College Hill, Box-D, Logan, Utah.
(d) Experimental, field and laboratory; basic and applied research.
(e) Not only existing but proposed and new methods are being tested to determine their feasibility and applicability for the control and distribution of irrigated water.
(h) "Irrigation, fertilization, and soil management of crops in rotation." Vaughn E. Hanse Jay L. Haddock, and Sterling A. Taylor, Annual Progress Report, 1951.

(1190) DISTRIBUTION OF WATER FROM PERFORATED PIPE.

(b) Laboratory project; Utah Agricultural Experiment Station, Bureau of Plant Industry, and W. R. Ames Company.
(c) Dr. Vaughn E. Hansen, Soil Conservation Service, College Hill, Box 70, Logan, Utah.
(d) Experimental; applied research.
(e) The effect of wind on the distribution pattern from perforated pipe is being studied tc provide design data and to determine the limitations of this type of distribution for irrigation purposes.

(1191) DETERMINATION OF THE DISCHARGE FROM HORIZONTAL PIPE BY THE COORDINATE METHOD.

See Utah State Agricultural College, Engineering Experiment Station, page 91.

(1192) FLOW THROUGH FLEXIBLE NON-ELASTIC PIPE.

See Utah State Agricultural College, Agricultural Experiment Station, page 90.

(1415) PERMEABILITY AND STABILITY OF SOIL AND SOIL MATERIAL.

(b) Laboratory project; Soil Conservation Service, Utah State Agricultural College, and Bureau of Reclamation cooperating.
(c) Dr. C. W. Lauritzen, Soil Conservation Service, Box 179, College Hill, Logan, Utah.
(d) Experimental; basic and applied research.
(e) Seepage losses from irrigation canals are being studied to determine: (1) losses taking place; (2) distribution of seepage losses in canal cross sections; (3) relationship between seepage losses and character of canal bed material; (4) relationship of seepage losses from canals to ground water; and (5) reliability of methods employed in estimati seepage losses.
(g) Seepage meter measurements do not furnish a reliable index to seepage losses. There appears to be a fairly constant relationship between the permeability of samples of bed material and seepage losses unless non-conformities such as coarse textured lenses and fractured rock are important factors contributing to seepage.

"Lining canals and reservoirs to reduce seepage losses." C. W. Lauritzen, O. W. Israelson, and Warren W. Rasmussen, Utah Agricultural Experiment Station Circular 129, 1952.

UTILIZATION OF LIMITED WATER SUPPLIES FOR GREATER ECONOMIC RETURNS.

Laboratory project; Arizona Agricultural Experiment Station.
Mr. Karl Harris, Soil Conservation Service, Room 24, P. O. Bldg., Phoenix, Ariz.
Experimental; applied research.
To determine the best irrigation practices to follow and amounts of water to use in each irrigation; the frequency of application during the hot and cool seasons; and how best to allocate the available water supply to the different crops during years of critical water shortage in order to secure the greatest economic return.
In alfalfa irrigation, the point of diminishing returns is not reached until 5 acre feet of water have been applied. In cotton irrigation, time of application is more important than the total amount applied.
Progress report; Harris and Peterson.

IRRIGATION REQUIREMENTS, EFFICIENCIES, AND METHODS OF WATER APPLICATION IN THE UPPER COLORADO RIVER BASIN.

Laboratory project; Colorado Agricultural Experiment Station, USBR, BPISAE.
Mr. Earl Cowley, Soil Conservation Service, P. O. Box 786, Grand Junction, Colo.
Field investigation; applied research.
To evaluate the irrigation efficiencies under present practices and the factors which fix the irrigation efficiencies; to develop and establish methods of water application which will reduce surface and deep percolation losses and erosion, result in increased irrigation efficiencies, and at the same time apply adequate moisture for plant growth; to determine the effect of tillage practices and crop rotation on infiltration rates and permeability of the soil; and to determine the consumptive uwter requirements, the total water requirements, and the net irrigation requirements for each crop grown in the area.
Inactive.

DRAINAGE OF IRRIGATED LAND IN THE UPPER COLORADO RIVER BASIN.

Laboratory project; Colorado Agricultural Experiment Station, USBR, BPISAE.
Mr. Earl W. Cowley, Soil Conservation Service, P. O. Box 786, Grand Junction, Colo.
Field investigation; applied research.
Cooperative research project on irrigation and soil management studies including drainage, salinity, and fertilization in the Upper Colorado River Basin. To develop and adapt procedures for making drainage investigations involving the source, amount, and distribution of excess water based upon the amount and distribution of water to be removed and the rate of movement of the water through the soil and to develop effective methods of drainage by open surface drains, tile drains, or pumping for drainage.

METHODS OF WATER APPLICATION AND IRRIGATION EFFICIENCIES IN KANSAS.

Laboratory project; Kansas Agricultural Experiment Station.
Mr. Walter R. Meyer, Branch Experiment Station, Garden City, Kansas.
Field investigation; applied research.
To study methods of water application and irrigation efficiencies as influenced by soil characteristics, topography, crops, source and quality of water, and climate; to determine the effects of the different methods of applying irrigation water on the physical and chemical properties of the soil, and the resulting effect on plant growth; to study infiltration rate, permeability, and quality of irrigation water; to compare the efficiency of sprinkler irrigation to that of surface methods; and to determine under what conditions sprinklers can be most effectively used.
"Progress report for Garden City Experiment Station, Irrigation Project, 1950." Walter R. Meyer, Ben L. Grover, Carl W. Carlson, Kansas Agricultural Experiment Station, Garden City, Kansas.

(1433) METHODS OF WATER APPLICATION ON IRRIGATED LANDS OF NEBRASKA.

(b) Laboratory project; Nebraska Agricultural Experiment Station, Bureau of Reclamation.
(c) Dr. Fred B. Hamilton, Department of Agricultural Engineering, University of Nebraska, Lincoln, Neb.
(d) Field investigation; applied research.
(e) To provide factual information necessary for making sound technical recommendations on irrigation practices; to compare methods of application as to irrigation efficiency an operational efficiency; to study the effects of topography, length of run, amount of water applied, and other factors on the uniformity with which water is added to the ro zone of the crops; and to develop techniques which will be usable by field workers in verifying and localizing irrigation practice recommendations.

(1434) STUDY OF THE EFFECT OF OPEN DRAINS ON GROUND WATER LEVELS IN THE PLATTE VALLEY.

(b) Laboratory project; Nebraska Agricultural Experiment Station.
(c) Mr. Fred B. Hamilton, Department of Agricultural Engineering, University of Nebraska, Lincoln, Neb.
(d) Field investigation; applied research.
(e) To determine the effect of an open drain on adjacent ground water levels and the effec of irrigation of adjacent land on ground water and on the flow of the drain.
(f) Inactive.

(1435) USE OF WATER BY AGRICULTURAL CROPS AND NATIVE VEGETATION IN NEVADA.

(b) Laboratory project; Nevada Agricultural Experiment Station, Nevada State Engineer.
(c) Mr. Clyde E. Houston, Soil Conservation Service, Agricultural Experiment Station, Reno, Nevada.
(d) Field investigation; applied research.
(e) To determine basic consumptive use of the more important agricultural crops in Nevada; the irrigation efficiencies which are practical and feasible under Nevada conditions ar the resulting water application and farm delivery requirements; and the use of water by phreatophytes in irrigated and irrigable areas of Nevada.

(1436) SURFACE AND INTERNAL DRAINAGE AS AFFECTED BY ARTIFICIAL APPLICATION OF WATER TO SOUTH DAKOTA SOILS.

(b) Laboratory project; South Dakota Agricultural Experiment Station.
(c) Mr. Leonard J. Erie, Soil Conservation Service, Department of Agricultural Engineering, South Dakota State College, Brookings, S. D.
(d) Field investigation; applied research.
(e) To study surface and sub-surface drainage under conditions of natural rainfall and to determine and evaluate such changes as occur under conditions where irrigation water is added; to determine source and quantity of water to be removed from surface and sub-surface together with desirable time and rates of removal; to determine infiltratinn rates and rates of movement of water through the various soil horizons; to investigate the effects of quality of water and methods of application on the accumulation of alkal salts; and to develop methods of prevention of water-logging and alkali accumulations and relief when such conditions exist.
(f) Inactive.

(1437) DEVELOPMENT OF PRACTICAL AND EFFICIENT METHODS OF WATER APPLICATION OF SOUTH DAKOTA LAN

(b) Laboratory project; South Dakota Agricultural Experiment Station.
(c) Mr. Leonard J. Erie, Soil Conservation Service, Department of Agricultural Engineering, South Dakota State College, Brookings, S. D.
(d) Field investigation; applied research.
(e) To study infiltration and permeability, erosivity, compaction, and volume weights of soil under different cultural practices; to determine irrigation requirements of different crops, and the time, frequency, and amount of each application of water; to develop methods of applying water which will provide uniform distribution of moisture with a min imum of water and soil loss taking into consideration the topography, soils, crops, cultural practices, cost, source, and quality of water; and to adapt the results of research under controlled conditions to typical farms of the area.

DETERMINATION OF OPTIMUM REQUIREMENTS AND METHODS OF APPLICATION OF IRRIGATION WATER IN TEXAS.

Laboratory project, Texas Board of Water Engineers.
Dean W. Bloodgood, Soil Conservation Service, P. O. Box 2169, 3rd floor P. O. Bldg., 207 East 5th, Amarillo, Texas.
Field investigation; applied research.
To determine optimum irrigation requirements for typical crops grown in Texas under widely varying climatic and soil condktions; the methods of water application best suited to the different crops grown in Texas under given site conditions and the effect of the source of supply on the methods of application, and to develop irrigation practices which will increase irrigation efficiencies.

IRRIGATION WATER APPLICATION EFFICIENCIES IN THE LOWER RIO GRANDE VALLEY OF TEXAS.

Laboratory project; Texas Agricultural Experiment Station.
Mr. P. Earl Ross, Soil Conservation Service, P. O. Box 335, Weslaco, Texas.
Field investigation; applied research.
To measure infiltration rates, surface runoff, and deep percolation losses on near level and graded runs; to determine the total seasonal use of water by crops; to measure the cost of water application; to determine the water application efficiency; and to establish criteria for fixing limits of slope for irrigation.

METHODS OF WATER APPLICATION ON THE HIGH PLAINS OF TEXAS.

Laboratory project; Texas Agricultural Experiment Station.
Mr. Norris P. Swanson, Soil Conservation Service, P. O. Box 101, 3rd floor P. O. Bldg., 207 East 5th, Amarillo, Texas.
Field investigation; applied research.
To measure irrigation efficiencies under present methods of water application on the High Plains of Texas; to develop methods of application best suited to the limited water supply, soil characteristics, cropping systems, and climate of this area; to compare sprinkling versus surface applications; to study time of application, amount and uniformity of moisture distribution in the soil with different methods of application; and to study effect of irrigation upon yield and quality.

IRRIGATION REQUIREMENTS OF CROPS ON THE HIGH PLAINS OF TEXAS.

Laboratory project; Texas Agricultural Experiment Station.
Mr. Norris P. Swanson, Soil Conservation Service, P. O. Box 101, 3rd floor P. O. Bldg., 207 East 5th, Amarillo, Texas.
Field investigation; applied research.
To determine the consumptive use, water requirements, and irrigation requirements of all agricultural crops on the High Plains of Texas under field conditions; to measure precipitation and determine the portion of it that is effective in plant production; to measure evaporation and wind movement and evaluate their effect upon water requirements of crops; and to determine irrigation efficiencies for different crops under different methods of water application.

IRRIGATION WATER REQUIREMENTS, METHODS OF WATER APPLICATIONS, AND DRAINAGE OF GRASS MEADOWS IN THE MOUNTAIN VALLEYS OF WYOMING.

Laboratory project; Wyoming Agricultural Experiment Station, BPISAE.
Mr. Byron R. Tomlinson, Soil Conservation Service, Agricultural Building, University of Wyoming, Laramie, Wyo.
Field investigation; applied research.
To investigate the current use and application of water on mountain natural grass meadows, and to establish optimum water management practices relating to reseeded and natural grass meadows in the Green River and Little Laramie Valleys of Wyoming.

(g) At Pinedale, Wyoming the second year reseeded meadows produced an average of 52% more hay than the native vegetation with a three hour irrigation every seven days. With a three hour irrigation every fourteen days, the reseeded meadows produced 94% more for than the native vegetation. With a six hour irrigation every fourteen days, the rese meadows produced 66% more forage than the native vegetation. The forage production w definitely retarded on the reseeded meadows when the irrigation water was applied con uously throughout the growing period. The production of hay on the native vegetation has been increased 85% over the average of the area in the past two years. This was accomplished by the application of commercial fertilizers and water control.
(h) "A progress report on the cooperative Mountain Meadow Project at Pinedale, Wyoming." Byron R. Tomlinson, July, 1952.

(1445) IRRIGATION PRACTICES, EVAPO-TRANSPIRATION, AND RAINFALL PENETRATION AS THEY AFFECT WA SUPPLY.

(b) Laboratory project; San Bernardino County.
(c) Dean C. Muckel, Soil Conservation Service, P. O. Box 629, Room 202, P. O. Bldg., Pomo Calif.
(d) Field investigation; applied research.
(e) To determine the contribution to the ground water supply by return flow from the irri ted areas and by penetration of rains on the valley floor, and from the foothill area on the Upper Santa Ana River Basin. The study also includes a determination of farm irrigation use, efficiency of irrigation and water losses by evapo-transpiration.
(f) Completed.
(h) "Rainfall and irrigation water penetration in the Upper Santa Ana River Valley, San Bernardino County, California." Dean C. Muckel and V. S. Aronovici, Soil Conservatio Service, Berkeley, Calif. April, 1952.

(1446) WATER REQUIREMENTS IN IRRIGATED AREAS OF THE SOUTHWEST.

(b) Laboratory project; State Agricultural Experiment Station and State Engineers of the Southwest.
(c) Mr. Harry F. Blaney, Soil Conservation Service, 1509 P. O. Courthouse Bldg., Los Ange 12, Calif.
(d) Field investigation; applied research.
(e) To investigate the quantity of water required by standard cropping systems under the vailing conditions to be met within the principal irrigated locations of the Southwes to collect, compile, and tabulate the reliable available data whether published or un published, relating to irrigation requirements and consumptive use of water as determ by tank, plot, and field experiments; to make estimates of water requirements from cl matological and other data in irrigated areas where reliable information on irrigatio use is not available; and to prepare reports by states for in-service use of technici of the Operations Division of the Soil Conservation Service.
(h) "Consumptive use and irrigation requirements of crops in Arizona." Harry F. Blaney a Karl Harris, Soil Conservation Service, Logan, Utah, Dec. 1951.
"Consumptive use of water rates in the Lower Colorado River Basin." Harry F. Blaney Karl Harris, Soil Conservation Service, Los Angeles, Calif., March 1952.
"Irrigation requirements of crops in Shiprock and South San Juan Projects, New Mexico Soil Conservation Service, Los Angeles, Calif., Oct. 1952.
"Determining evapotranspiration by phreatophytes from climatological data." Harry F. Blaney, Trans. Amer. Geophys. Union, Vol. 33, No. 1, Feb. 1952.
"Irrigation requirements of crops." Harry F. Blaney, Agricultural Engineering, Vol. No. 12, Dec. 1951.

(1447) IRRIGATION AND WATER CONSERVATION STUDIES IN SOIL CONSERVATION DISTRICTS.

(b) Laboratory project; Soil Conservation Districts in Southern California.
(c) Mr. William W. Donnan, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
(d) Field investigation; applied research.
(e) To develop improved irrigation practices for increasing water application efficiencie and conserving the available water supply in soil conservation districts.

a) IRRIGATION PRACTICES AND CONSUMPTIVE USE OF WATER IN CENTRAL CALIFORNIA VALLEYS.

b) Cooperative with Director of Water Resources, Department of Public Works of California and Soil Conservation Districts.
c) Mr. Harry F. Blaney, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
d) Field investigation; applied research.
e) To obtain information on irrigation practices and farm irrigation use, and to determine the consumptive use of water by agricultural crops and native vegetation in specific areas of Central Valley of California. Of particular interest at this time are areas in Lake County, Tehachapi area, Livermore area, Auburn-Placerville area, Pajaro Valley, areas in Santa Cruz County, Salinas Valley, and the Central Valley of California.

a) SOIL WATER RELATIONSHIPS INFLUENCING THE APPLICATION OF WATER TO AND THE DRAINAGE OF WATER FROM IRRIGATED LANDS.

b) Laboratory project; Soil Conservation Districts.
c) Mr. Vladimir S. Aronovici, Soil Conservation Service, P. O. Box 529, Room 202, P. O. Bldg., Pomona, Calif.
d) Field investigation; applied research.
e) To develop techniques for measuring and to evaluate infiltration rates and permeability characteristics of soils under irrigation agriculture in Southern California; to determine the effect of soil characteristics upon the amount and uniformity of distribution of waters applied to irrigated lands; and to determine effects of soil characteristics upon irrigation practices and of soil permeability upon depth, spacing, and capacity of drainage facilities.

a) FORMATION OF WATER BALANCE SHEETS (LOS ANGELES WEST COAST BASIN).

b) Laboratory project; Director of Water Resources, Department of Public Works, State of California.
c) Mr. Harry F. Blaney, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
d) Field investigation; applied research.
e) To make a complete inventory of the water supply and utilization within the West Coast Basin, Los Angeles County, California. The specific objective of the Division of Irrigation and Water Conservation in this cooperative study is to establish the monthly and average annual quantity of water utilized by native vegetation, irrigated and non-irrigated crops, to estimate the rainfall and percolation, and to establish the limits of a safe water supply in the basin.
f) Completed.
h) "Report of cooperative investigations on consumptive use of water in the West Coast Basin, Los Angeles County, California." V. S. Aronovici, W. W. Donnan and G. Marvin Litz, Soil Conservation Service, Los Angeles, Calif., August, 1951 (typed).

a) IRRIGATION USE AND WATER SUPPLY OF TEHACHAPI VALLEY, KERN COUNTY, CALIFORNIA.

b) Laboratory project; Water Resources Branch, Department of Public Works, State of California; Tehachapi Soil Conservation District.
c) Mr. G. Marvin Litz, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
d) Field investigation; applied research.
e) To make an inventory of the irrigation water supply for the Tehachapi Soil Conservation District and to determine the potential net safe yield of undeveloped surface and underground water for agricultural use within the District boundaries.
h) "Progress report on irrigation and water supply investigations in Tehachapi Soil Conservation District." William W. Donnan and G. Marvin Litz, Soil Conservation Service, Los Angeles, Calif., April, 1952.

(1452) EFFECT OF METHODS OF IRRIGATION UPON SOIL AND WATER LOSSES AND INFILTRATION.

(b) Laboratory project; Oregon Agricultural Experiment Station, U. S. Regional Salinity Laboratory, USBR, BPISAE.
(c) Mr. Fred M. Tileston, Soil Conservation Service, The Guss Building, Ontario, Ore.
(d) Field investigation; applied research.
(e) To determine means for increasing infiltration rates and reducing soil and water losse during irrigation of certain Eastern Oregon soils, and to apply the results to the fie conditions encountered in the area.

(1453) STREAM FLOW FORECASTING.

(b) Laboratory project; Corps of Engineers, Bureau of Reclamation, Bonneville Power Adminis tration.
(c) Mr. Morlan W. Nelson, P. O. Box 835, Boise, Idaho.
(d) Experimental; basic and applied research.
(e) Various factors influencing the rate and volume of runoff from various mountain watersheds are being measured and their effect analyzed.
(g) Summer runoff of the Columbia River at The Dalles, Oregon, can be predicted on April 1 each year within reasonable accuracy based on historical records. On the same basis, the peak flow which usually occurs in late May or June can be rather accurately predicted.
(h) "Soil priming in relation to snow surveys and flood regulation." Morlan W. Nelson, H. G. Wilm, and R. A. Work.

(1454) USE OF IRRIGATION WATER IN NORTHWEST AND INTERMOUNTAIN STATES.

(b) Laboratory project; various state experiment stations and state engineers.
(c) Mr. Wayne D. Criddle, Soil Conservation Service, Box D, College Hill, Logan, Utah.
(d) Experimental; basic and applied research.
(e) To determine and publish the water requirements of crops under various cropping system climatic conditions, and methods of water application.
(g) A method for estimating use has been developed which has proven to be sufficiently accurate for many purposes.
(h) State reports have been completed for Oregon, Wyoming, North Dakota, South Dakota, and Colorado. Reports for Washington, Idaho, Montana, Utah and Kansas are in various stag of preparation and publication.

(1455) APPLICATION AND CONTROL OF IRRIGATION WATER APPLIED BY SURFACE METHODS.

(b) Laboratory project; U. S. Bureau of Reclamation and Idaho Agricultural Experiment Station.
(c) Mr. Sterling Davis, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) Information is being gathered on the design, layout, construction, and operation of farm irrigation systems on new and old land.
(h) Annual progress reports have been prepared.

(1456) PAYETTE VALLEY, IDAHO DRAINAGE INVESTIGATIONS.

(b) Laboratory project; Idaho Agricultural Experiment Station, Production Marketing Adminis tration, Gem County Commissioners.
(c) Mr. George B. Bradshaw, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) To improve and develop new investigational technique and develop better drainage metho for the valley.

(1715) CONSUMPTIVE USE OF WATER AND IRRIGATION REQUIREMENTS IN THE BONNEVILLE BASIN OF UTAH.

(b) Laboratory project; Utah State Engineering Experiment Station, Utah Agricultural Experi ment Station; Utah State Engineer.

Mr. Wayne D. Criddle, Soil Conservation Service, College Hill, Box-D, Logan, Utah.
Field investigation; applied research.
To determine the consumptive use of water by agricultural crops and all other water consuming items in selected hydrological areas in the Bonneville Basin in Utah; to correlate their uses with hydrological and such other data as may be available in this area, and which are generally available in other areas of the Bonneville Basin of Utah; and by this method of correlation to be developed, determine the consumptive use in other irrigated areas of the Bonneville Basin in Utah.
The consumptive use of water in Milford Valley, Utah." Terrel Tovey, Master's Thesis, Utah State Agricultural College, Logan, Utah, 1952.

SPRINKLING AS A METHOD OF APPLYING WATER TO IRRIGATED FARM LANDS, ITS PROBLEMS AND LIMITATIONS.

Laboratory project; Bureau of Reclamation and Idaho Experiment Stations.
Mr. Claude H. Pair, Soil Conservation Service, P. O. Box 835, Boise, Idaho.
Experimental; applied research.
To obtain more precise information for the design, layout, installttion and operation of sprinkler irrigation systems and assist in the development and testing of better sprinkler equipment and more efficient operating procedure.
Progress reports published for years 1949, 1950, and 1951.

FIREBAUGH SOIL CONSERVATION DISTRICT DRAINAGE INVESTIGATIONS.

Laboratory project; Firebaugh Soil Conservation District.
Mr. William W. Donnan, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
Field investigation; applied research.
To make a reconnaissance of the drainage problem in the Firebaugh Soil Conservation District and obtain the necessary physical data to design adequate drainage systems in the area.

IRRIGATION AND CONSUMPTIVE USE INVESTIGATIONS IN THE SANTA MARGARITA RIVER BASIN.

Laboratory project; Water Resources Branch, Department of Public Works, State of California.
Mr. William W. Donnan, Soil Conservation Service, 1509 P. O. and Courthouse Bldg., Los Angeles 12, Calif.
Field investigation; applied research.
To determine the consumptive use of water by agricultural crops, native vegetation and other water consuming areas and to obtain information on irrigation practices and farm irrigation use.

GROUND WATER REPLENISHMENT BY PENETRATION OF IRRIGATION, RAINFALL AND WATER SPREADING IN ZONE III, VENTURA COUNTY FLOOD CONTROL DISTRICT, CALIFORNIA.

Laboratory project; Ventura County Flood Control District.
Dean C. Muckel, Soil Conservation Service 222 P. O. Bldg., Berkeley, Calif.
Field investigation; applied research.
To determine the feasibility of artificial recharge of underground aquifers in Zone III of Ventura County and to determine the present natural replenishment by deep penetration of irrigation water and rainfall.
"Progress report on ground water replenishment by penetration of rainfall; irrigation and water spreading investigations in Zone III, Ventura County Flood Control District, California, 1950-51." V. S. Aronovici, William W. Donnan and G. Marvin Litz, Soil Conservation Service, Los Angeles, Calif., Jan. 1952.

IRRIGATION AND WATER SUPPLY STUDIES IN THE UPPER SANTA CLARA SOIL CONSERVATION DISTRICT.

Laboratory project; Upper Santa Clara Soil Conservation District.
Mr. G. Marvin Litz, Soil Conservation Service, 1509 P. O. and Courthouse, Los Angeles 12, Calif.

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(d) Field investigation; applied research.
(e) To determine the potential net safe yield of the underground and surface water suppli of this area.

(1721) DRAINAGE OF IRRIGATED LANDS IN THE LOWER RIO GRANDE VALLEY OF TEXAS.

(b) Laboratory project; Texas Agricultural Experiment Station.
(c) Mr. P. Earl Ross, Soil Conservation Service, P. O. Box 335, Weslaco, Texas.
(d) Field investigation; applied research.
(e) To measure soil permeability of lands to be drained. To measure the effect of tile o the hydraulic gradient of the water table, the quantity of water drained, the effect the tile on the fluctuation of the water table, and to study the depth at which the water table should be maintained.
(h) "Drainage of irrigated lands in the lower Rio Grande Valley of Texas." Agricultural Engineering, Dec. 1951.

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, North Appalachian Experimental Watershed; Blacklands Experimental Watershed; and Central Great Plains Experimental Watershed

(150) HYDROLOGIC EXPERIMENT STATIONS.

(b) Soil Conservation Service, Department of Agriculture, and State Agricultural Experimer Stations of Ohio, Texas, and Nebraska.
(c) Mr. Lewis A. Jones, Division of Drainage and Water Control, Soil Conservation Service, Washington 25, D. C.
(d) Experimental; for design and general information in planning farms for soil and water conservation.
(e) Rainfall and runoff are measured on watersheds ranging from 1 to 5,000 acres. In addi tion to rainfall and runoff measurements, studies are made on small Government-operate areas of evapo-transpiration, moisture storage, moisture transmission through the soil and percolation of water to the ground-water table. The purpose is to determine the hydrologic effect of physiography, tillage, and ground surface conditions, vegetal cov and soils and geology, and the effect of conservation farming on runoff and erosion, a well as the characteristics of flood runoff from agricultural watersheds.
(h) North Appalachian Experimental Watershed, Coshocton, Ohio.
"The use of soil porosity for conservation of water." L. L. Harrold, Agr. Engin. 33:287-289, 292, illus, 1952.
"Effect of increasing grassland on water yields in humid areas." L. L. Harrold, pres. at 6th International Grassland Congress, State College, Pa., Aug. 17-23, 1952.
"Ecology and water conservation." L. L. Harrold, pres. Friends of Land meet., Chicago Ill., June 30, 1952.
"Upstream engineering." L. L. Harrold, Ohio Water Clinic, Columbus, Ohio, 1952.
"Basic water concepts for soil and water conservation." L. L. Harrold, Pres. Ohio Academy of Science, Kent, Ohio, 1952.
Blacklands Experimental Watershed, Waco, Texas.
"Summary of rainfall and runoff, 1940-51, at Blacklands Experimental Watershed, Waco, Texas." R. W. Baird, May 1952, mimeo.
Central Great Plains Experimental Watershed.
"Story of two watersheds." John A. Allis, sub. July 21, 1952, for pub. in Jour. Soil and Water Conserv.

. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, St. Anthony Falls Hydraulic ratory.

Reports on projects conducted by the Soil Conservation Service at the St. Anthony Falls Hydraulic Laboratory are listed under St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minn., Projects Nos. 111, 114, 1168, and 1398. Inquiries should be addressed to Mr. Fred W. Blaisdell, U. S. Soil Conservation Service, St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minn.

. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Stillwater Outdoor Hydraulic Laboratory.

)(153) THE HYDRAULICS AND STABILITY OF CONSERVATION CHANNELS.

b) Cooperative with Oklahoma Agricultural Experiment Station.
c) Mr. Lewis A. Jones, Division of Drainage and Water Control, Soil Conservation Service, Washington 25, D. C.
d) Experimental; for design.
e) Measured flows up to 150 cfs are passed through outdoor test channels of various cross-sections up to 40 feet in width with slopes up to 10 percent. Measurements of hydraulic elements and scour rates are made for flows of different velocities and for various channel linings. The purpose is to obtain (1) effects of linings, vegetal and non-vegetal, on the water carrying capacity and other hydraulic characteristics of channels used in soil and water conservation operations; and (2) protective characteristics of various types of linings, vegetal and non-vegetal.

2) RUNOFF CHARACTERISTICS OF AGRICULTURAL AREAS IN NORTH CENTRAL OKLAHOMA.

b) Cooperative with Oklahoma Agricultural Experiment Station.
c) Mr. W. O. Ree, Soil Conservation Service, Stillwater, Okla.
d) Experimental; design.
e) Rainfall and runoff are measured on three watersheds ranging from 15 to 210 acres. The highway culverts through which the watersheds discharge are used as rate measuring devices. The purpose is, first, information is obtained for planning farms for soil and water conservation and second, the technique of using existing highway drainage structures for runoff measurement is being developed.
g) Rating characteristics have been determined for the weir sills installed in the culverts for measuring low flows. Runoff rates and amounts have been compiled for the period of the study.

3) THE HYDRAULICS OF CONSERVATION STRUCTURES.

b) Cooperative with Oklahoma Agricultural Experiment Station.
c) Mr. Lewis A. Jones, Division of Drainage and Water Control, Soil Conservation Service, Washington 25, D. C.
d) Experimental; design.
e) Tests are made on full size conservation structures built under field conditions at the Stillwater Outdoor Hydraulic Laboratory. Flows up to 175 cfs are available for the testing. Experiments have been run on a chute with stilling basin and on a pipe outlet spillway.
h) "Results of tests on a chute with a St. Anthony Falls Stilling Basin." W. O. Ree, Soil Conservation Service Technical Publication 107.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Beach Erosion Board.

Inquiries concerning Projects Nos. 181, 184, 399, 660, 661, 663, 970, 972, 973, 974, 975, 977, 1457 to 1461, incl., and 1724 to 1727 incl., should be addressed to the Pres dent, Beach Erosion Board, 5201 Little Falls Road., N. W., Washington 16, D. C.

For further information on projects see Quarterly Summary, Waterways Experiment Static

(181) EQUILIBRIUM PROFILE OF BEACHES.

(f) Completed.
(h) Report in preparation.

(184) STUDY OF MODEL SCALE EFFECTS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The purpose is to determine the laws of model similarity governing the action of waves on moveable sand beaches. The tests are made in a wave tank 42 feet by 1.5 feet by 2 feet. Conditions of wave height, wave period, beach slope and grain size of sand are adjusted to various scales in an attempt to simulate the results of the tests obtained in the large wave tank for Project 181.
(f) Suspended until completion of Project 399; thereafter further testing scheduled.

(399) DEVELOPMENT AND CONSTRUCTION OF SIX-FOOT WAVE TANK.

(b) Laboratory project.
(d) Experimental; design.
(e) To design and construct a wave tank for the study of the effect of waves 6 feet high and 300 feet long. Various types of wave generating mechanisms, the power required by the generator to form the waves, and the action of the waves on a beach which is placed at an angle to the axis of the tank have been studied in a 1:12 scale model. The large wave tank is completed and is 635 feet long, 15 feet wide, and 20 feet deep. Generation of the waves is to be accomplished by a pusher-type wave generator.
(f) Design and specifications for the wave generator have been completed. Construction wil be started when funds are made available.

(660) OBSERVED WAVE CHARACTERISTICS.

(b) Laboratory project; additional research by New York University.
(d) Field investigation; basic research.
(e) To secure a more thorough knowledge of the characteristics of ocean waves in comparison to the uniform wave train generally studied in the laboratory. Several electrical recording wave gages have been installed in coastal waters and an extensive series of wave records are being analyzed by methods of significant heights and periods. The validity of wave refraction diagrams by present methods as applied to areas with gently shelving bottom topography such as encountered on the Atlantic and Gulf coasts are being studied. Further research for the Board has been undertaken by New York University to develop wav forecasting methods applicable to the Atlantic coast, and to develop electronic means of analyzing the wave records.
(h) Preliminary report on "A unified mathematical theory for the analysis, propagation, and refraction of storm-generated ocean surface waves" was completed by New York University under contract to the Beach Erosion Board.

(661) REPORTS ON BEACH PROCESSES BASED ON EXISTING MISSION, ANAHEIM, AND SANTA MONICA BAY FIELD DATA.

(f) Field work completed.
(h) Reports in preparation.

) SAND MOVEMENT AND WAVE STUDY, LONG BRANCH, NEW JERSEY.

) Laboratory project.
) Field investigation; basic research.
) To determine if sand placed in deep water will be moved onto the beach by wave action. Six hundred thousand cubic yards of sand have been placed in 38 feet of water at Long Branch, N. J. Movement of sand is being studied by frequent hydrographic surveys. Wave intensity and direction is being recorded for comparison with any sand movement. An effort is being made to measure the amount of sand moving along the bottom and the amount thrown into suspension by the waves.
) Reactivated to determine disposition of dumped sand after 3 years (October 1949 to October 1952).
) Beach Erosion Board Technical Memorandum No. 17, "Test of nourishment of the shore by offshore deposition of sand." (Covering April 1948 to October 1949).

) STUDY OF THE EFFECTS OF JETTY CONSTRUCTION AT MISSION BAY, CALIFORNIA, ON THE MOVEMENT OF LITTORAL DRIFT.

) Laboratory project.
) Field investigation; basic research.
) To observe the effects of construction of the two jetties at Mission Bay, California upon the littoral drift of sand past the inlet with a view of determining the changes in regime associated with jetty construction. Movement of the beach material is to be correlated with natural forces.
) Field work completed. Analysis of data continuing.

) STRUCTURAL DESIGN OF SHORE STRUCTURES.

) Laboratory project.
) Experimental; basic research.
) To aid in the preparation of a handbook on the design of shore structures. Field and model tests on the wave pressures caused by breaking waves which act on structures will be made in order to fill such gaps in our present knowledge of these forces not covered by other current investigations.
) Study resumed; laboratory pressure-measuring tests completed.
) Report in preparation.

) CONSTRUCTION OF COAST MODEL BASIN.

) Laboratory project.
) Experimental; basic research.
) To study beach problems involving waves, littoral currents and tides. The basin is 300 feet long, 150 feet wide and 3 feet deep.
) The basin has been completed; ten portable wave machines have been constructed and are undergoing acceptance tests; the tide system is under construction.

) SURVEY METHODS-SHALLOW WATER SOUNDINGS.

) Laboratory project.
) Experimental; basic research.
) To coordinate the development of improvements in shallow water hydrographic survey methods within the Corps of Engineers. A report has been prepared on the magnitude of sounding error to be expected in sonic and lead-line sounding and the magnitude of the error to be expected due to different spacing of the profiles.
) Completed.
) Report presented at Third Coastal Engineering Conference, M.I.T., October, 1952.

) METHODS OF BY-PASSING SAND PAST INLETS.

) Laboratory project.
) Field investigation; applied research.

(e) To study methods and requirements for pumping sand past inlets and to determine the applicability of the methods in stabilization of beaches adjacent to inlets. A compo of this study is the correlation of effectiveness of South Lake Worth Inlet, Florida, By-Passing Plant with rate of drift reaching plant." Data were collected (3/6/52 to 6/10/52) which included daily recorded wave heights and periods, daily observed litto currents, measured volume of material pumped at by-passing plant, and sand samples.

(g) Preliminary analysis of a portion of the collected data indicates that a relationship between wave energy and material pumped by the by-passing plant can be developed for t period that the data were obtained.

(977) DEVELOPMENT OF WAVE HEIGHT AND WAVE DIRECTION GAGES.

(b) Laboratory project.

(d) Experimental; development.

(e) To develop wave height and wave direction gages for use in securing accurate records c wave characteristics. Eight wave gages of the step-resistance surface mounted type an pressure bottom mounted type are now in operation and equipped to operate on a 7-day unattended basis. Laboratory development of a wave direction gage which utilizes two wave height gages operating concurrently is continuing. Further laboratory study of a wave direction gage is being made by utilizing a sensitive pressure cell in conjunctic with the Raleigh Disc principle.

(h) Beach Erosion Board Bulletin, Volume 6, No. 2, April, 1952.

(1457) WIND SET-UP AND WAVE GENERATION IN INLAND WATERS.

(b) Office of the Chief of Engineers.

(d) Analysis field data; basic research.

(e) Analysis of field data from two hurricanes over Lake Okeechobee, Florida to obtain formulae for the determination of wind tides, and the revisions necessary to the Sverdrup Munk method of forecasting for deep-water waves to be extended to cover wave generatio in shallow water.

(f) Completed.

(g) Keulegan's formula for wind set-up appears to check the data extremely well; the wave periods and heights are generally lower than would be expected from the use of the dee water equation, the degree seeming to depend primarily on the depth-fetch and depth-height ratios.

(h) Beach Erosion Board Technical Memorandum No. 27, June 1952.

(1458) STUDY OF QUANTITY OF SAND IN SUSPENSION IN COASTAL WATERS.

(b) Laboratory project.

(d) Field experiment; basic research.

(e) The amount of sand in suspension is measured at selected locations, and these measurements are correlated with the wave action observed at the time of sampling in order to establish a relationship between wave action and the average amount of beach material maintained in suspension by the wave action. For selected littoral current velocities, it will then be possible to compute the rate of drift due to sand in suspension.

(f) Completed.

(g) Analysis indicates the greatest concentration of suspended sand to be in the bottom one third of the water depth. The average concentration inside the breaker zone appears tc vary directly with wave height.

(h) Report in preparation.

(1459) WAVE TANK STUDY OF EFFECT ON BEACH PROFILES OF VARYING WAVE PERIODS.

(b) Laboratory project.

(d) Experimental; basic research.

) It is believed that constant period wave trains as presently used in most small scale tanks unduly accentuate profile irregularities peculiar to the wave period used. In these tests the wave period will be varied both rapidly and slowly from 10% to 30% from a mean period. Profiles obtained with varying periods will be compared with those obtained with a constant period equal to the mean of the varying period in order to determine how much and how frequently the wave period should be varied in wave tank tests in order to eliminate irregularities due to the use of a fixed period and thereby approximate more nearly a profile resulting from a "significant" wave period with its multitude of components.

) Completed.

) Report in preparation.

) MEASUREMENT OF DEEP WATER OCEAN WAVES WITH AN AIRBORNE WAVE RECORDER.

) Laboratory project.

) Experimental; basic research.

) To assess the reliability of present wave forecasting procedures and formulae for wave transformation in shallow water. In cooperation with the Navy, the Beach Erosion Board established a shore-based recorder off Martha's Vineyard and fabricated a wave gage for use off the Nantucket Lightship by the Navy Hydrographic Office. Simultaneous records at these two stations together with those from a Navy plane equipped with an airborne wave recorder were planned. The Navy failed to assign the plane at the selected time and only the lightship and shore records were obtained. The data thus obtained are being analyzed.

) Report in preparation.

) LOSS OF WAVE ENERGY BY BOTTOM FRICTION AND PERCOLATION IN A PERMEABLE BOTTOM.

) Laboratory project.

) Experimental; basic research.

) To test theories developed by J. A. Putnam and J. W. Johnson concerning the amount of energy lost due to percolation in a permeable sea bottom and bottom friction by a wave as it moves from deep water to the beach. On one side of a splitter wall in the test flume is a smooth, impermeable beach and sands of various sizes are placed on the other side. By running waves of varying periods and heights over the beaches concurrently and measuring the wave heights on both sides at points along the length of the flume, the energy loss can be determined.

) Completed.

) Report in preparation.

) STUDY OF THE PARALLEL LINE METHOD FOR DETECTING AND MEASURING WAVE TRAINS.

) Laboratory project.

) Experimental; development.

) To evaluate the parallel line method for observing and measuring wave trains, and study possible means of improving the method and extending its application. A large number of photographs of wave trains are being examined with the parallel line method for identifying and measuring wave trains for use in water depth determinations. Multiple wave systems generated in the Coast Model Basin (Project 973) will be utilized to check the method.

) STUDY OF EFFECT OF TIDAL FLUCTUATIONS ON WAVE-PRODUCED BEACH PROFILES.

) Laboratory project.

) Experimental; basic research.

) To determine the effect, on a wave-produced beach profile, of introducing tidal fluctuations during the period the beach is being formed. Tests are being conducted in a concrete wave tank, 88 by 14 by 4 feet. Constant period waves are being generated against four types of sand beaches and periodic tidal fluctuations introduced into the system. These results will be compared with the data in Projects 181 and 1459.

(1726) CORRELATION OF WAVES AND ALONGSHORE CURRENTS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To establish a correlation between incident wave characteristics and the resulting littoral currents. Measurements of wave height, period, and angularity of approach were made at selected beaches coincident with measurements of alongshore current velc ities and hydrographic changes.

(1727) STATISTICAL WAVE DATA FOR GREAT LAKES, ATLANTIC, AND PACIFIC COASTS.

(b) Laboratory project.
(d) Applied research; development.
(e) To compile statistical wave data, by hindcasting from weather maps, into a form suita for engineering usage. The present study includes five stations on Lake Michigan, fo on Lake Erie, three on Lake Ontario, four on North Atlantic, four on North Pacific wh have been selected to give as complete a coverage as possible in these areas. Hindca data are being obtained and compiled for all stations.
(g) Publication of compilation for Lake Michigan, January 1953.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Bonneville Hydraulic Laboratory.

Inquiries concerning Projects Nos. 408, 410, 979, 1198, 1462, 1464, 1465, 1466, and 1728 to 1730, incl., should be addressed to Mr. R. B. Cochrane, Office of the District Engineer, Portland District 628 Pittock Block, Portland 5, Ore.

(408) GENERAL MODEL STUDY OF CHIEF JOSEPH DAM, COLUMBIA RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Seattle District, Seattle, Wash.
(d) Experimental; for design.
(e) The 1:80-scale fixed bed model, including 2.4 miles of the river, reproduces the revis 19-bay spillway, 20-unit powerhouse, and a powerhouse intake channel. Normal operatin head will be 162 ft. Study is being made to determine the most economical arrangement of spillway dam and powerhouse, to determine forebay and tailbay flow conditions with various operating conditions, and to obtain a satisfactory program of cofferdam constr tion.
(f) Tests completed.
(g) The configuration and alignment of the powerhouse approach channel were modified to pr duce relatively uniform flow to the intakes. A satisfactory program of cofferdam construction and flow diversion was determined. Economical tailrace alignments were dete mined for initial and ultimate construction.
(h) Preliminary or memorandum reports have been issued on results of all tests; final repo being prepared.

(410) MODEL STUDY OF CHIEF JOSEPH DAM PENSTOCK, COLUMBIA RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Seattle District, Seattle, Wash.
(d) Experimental; for design.
(e) The 1:25-scale model reproduces a section of the powerhouse forebay, one penstock 25 ft in diameter and some 300 ft in length, and the turbine scroll case and wicket gates. The entrances of the adjacent penstocks on either side of the test penstock were also simulated. Normal head for the dam is 162 feet. To study the effects of non-uniform flow conditions at the penstock entrance (as determined from Chief Joseph General Model on velocity distribution at the entrance to the scroll case.
(f) Tests completed.
(g) Results indicate that the direction of flow approaching these particular penstock intakes had little effect on velocity distribution at the scroll case.
(h) Preliminary reports have been issued on results of all tests; final report is being prepared.

MODEL STUDY OF LUCKY PEAK OUTLET TUNNEL, BOISE RIVER, IDAHO.

Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Wash.
Experimental; for design.
The 1:28.75 model includes 575 feet of the 1,200-foot straight section of 23-foot diameter tunnel, a six-branch manifold outlet with vertical slide valves and flip buckets, the stilling basin, and a 1,600-foot reach of the river downstream. To determine the hydraulic characteristics of the manifold, valves and valve slots and to develop flip bucket and stilling basin designs which will sufficiently dissipate the energy of flow, when operated with a head of 230, feet, so as to prevent damage to the opposite river bank and areas downstream.
Tests completed.
Protection for the opposite river bank was obtained by rotating the manifold 15° so as to direct the jets downstream. Improved energy dissipation was obtained by constructing the flip buckets in pairs with flip angles of 22°, 35°, and 54° (compound curve). Cavitational pressures were developed in the valve slots with the valves three-quarters to full open.
Memorandum reports have been issued on results of all tests; final report is being prepared.

MODEL STUDY OF FRICTION LOSSES IN CORRUGATED METAL PIPE.

Office, Chief of Engineers, U. S. Army, Washington, D. C.
Experimental; applied research.
Tests are being conducted to determine values of Manning's "n" for corrugated metal pipe of 3-, 5-, and 7-foot diameters with velocities of 1 to 10 fps. Additional data consisting of velocity distribution at various sections of the pipe and pressure distribution along the corrugations are being obtained.
Results to date indicate that the "n" values for 3-ft-diameter corrugated metal pipe vary between 0.0236, 0.0245, and 0.0234 for Reynolds numbers of 300,000, 900,000, and 4,000,000, respectively.
Preliminary report issued on 3-foot diameter pipe.

GENERAL MODEL STUDY OF THE DALLES DAM, COLUMBIA RIVER, THE DALLES, OREGON.

Department of the Army, Corps of Engineers, Portland District, Portland, Ore.
Experimental; for design.
A 1:80-scale undistorted fixed bed model reproduces 2.7 miles of the Columbia River at the dam site. The original layout consisted of a circular 30-bay spillway, a 22-unit powerhouse, an 86- by 675-foot navigation lock, a rockfill nonoverflow section, and facilities for passing fish over the dam. Maximum head is 90 feet. Revised layout has a straight 23-bay spillway. Purposes are to study the structures alignment and flow conditions affecting navigation, power generation, cofferdam placement, and fish passage.
Four major layout plans were tested and the most economical plan that effected satisfactory hydraulic conditions was selected. Tests indicated ability to reduce spillway from 30 to 23 bays, and reduce forebay excavation by 30 feet.
Preliminary reports issued on all tests completed to date.

MODEL STUDY OF ROCK FILL, THE DALLES DAM, COLUMBIA RIVER, THE DALLES, OREGON.

Department of the Army, Corps of Engineers, Portland District, Portland, Ore.
Experimental; for design.
A 1:36-scale model of the 600-foot wide by 200-foot high rockfill nonoverflow section of The Dalles Dam including portions of the river channel upstream and downstream therefrom is being constructed to provide information relative to rock sizes and placement necessary to construct the fill during river discharges up to 200 000 cfs and withstand overtopping flows of 600 000 cfs.
Model construction has been temporarily postponed.

MODEL STUDY OF THE DALLES DAM SPILLWAY, COLUMBIA RIVER, THE DALLES, OREGON.

Department of the Army, Corps of Engineers, Portland District, Portland, Ore.
Experimental; for design.
Three bays of the spillway are reproduced to a scale of 1:36 to study the hydraulic characteristics of the spillway crest, piers, gates, stilling basin and baffle piers.

(f) Testing completed.
(g) The increased crest efficiency indicated by the model, in conjunction with a crest sh designed for 75 percent of maximum head, permitting a reduction in the number of spil way bays from 30 to 23. The stilling basin was shortened 50 feet to a total length o 170 feet, and one row of baffle piers, of the Bluestone type, was eliminated.
(h) Memorandum reports issued on results of all tests to date.

(1466) MODEL STUDY OF THE DALLES DAM NAVIGATION LOCK, COLUMBIA RIVER, THE DALLES, OREGON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oreg.
(d) Experimental; for design.
(e) A 1:25-scale model of the 86- by 675-foot lock chamber including its culvert systems and portions of the upstream and downstream approach channels is reproduced. Maximum lift is 90 feet. Studies will be made of various types of filling and emptying syster to determine the most advantageous from the standpoints of rate of operations, degree of turbulence, and economy. The several proposed plans include lateral culverts withi the lock chamber combined with several locations of intake ports, longitudinal culvert and outlet works.
(g) Tests of originally designed filling and emptying systems resulted in a filling time 12 minutes, hawser pulls of 14 tons, and lock emptying in 15.8 minutes. These results are in excess of design criterion, and revisions are now being made with a view of reducing these values.
(h) One memorandum report issued.

(1728) MODEL STUDY OF THE DALLES DAM FISHLADDERS, COLUMBIA RIVER, THE DALLES, ORE.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oregon.
(d) Experimental; for design.
(e) The 1:8-scale model reproduces a straight portion of a fishladder containing ten still pools. Tests are being made to study flow conditions with ladder slopes of 1 on 16 an 1 on 20 and to determine the most efficacious orifice sizes for ladder widths of 24 an 30 feet.
(g) Results indicate insignificant differences in flow conditions between 1 on 16 and 1 on 20 slopes. Orifices 21 by 23 in. and 25 by 26 in. have been selected for the 24- and 30-foot ladders, respectively.
(h) One memorandum report issued.

(1729) MODEL STUDY OF THE DALLES DAM POWERHOUSE INTAKE, COLUMBIA RIVER, THE DALLES, OREGON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Ore.
(d) Experimental; for design.
(e) The 1:25 scale model contains a test unit consisting of intake and scroll case, two adjacent units with intakes only, and a semi-circular forebay in which flow can be introduced from any desired direction. To determine the effect of the direction of approach flow on velocity distribution in the intake, discharge distribution through th scroll case, and head loss.
(g) Results indicate that oblique approach flows, at an angle of 15° from the powerhouse axis, have little effect on the efficiency of the unit, as indicated by head loss and flow distribution through the scroll case. Velocity distribution in the intake was affected.
(h) One memorandum report issued.

(1730) MODEL STUDY OF MCNARY DAM FISHLADDER DIFFUSER CONDUIT, COLUMBIA RIVER, UMATILLA, OREGON

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Washingt
(d) Experimental; for design.
(e) A 1:10-scale model reproduced a portion of a 6- by 8-foot water-supply conduit and a 20 inch branch pipe leading to the expansion chamber of a fishladder diffusion chamber, to determine the discharge capacity of the 20-inch branch pipe and the pressures at a 90° bend and at its juncture with the supply conduit.
(f) Tests completed.

g) With the original design, cavitational pressures developed at the square-edged entrance to the 20-inch pipe and at the 90° elbow. Satisfactory discharge capacity and pressures were obtained by installing a 19-inch flat plate orifice over the pipe outlet in conjunction with a bell mouth entrance.
h) One preliminary report issued.

. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Jacksonville District.

1) WAVE ACTION IN INLAND WATERS.

b) Department of the Army, Office of the Chief of Engineers.
c) The District Engineer, Jacksonville District, Corps of Engineers, Jacksonville, Fla.
d) Analytical; for design.
e) The program of observation and analyses of wind and wave action in inland reservoirs was initiated to develop more rational and reliable methods of estimating freeboard and slope protection requirements for dams and levees, effect of waves on static structures, and similar problems of a practical nature. Determination of the heights to which water may be expected to rise on dams and levees as the result of wind tides, the duration of such high tides, and the accompanying wave action govern design features representing many millions of dollars.
g) To date the studies have been limited to compilations of wind, barometric pressure, and water-stage data recorded during severe hurricanes in Florida. Future studies will be devoted to the analytical discussions of various theories and their applications to the Lake Okeechobee wave and wind-tide problem.
h) Hurricane Data, Project Bulletins No. 2, Aug. 26-27, 1949; No. 3, Sept. 21-22, 1948; No. 4, Sept. 16-18, 1947; No. 5, Oct. 17-18, 1950; and No. 6, Sept. 15-16, 1945 - Aug. 1, 1952.

. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Little Rock District.

9) TESTS OF TAINTER GATE FOR CONTROL OF CONDUIT FLOW.

b) Department of the Army, Office of the Chief of Engineers.
c) The District Engineer, Little Rock District, Corps of Engineers, Little Rock, Ark.
d) Experimental; design and operation.
e) A 4-foot wide by 6-foot high tainter gate was constructed and installed at Norfork Dam at the downstream end of an existing conduit. It was operated under a head of about 180 feet. Tests were made to determine down pull, vibration, air intake volume, and measurement of pressures on the face of the gate and in the conduit. Different types of rubber seals were used during the tests and an eccentric trunnion-type gate was also tested. The eccentric trunnion permitted a horizontal movement of one-half inch which relieved the pressure on the seal for movement of the gate.
f) Field measurements completed.
g) The results indicate that both the tainter gate and the eccentric-type tainter gate operated in a satisfactory manner. The hydraulic seals tested are not considered adequate. However, the pneumatic seals are considered satisfactory. Two types of seals were tested with the eccentric trunnion-type gate. One was the "J" type which proved satisfactory and the other was a rectangular seal which was less satisfactory.
h) Report in preparation.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Los Angeles District.

Inquiries concerning Projects Nos. 980, 1203, 1204, and 1732, should be addressed to t District Engineer, Los Angeles District, Corps of Engineers, P. O. Box 17277, Foy Station, Los Angeles 17, Calif.

(980) MODEL STUDY OF WHITTIER NARROWS FLOOD-CONTROL BASIN.

(b) Laboratory project.
(d) Experimental; for design.
(e) Earth dam with gated outlets and spillway. Three models are being used: a 1:24-scale model of the outlet works for tests on the operation of the four 30 ft by 19 ft radial sluice gates with maximum head of 50 ft, a 1:42-scale model of a half plan of the spil way for tests on the operation of the nine 50 ft by 29 ft tainter gates with maximum head of 34 ft., a 1:60-scale general model of the flood-control basin for tests on the over-all operation of the project.
(g) In the 1:60-scale model, tests were made to determine the design of the San Gabriel River channel which will control the major inflow to the flood-control reservoir.

(1203) MODEL STUDY OF LOS ANGELES RIVER CHANNEL IMPROVEMENT, RIO HONDO TO PACIFIC OCEAN.

(b) Laboratory project.
(d) Experimental; for design.
(e) From Rio Hondo to Spring Street (44,500 ft) the improvement proposed is a paved trapezoidal channel with 300-ft base and 1 on 2 1/4 side slopes. Normal velocity would be supercritical (25 ft/sec) but numerous bridges would produce Class "B" flow and attendant hydraulic jumps upstream of the bridges. From Spring Street to Pacific Ocean (17,600 ft) the channel will be trapezoidal with a base width varying between 530 ft ar 470 ft., the 1 on 2 side slopes will be paved, the bottom unpaved, and the velocity sut critical (12 ft/sec). The design discharge is 140,000 cfs in the first reach and 146,000 cfs in the second. A 1:50-scale model will be used to study flow conditions at confluences, at bridges, and at the junction of the paved and unpaved channels. The model tests will be accomplished in stages.
(g) Tests were made to determine the backwater and class of flow which would result from a discharge of 146,000 cfs at two railroad bridges.

(1204) AIRFIELD SURFACE DRAINAGE INVESTIGATION.

(b) Chief of Engineers, Department of the Army, Washington 25, D. C.
(d) Experimental; applied research.
(e) Paved, turfed, mulched, and bare test sections simulating portions of a landing strip or parking apron have been constructed to obtain basic data for analysis of rainfall-runoff relationships for various types of surfaces, cover conditions, and slopes, Natural and simulated rainfall will be studied. Test facilities consist of (1) 6 test plots (25 ft wide) and 3 airfield test areas (250 ft wide), with slopes of 1.5% and lengths varying between 100 ft and 1180 ft., and (2) 3 test troughs 3 ft wide by 500 ft long with slopes of 0.5, 1.0, and 2.0% respectively. Special control devices and recorders are being used to obtain the data.
(f) Completed.
(h) Report in preparation.

(1732) MODEL STUDY OF SPILLWAY AND OUTLET WORKS FOR SAN ANTONIO DAM.

(b) Laboratory project.
(d) Experimental; for design.
(e) The outlet works, designed for a maximum discharge of 10,000 cfs, will be at right abutment and will consist of an intake with 3 gated openings converging into a circular conduit. The spillway, designed to pass 54,000 cfs, will be in right abutment and will consist of a concrete ogee and a concrete side channel and chute terminating in a flip bucket. Three models are being used to study various designs; a 1:20-scale model of the outlet works, a 1:36-scale model of the ogee and side channel of the spillway; and a 1:48-scale general model of the spillway.

f) Tests on 1:36-scale spillway model are completed.
g) A satisfactory design was developed for the spillway side channel to allow an average submergence of the ogee crest of 40 percent.

. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, St. Paul District.

In cooperation with St. Anthony Falls Hydraulic Laboratory.

Inquiries concerning Projects Nos. 194, 412, 985, 1206, and 1733 should be addressed to the District Engineer, Corps of Engineers, St. Paul District, 1217 U. S. P. O. and Custom House, St. Paul 1, Minn.

4) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

b) Federal Inter-Agency River Basin Committee, Subcommittee on Sedimentation.
d) Experimental; applied research and development.
e) Designs for point-integrating and depth-integrating sediment samplers and laboratory apparatus have been developed. Sampler designs include a light-weight depth sampler (4 lb) operated by hand, medium weight depth sampler (62 lb) and point sampler((100 lb), and a heavy point sampler (300 lb) for use in deep, fast streams. A design for a bed-material sampler is also available.
g) Light and medium weight suspended sediment samplers were produced in sufficient quantities to satisfy the demands of the Federal cooperating agencies. One 300-lb point sampler and six bed-material samplers were produced for field tests. Recording apparatus is being fabricated to facilitate field testing of a visual accumulation tube used to determine particle size gradations of fluvial sediment in the sand-size range.
h) "The design of improved types of suspended sediment samplers." Report No. 6, May 1952.
"Accuracy of the bottom withdrawal tube method for size analysis of materials in the sand size range." Preliminary Report No. 10, June 1952.
"The visual tube method for sedimentation analysis of sands." Preliminary Report, Aug. 1952.

2) ST. ANTHONY FALLS LOCKS.

b) St. Paul District, Corps of Engineers.
d) Experimental; for design.
e) The complete hydraulic systems of the upper lock and the lower lock are being studied in 1:22.4 models. The lower lock is to have a single culvert and chamber laterals, and the upper lock a culvert in each wall and a system of chamber laterals alternating from the two culverts. The two locks will have a total lift of 75 ft.
g) A slow period of opening the culvert valves was used to reduce vortex action at the intake manifolds of the upper lock. The hydraulic system has sufficient capacity in lock filling to make a slow valve operation feasible.

8) ARCTIC AND SUBARCTIC DRAINAGE INVESTIGATIONS.

See St. Anthony Falls Hydraulic Laboratory, page 77.

5) FILLING AND EMPTYING SYSTEMS FOR HIGH-LIFT LOCKS.

b) Chief of Engineers, Corps of Engineers, Washington, D. C.
d) Experimental; applied research.
e) To develop adequate criteria for the design of filling and emptying systems for high-lift locks. Tests will be conducted in prototype locks, in model locks for definite projects, and in a general lock model simulating a maximum lift of 150 feet.
g) The general lock model was used to study a mono-culvert bottom lateral hydraulic system. The cause, effect, and elimination of cross currents in the lock chamber and the merits of streamlining the lateral culvert ports were determined. The flow phenomena in the culverts, valves, and manifolds were measured in conventional units. A separate model was constructed for the study of various types of valves.

(1206) CONDUIT GATE STRUCTURES AND TRANSITIONS.

(b) Chief of Engineers, Corps of Engineers, Washington, D. C.
(d) Experimental; applied research.
(e) A general model study is being made to establish gate operating procedures for multipl gate conduits and design criteria for conduit transitions downstream from single and multiple control gates. The model includes a complete outlet conduit with upper pool reservoir, multiple control gates in conduit intake, and a stilling basin.
(g) Guide vanes located in the conduit transitions reduced spiral or turbulent flow result from the operation of one gate alone in the multiple gate intake structure.

(1733) SCOUR BELOW SPILLWAY APRON OF DAM NO. 1, MISSISSIPPI RIVER.

(b) St. Paul District, Corps of Engineers.
(d) Experimental; for design.
(e) Dam No. 1 has a fixed, Ambursen type spillway and an 80-ft apron located at an elevation 30 ft below the spillway crest. Excessive scour observed below the dam probably occurs during the time that flow is in the middle range when the hydraulic jump is located near the downstream end of the apron. A 3 to 100-scale sectional model of the spillway was used to determine what scour-preventive measures would provide permanent protection for the spillway apron of the dam.
(f) Tests completed.
(g) A satisfactory hydraulic jump causing a minimum of scour and no undercutting of the apron was obtained by installing, at approximately the upstream third point of the apron, a rectangular sill 4-ft high, having flared slots along its base and buttresses on its downstream side.
(h) Final report being prepared.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Waterways Experiment Station.

Inquiries concerning Projects Nos. 211, 218, 219, 226, 230, 236, 237, 257, 419, 425, 672 to 676 incl., 678, 679, 682, 683, 986 to 989 incl., 991 to 1004 incl., 1207, 1209 to 1212, incl., 1467 to 1475, incl., and 1734 to 1741 incl., should be addressed to The Director, Waterways Experiment Station, Corps of Engineers, P. O. Box 631, Vicksburg, Miss.

(211) MODEL STUDIES OF OUTLET WORKS, SPILLWAY AND STILLING BASIN, GARRISON DAM, MISSOURI RIVE NORTH DAKOTA.

(b) The District Engineer, Garrison District, Corps of Engineers, Bismarck, N. D.
(f) Testing completed.
(h) Final report in preparation.

(218) CONDUIT INTAKE MODEL TESTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Scale models are being used for a general study of the hydraulic characteristics of entrance curves for (1) rectangular conduits in which the entrance is flared in four directions, and (2) a gated tunnel having a rectangular entrance with floor at same elevation as approach channel (entrance flared in three directions). Tests involve determination of pressures and discharge coefficients.
(g) Tests to date indicate that, for a gradual reduction in the pressure gradient through the conduit entrance and a minimum size entrance, the entrance curve should be shaped to the elliptical curve of $X^2/D^2 + Y^2/(1/3\ D)^2 = 1$, where D is the dimension of the conduit in the direction concerned.
(h) Report in preparation.

SLIDE GATE MODEL TESTS.

The Chief of Engineers, Department of the Army, Washington, D. C.
Experimental; applied research.
A general study by model and prototype tests to determine (1) the best shape of gate lip to reduce downward hydraulic pull on the gates and any vibration tendencies during opening or closing, and (2) the optimum shape for gate slots to eliminate or reduce cavitation tendencies. A 1:6 model reproducing the gate slots, the slide gate, a portion of the conduit upstream and downstream from the gate section, and the air vent has been tested. Also a 1:10-scale gate with a 45° lip, designed to fit the 1:6-scale gate slots, is being used to study effect of conduit height on pressure conditions on the gate lip. Some of the tests are being conducted in a vacuum tank to determine the point of incipient cavitation.
Tests of slide gates have been suspended temporarily and study of gate slots has been incorporated in cavitation investigations reported in Project 993.
Tests conducted with a gate slot 2.5 feet or 1 foot deep and 4, 3, or 2 feet wide and the downstream edge tapered 1 in 12 inches revealed very little dffference in pressure conditions along the downstream edge.

POTAMOLOGY INVESTIGATIONS.

The President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.
Experimental and field investigations; applied research.
Model studies to provide a means of predicting future changes in meandering of the Mississippi River and the need for bank protection have been completed. Additional model studies involve (1) study of revetment stability, (2) study and development of methods of channel stabilization by means other than revetment, and (3) development and testing of comprehensive plans for improving specific troublesome reaches of the Mississippi River. Full-scale revetment tests under simulated river turbulence conditions were made at the St. Anthony Falls Hydraulic Laboratory, University of Minnesota. Pressure fluctuations above and below the revetment and in the underlying sand strata were studied. The action of the revetment resulting from leaching of the sand from between the revetment interstices was also studied. Other field investigations include (1) soil surveys to determine the nature, characteristics, and physical properties of the banks of the Mississippi River to permit recognition of soil factors affecting bank stability, and (2) hydrographic and hydraulic surveys to provide information in specific revetted reaches to permit recognition of hydraulic and hydrographic factors affecting revetment stability.
Testing completed.
A combined test of articulated concrete revetment, asphalt blocks, and floating baffles produced several failures in the concrete revetment primarily as a result of leaching of material through the revetment interstices. The model asphalt blocks failed completely after about 18 hours operation. Fill occurred between and in the vicinity of the floating baffles with deeper soundings obtaining along the offshore line of the baffles. One test of standard articulated concrete revetment and two tests of experimental mattresses indicated that the latter were more effective in preventing scour of the underlying sand bed than was the standard mattress. Tests at the St. Anthony Falls Hydraulic Laboratory on a double thickness of articulated concrete mattress showed that leaching of the underlying sand through the interstices was largely eliminated when the mattress blocks were staggered.
Final reports in preparation.

MODEL STUDY OF FLOOD CONTROL, CUMBERLAND, MARYLAND.

The District Engineer, Washington District, Corps of Engineers, Washington, D. C.
Testing completed.
Final report in preparation.

(236) MISSISSIPPI BASIN MODEL.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; for design.
(e) Plans provide for a model of the Mississippi River watershed including the Ohio, Missouri, White, Arkansas, and Red Rivers and their principal tributaries. Initial c struction has been limited to the Missouri River from Sioux City to the mouth, the Arkansas River from Blackburn Dam Site to Pine Bluff, the Upper Mississippi River fro Hannibal to Tiptonville, and the Ohio River and tributaries from above Pittsburgh to Wheeling. Coordination of releases from reservoirs, effect of reservoir operation on flood stages, routing of project and other floods, levee grades, stage predictions, a effect of floodways on stage reduction will be studied. Model scales are 1:2000 hori- zontal, and 1:100 vertical.
(g) Formal tests of specific flood-control measures are under way. During the April 1952 flood on the Missouri River, the model was operated continuously on flood-prediction tests. Results obtained were of inestimable value by giving, in advance, a warning as to critical sections of levees, stages in remote portions of the flooded areas, flood limits, effect of valley storage on flood crest, and related information.
(h) "Verification of Sioux City-to-Hermann Reach, Missouri River and Tributaries, 1950 and 1947 Floods." Mississippi Basin Model Report No. 12-1, April 1952. (Available on loa "Verification of Hannibal-to-Thebes Reach, Mississippi River and Tributaries, 1947, 1944, and 1943 floods." Mississippi Basin Model Report No. 15-2, May 1952. (Availabl on loan.)

(237) MISSISSIPPI RIVER FLOOD-CONTROL MODEL.

(f) Suspended.

(257) MODEL STUDY OF STABILITY OF RUBBLE-MOUND BREAKWATERS.

(b) The Chief, Bureau of Yards and Docks, U. S. Navy, Washington, D. C.
(f) Testing completed.
(h) Final report in preparation.

(419) SLIDE GATE TESTS, NORFORK DAM, ARKANSAS.

(b) The District Engineer, Little Rock District, Corps of Engineers, Little Rock, Ark.
(f) Testing completed.
(h) Report in preparation, and results will be incorporated in the comprehensive report on the model and prototype study of slide gates for Norfork Dam.

(425) COMPREHENSIVE MODEL STUDY, DELAWARE RIVER, PENNSYLVANIA.

(b) The District Engineer, Philadelphia District, Corps of Engineers, Philadelphia, Pa.
(d) Experimental; for design.
(e) To develop and test plans for reduction of shoaling in several ranges of the navigation channel, the entire Delaware River estuary from the Atlantic ocean to Trenton is reproduced in the model which is of the fixed-bed, silt-injection type, with scale ratios of 1:1000 horizontally, and 1:100 vertically. Tides and tidal currents are reproduced by automatic tide-control machines. Observed prototype salinities are reproduced in the Delaware Bay portion of the model, and provisions made for the injection of silt, and for measuring silt deposits.
(g) Tests were made to determine salinity concentration and distribution throughout the estuary for various fresh-water discharges, tidal ranges, and mean-tide levels.
(h) "Delaware River model study; report No. 3, effects of proposed channel enlargement between Philadelphia and Trenton." Waterways Experiment Station Technical Memorandum No. 2-337, Jan. 1952. (Available for sale or loan.)

MODEL STUDIES OF LYNNHAVEN BAY AND INLET, VIRGINIA.

The District Engineer, Norfolk District, Corps of Engineers, Norfolk, Va.
Completed.
Tests indicated that (1) a channel 12 feet deep and 400 feet wide through Lynnhaven Inlet and across the outer bar will be adequate for tidal circulation to and from the interior bay system; (2) a channel through Long Creek to Broad and Linkhorn Bays, either 200 feet wide by 7 feet deep or 100 feet wide by 10 feet deep, will provide the desired tidal range in the upper reaches of Broad and Linkhorn Bays; (3) the entrance channel will be subject to some shoaling, largely confined to a relatively short length of channel, unless the channel is protected by a jetty system; (4) a single jetty on the east side of the channel will be almost as effective as parallel jetties of equal length in preventing shoaling of the channel; and (5) since it was not possible to determine the amount of shoaling of the entrance channel per unit of time, the channel should first be dredged and the rate of shoaling observed prior to construction of a protective jetty or jetties.
"Lynnhaven Bay and Inlet, Virginia; model investigation." Waterways Experiment Station Technical Memorandum No. 2-348, July 1952. (Available for loan.)

GENERAL SPILLWAY MODEL TESTS.

The Chief of Engineers, Department of the Army, Washington, D. C.
Experimental; applied research.
Tests on a 1:40 model are used to study hydraulic characteristics of the standard spillway shape with heads up to 1-1/3 times the design head of the crest, including the effect of crest piers and gates, elevation of downstream floor of spillway, and downstream slope of spillway. Tests are also being made to establish general rules for design of roller-type energy dissipators. The drop from spillway crest to bucket will be varied to study the effect of nappe thickness.
Tests to obtain discharge and pressure data for various approach elevation conditions indicated that with height of weir equal to or greater than the head, coefficient and pressure data were in the same range for the same crest shape. The spillway discharge per net foot of width is not materially affected by the use of crest piers or by variation in the shape of these piers.

MODEL STUDIES OF FORT RANDALL DAM, MISSOURI RIVER, SOUTH DAKOTA.

The District Engineer, Omaha District, Corps of Engineers, Omaha, Nebr.
Testing completed.
Final report in preparation.

MODEL STUDY OF FLOOD-CONTROL OUTLET WORKS, BLAKELY MOUNTAIN DAM, OUACHITA RIVER, ARKANSAS.

The District Engineer, Vicksburg District, Corps of Engineers, Vicksburg, Mississippi.
Completed.
Model tests indicated that flow conditions could be improved by a more gradual change in entrance alignment, a longer radius of the horizontal curvature of the conduit, and the use of a 7-ft vertical-faced end sill in the stilling basin. Only the latter revision was incorporated in the final design because of economic factors. A gate-operating schedule was developed that minimized the unstable hydraulic jump action in the conduit.
"Flood-control outlet works for Blakely Mountain Dam, Ouachita River, Arkansas; hydraulic model investigation." Waterways Experiment Station Technical Memorandum No. 2-347, June 1952. (Available for loan.)

MODEL STUDIES OF JIM WOODRUFF DAM, APALACHICOLA RIVER, FLORIDA.

The District Engineer, Mobile District, Corps of Engineers, Mobile, Ala.
Completed.

(g) The spillway crest was modified in shape and the stilling basin shortened. The lock walls were decreased in length and the depth of approach channel increased. A flip bucket was added to the overflow dike section to prevent erosion of the dike.
(h) "Spillway and lock approach, Jim Woodruff Dam, Apalachicola River, Florida; model investigation." Waterways Experiment Station Technical Memorandum No. 2-340, May 1952. (Available for loan.)

(678) CHARLESTON HARBOR MODEL STUDY.

(b) The District Engineer, Charleston District, Corps of Engineers, Charleston, S. C.
(f) Testing completed.
(h) Final report in preparation.

(679) RARITAN RIVER MODEL STUDY.

(b) The District Engineer, New York District, Corps of Engineers, New York, N. Y.
(f) Completed.
(g) Model tests indicate that realignment of a part of the 25-foot deep portion of South Channel, together with closure of the main channel by a dike, would afford the maximum reduction of shoaling in the problem area but would probably increase shoaling in the Raritan Arsenal turning basin. The top of the dike should not be higher than mean high water in order to pass flood flows in the river safely.
(h) "Plans for reduction of shoaling in Raritan River, New Jersey; model investigation." Waterways Experiment Station Technical Memorandum No. 2-342, March 1952. (Available for loan.)

(682) HYDRAULIC CAPACITY OF MEANDERING CHANNELS IN STRAIGHT FLOODWAYS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general investigation of the hydraulic capacity of meandering channels in straight floodways. Model tests are used to study effects of radius of curvature of bends; sinuosity of channel; depth of overbank flow; overbank roughness; water-surface slope; valley slope; and ratio of overbank area to channel area. Scales are proportionate to average conditions in nature so that the data obtained can be applied to natural problems.
(f) Suspended.
(g) Tests in which changes in one or more of the factors listed in (e) were involved indicated that overbank roughness is an important factor affecting the hydraulic capacity. Preliminary analysis indicated also that discharge is reduced about 35 percent by increasing the sinuosity of a 2-ft (bottom width) channel from straight to semicircular; the discharge is reduced about 25 percent by increasing the sinuosity of the 2-ft channel from 1.00 (straight) to 1.2.

(683) MODEL STUDIES OF FLOW CONDITIONS IN PUMPING PLANT SUMP AND SURGES IN SEWERS.

(b) The District Engineer, Louisville District, Corps of Engineers, Louisville, Ky.
(f) Testing completed.
(h) Final report in preparation.

(986) MODEL TESTS OF CHEATHAM DAM, CUMBERLAND RIVER, TENNESSEE.

(b) The District Engineer, Nashville District, Corps of Engineers, Nashville, Tenn.
(d) Experimental; for design.
(e) Tests of 1:12 model of one wicket of the emergency dam for the lock were conducted to determine the relative force required to raise a wicket under various operating conditions and to determine the optimum angle for the face of the wicket, the guard sill, and the strut. A 1:36 model of a portion of spillway crest and bucket was used to determine the most advantageous shape for the submergible tainter gates and the aeration required; the forces acting on the gate; and flow conditions for various tailwater elevations. In addition, the submergible tainter gate developed in the 1:36 model was tested in a 1:10 model to determine its operating characteristics at the larger scale. Tests to determine the location and height of end sill for use with a partially submergible tainter gate are currently under way.

Uplift forces acting on the upstream emergency dam were eliminated by use of a wicket gate with a curved upstream face. A design has been developed for the submergible tainter gate that eliminates the tendency of the gate to oscillate under certain operating conditions. Results obtained on the 1:10-scale model verified those previously obtained on the 1:36-scale model. Optimum stilling basin dimensions were determined for flow over and under a partially submergible tainter gate.

MODEL STUDY OF CHANNEL IMPROVEMENTS, FARM CREEK, ILLINOIS.

The District Engineer, Chicago District, Corps of Engineers, Chicago, Ill.
Testing completed.
Final report in preparation.

MODEL STUDY OF SPILLWAY, GENEGANTSLET DAM, NEW YORK.

The District Engineer, Baltimore District, Corps of Engineers, Baltimore, Md.
Completed.
Revisions to the spillway involving the extension of the right approach wall upstream, realignment of walls in the approach and chute areas, and a change in the location and cross section of the weir resulted in satisfactory performance.
"Spillway for Genegantslet Dam, Genegantslet Creek, New York; hydraulic model investigation." Waterways Experiment Station Technical Memorandum No. 2-351, Oct. 1952. (Available for loan.)

MODEL STUDY OF MISSISSIPPI RIVER, VICINITY OF GREENVILLE BRIDGE, GREENVILLE, MISSISSIPPI.

The District Engineer, Vicksburg District, Corps of Engineers, Vicksburg, Miss.
Testing completed.
Final report in preparation.

MODEL STUDY OF OUTLET WORKS, TEXARKANA DAM, TEXAS.

The District Engineer, New Orleans District, Corps of Engineers, New Orleans, La.
Completed.
A stilling basin of the hydraulic-jump type, incorporating warped inverts at the conduit outlets and a vertical wall midway between the two conduits extending into the stilling basin, provided satisfactory energy dissipation.
"Outlet works stilling basin for Texarkana Dam, Sulphur River, Texas; hydraulic model investigation." Waterways Experiment Station Technical Memorandum No. 2-346, June 1952. (Available for loan.)

MODEL STUDIES OF PINE FLAT DAM, KINGS RIVER, CALIFORNIA.

The District Engineer, Sacramento District, Corps of Engineers, Sacramento, Calif.
Testing completed.
Final report in preparation.

CAVITATION RESEARCH.

Chief of Engineers, Department of the Army, Washington, D. C.
Experimental; applied research.
Cavitation characteristics of such structures as baffle piers, steps in stilling basin, spillway gate slots, offset joints, etc., and pressures in horizontal bends are being studied on models installed in a vacuum tank and in a water tunnel. Models tested to date have been generally of three types; (1) offsets into flow; (2) offsets away from flow; and (3) gate slots. All shapes have been tested in the floor of a conduit 0.500 foot high by 0.283 foot wide. All test data are compared on the basis of a cavitation index K_i from the formula $K_i = (h_o - h_v)/(V_o^2/2g)$ where h_o and V_o are pressure and velocity in the vicinity of the area concerned; h_v is the vapor pressure of the water.

(994) EFFECTS OF MODEL DISTORTION.

(b) Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study is being made to determine the effects of model distortion on velocity distribution, bed movement, and other hydraulic conditions. A series of tests has bee completed in a triangular flume having an adjustable central angle and adjustable slop
(f) Suspended.
(g) The initial results are being analyzed to ascertain what additional tests if any are warranted.

(995) SIMULATION OF AIR ENTRAINMENT IN MODELS INVOLVING HIGH VELOCITY FLOW.

(b) Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) This investigation comprises a series of studies to determine; (1) the spread of the boundary layer in accelerating flow; (2) the effect of air entrainment on stilling bas performance; and, (3) the relationship between air demand in a model and prototype sluice.
(g) The experimental phase of the analysis of boundary layer development in accelerating flow conducted at the University of Iowa has been completed and the report is now being reviewed by the Waterways Experiment Station. Studies outlined in e (2) and (3) above have been suspended temporarily.

(996) USE OF AIR INSTEAD OF WATER IN MODEL TESTING.

(f) Suspended.

(997) SLUICE OUTLET MODEL TESTS.

(f) Suspended.

(998) STUDY OF WAVE FORCE ON BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general investigation of wave phenomena and resulting forces is being conducted in a wave tank to develop formulas, supported by experimental data, from which wave pressure on impervious surfaces, vertical and inclined, can be determined.
(g) Accuracy of wave-height measuring equipment has been determined. Initiation of wave-force tests awaiting development of a suitable pressure measuring and recording apparat

(999) STABILITY OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Rubble-mound structures are studied in a wave tank to determine size of cap rock and slope of mound necessary to withstand action of waves and to develop formulas, supportec by experimental data, from which the action of waves on rubble structures can be determined. Test data will be presented in dimensionless form, therefore no model scale, as such, is being utilized. Tests have been conducted to determine the accuracy of wave-height measuring equipment, and the over-all accuracy of the test results.
(g) Results of accuracy tests showed that the wave-height measuring equipment, the testing techniques and the experimental data are sufficiently accurate for the purposes of the general investigation of rubble breakwaters.

(1000) ROUGHNESS STANDARDS FOR HYDRAULIC MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.

) A general study of roughness standards for models is being conducted to evaluate the resistance of definite types of roughness in terms of Manning's "n" and other parameters, so that much of the trial-and-error process of adjusting the surface roughness of river models can be eliminated. Tests were conducted in three rectangular flumes.

) Curves prepared from test data were used to determine the channel roughness for the portions of the Mississippi Basin Model now in operation.

) SCALE EFFECTS ON SPILLWAY DISCHARGE COEFFICIENTS.

) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

) Experimental; applied research.

) Tests are conducted on ogee and sharp-crested weirs to permit comparison of spillway discharge coefficients obtained from models of different scales. Tests to determine effect of variation of viscosity from a high of 220 centipoises to about 3 centipoises were also completed.

) Tests to determine effect of surface tension on discharge coefficients of spillways revealed no appreciable effect in small-scale spillway models. Analysis of viscosity data has not progressed sufficiently to permit conclusions.

) Report in preparation.

) SCALE EFFECTS IN HARBOR MODELS.

) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

) Experimental; applied research.

) Tests will be conducted to determine effects of various model scales and distortion on wave characteristics in a harbor.

) Initiation of tests awaiting development of testing program.

3) STUDY OF HARBOR DESIGN.

) Suspended.

) INSTRUMENTATION.

) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

d) Experimental; development.

) Various types of instruments for use in hydraulic models are being developed to make such measurements as those of wave heights, dynamic fluid pressures, gate vibration and downpull, and low velocity flow. Apparatus is under development to analyze the frequency spectrum of recorded wave forms. Development of an improved tidal reproducing apparatus is in progress.

7) MODEL STUDY OF PENSTOCK INTAKE AND SLUICE COASTER GATES.

) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

d) Experimental; applied research.

) A general study of relative merits of various penstock intake and sluice coaster gate lip shapes, seals and recesses is being conducted. The investigation includes determination of downpull effects of changes in gate-lip shape, length and shape of seals, size and shape of the recess in the face of the dam, and need for an air vent in the entrance. The 1:20 model of the sluice coaster gate is presently being tested in combination with a typical sluice which includes a slide gate, standard entrance curves conforming to the elliptical equation $(x^2/D^2) + (y^2/(D/3)^2) = 1$, and a removable constriction at downstream end of sluice.

g) Tests of the sluice coaster gate with various slide gate openings and sluice exit conditions revealed greatest downpull forces at coaster gate openings of 2 to 4 feet. The slide gate and air vent were then moved upstream 15 ft and tested to determine the effect, if any, of location on the over-all performance of the coaster gate. Moving the slide gate 15 feet closer to the intake was found to have little or no effect on the over-all performance of the sluice gate.

(1209) MODEL STUDY OF BELTON DAM, LEON RIVER, TEXAS.

(b) The District Engineer, Fort Worth District, Corps of Engineers, Fort Worth, Texas.
(f) Testing completed.
(h) Final report in preparation.

(1210) MODEL STUDY OF GRAYS HARBOR, WASHINGTON.

(b) The District Engineer, Seattle District, Corps of Engineers, Seattle, Wash.
(e) The fixed-bed model, scales 1:800 horizontally and 1:80 vertically, reproduced the Pacific Ocean area adjacent to the harbor entrance and the tidal portion of the harbor and Chehalis River. This model was used to develop a comprehensive plan to protect th existing south jetty from the undermining effects of tidal currents, and to protect Point Chehalis from erosion by current and wave action. Upon completion of this part of the investigation a portion of the model was converted to a movable-bed type to determine scour and shoal tendencies of the selected plan. Plans for reduction of shoaling in the 30-foot-deep navigation channel were also studied.
(f) Testing completed.
(g) A plan involving the lowering of the outer 6,000 feet of the south jetty to an elevati of 0.0 foot (MLLW) would reduce the maximum ebb velocity along the jetty by about 20 percent. The construction of groins at Point Chehalis will probably reduce erosion there. Model tests indicated that one spoil area retains almost all spoil deposited but that some proportion of the spoil placed in all other areas tested returns to the channel.
(h) Final report in preparation.

(1211) MODEL STUDIES OF HOOSIC RIVER, ADAMS AND NORTH ADAMS, MASSACHUSETTS.

(b) The District Engineer, New York District, Corps of Engineers, New York, N. Y.
(d) Experimental; for design.
(e) Two models were used to verify the hydraulic design for improvement of certain section of the channels of the North and South Branches of Hoosic River in North Adams, Mass., and of the main channel in Adams, Mass., and to determine whether changes should be ma for safety, increased efficiency, or economy. The flow in the major portion of these channels will be below critical depth. A 1:30 model reproduced the lower sections of the North and South Branches and about 1300 feet of the main stream below the confluenc of the North and South Branches. A 1:20 model reproduced a section of the main channel beginning approximately 8 miles above that reproduced in the 1:30 model. About 1200 feet of Tophet Brook, which joins the Hoosic River, was also reproduced.
(f) Tests of the initial plan of improvement have been completed. Plans for construction o Phase II of the North Adams plan of improvement are in progress. Work has been suspende on the portion of the river near Adams, Mass.
(g) The stilling basin as designed for the North Adams section was found unsatisfactory and a basin was developed that produced the desired flow conditions. The design and location of the stilling basin in the main channel at Adams were verified. Flow conditions at the junction of Tophet Brook and the culvert flume feeding into the brook were greatly improved and the turbulence existing in the Hoosic River below the mouth of Tophet Brook was eliminated.
(h) "Flood control project, Hoosic River, North Adams, Massachusetts; Phase I: Model investigation of stilling basin and junction section." Waterways Experiment Station Technical Memorandum No. 2-338, Report No. 1, Feb. 1952.
"Flood control project, Hoosic River, Adams, Massachusetts; model investigation of phase I of improvement works." Waterways Experiment Station Technical Memorandum No. 2-339, Report No. 1, Feb. 1952. (Available on loan.)

(1212) MODEL STUDIES OF OUTLET WORKS, OAHE DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) The District Engineer, Omaha District, Corps of Engineers, Omaha, Neb.
(d) Experimental; for design.

e) Two models are being used for complete investigation of the outlet works proposed for Oahe Dam. A 1:60 model, reproducing the downstream portion of six 18.5-foot-diameter outlet tunnels, the stilling basin, and 2300 feet of the discharge and pilot channels, is being used to investigate the performance of the outlet works and to effect revisions demonstrated to be desirable. A 1:25 model of the upstream portion of one of the tunnels, the control structure located in the center of the embankment, and a short length of the tunnel downstream is being used to: (1) check piezometric pressures at various points in the intake structure and transition, particularly pressure variations in the bulkhead slot area; (2) determine the effect of curvature on flow conditions in the upstream tunnel and critical areas downstream therefore; (3) check piezometric pressures at various points in the gate chamber of the control shaft and the upstream and downstream transitions, with particular attention to pressures near the gate slots; (4) study the forces acting on the service gate and effects of such forces on gate operation; and (5) measure air demand characteristics.

g) Tests of the initial design of basin on the 1:60 model indicated that several economies could be effected in construction without impairing the hydraulic performance of the stilling basin. These economies consisted primarily of shortening the over-all length of the outlet works by 90 feet; reducing the length of separation piers by 100 feet; raising the floor of the stilling basin 4 feet; and eliminating the slope downstream from the end sill. Tests of the 1:25 model have not progressed sufficiently to provide significant results.

7) ANALYSIS OF HYDRAULIC EXPERIMENTAL DATA (MODEL AND PROTOTYPE) AND DEVELOPMENT OF DESIGN CRITERIA.

b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

d) Experimental and field investigations; for design.

e) A general study to develop, analyze, and disseminate to Corps of Engineers establishments design criteria for hydraulic structures to insure adequate hydraulic capacity, economy of construction and safe and satisfactory operation. Criteria are developed from model tests and prototype observations relating to the design of spillways, outlet works and gates and valves. Program also includes hydraulic design criteria for navigation structures, flood-control channels and natural waterways.

g) Hydraulic design charts for air demand in outlet works, spillway crest discharge coefficients and bend loss coefficients have been completed.

8) VALDIVIA RIVER MODEL STUDY, CORRAL BAY, CHILE.

b) Government of Chile, South America.

d) Experimental; for design.

e) Model study is to determine whether training works or other remedial measures will make possible the maintenance of a channel at least 6 meters deep over the entrance bar from the Port of Corral to the Valdivia River mouth, and to determine the effect such structures might have on present depths and widths of Corral Harbor. The movable-bed model, with scale ratios of 1:400 horizontally and 1:80 vertically, reproduces Corral Bay upstream from Point San Carlos and the lower 3 miles of both the Valdivia and Tornagalenes Rivers.

g) The hydraulic and shoaling adjustments of the model were completed, and tests were made of three proposed improvement plans consisting of training walls.

9) MODEL STUDY OF FLOOD-CONTROL PROJECT, ALLENTOWN, PA.

b) The District Engineer, Philadelphia District, Corps of Engineers, Philadelphia, Pa.

d) Experimental; for design.

e) The proposed local improvement plan at Allentown is being studied to discover and correct any undesirable features of the plan. The fixed-bed model, scales of 1:150 horizontally and 1:50 vertically, reproduces 3 miles of Lehigh River and 1 mile each of Little Lehigh Creek and Jordan Creek.

f) Testing completed.

(g) Modifications in alignment and location of the closure and training dikes, and in the amount and location of dredging as outlined in the original proposed improvement plan were developed.
(h) Final report in preparation.

(1470) NIAGARA RIVER AND FALLS MODEL STUDY.

(b) The District Engineer, Buffalo District, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.
(e) Use of the Niagara River for power development and other purposes is controlled by treaty between the United States and Canada which includes a specific allotment of the waters for preservation of the scenic beauty of the Falls. Proposed redevelopment of the Niagara River for power includes large increases in diversion and redistribution o flow in the cascades to preserve the beauty of the Falls. A fixed-bed model is being used to determine the effects of the proposed redevelopment and remedial works require for efficient power diversion and maintenance of adequate river flows. All features o Niagara River from Lake Erie to below the Falls are reproduced to scales of 1:360 horizontally and 1:60 vertically.
(g) The location and length of control structure at the head of the cascades necessary to control natural elevations in Grass Island pool were determined. The design of remedi works near the crest of the Horseshoe Falls, with a view toward obtaining the desired distribution of flow under flow conditions provided by recent treaty, has been accomplished.

(1471) HYDRAULIC MODEL STUDY OF SAVAGE RIVER DAM SPILLWAY.

(b) The District Engineer, Washington District, Corps of Engineers, Washington, D. C.
(d) Experimental; for design.
(e) Model tests of the side-channel spillway are being conducted on a 1:36 model to determine the discharge rating curve and other hydraulic characteristics of the spillway at heads greater than that for which the spillway was originally designed because the spillway design flood for this dam has been increased.
(f) Testing completed.
(g) The increase in head on the spillway did not result in dangerous pressure conditions.
(h) Final report in preparation.

(1472) MODEL STUDY OF WAVE ACTION, INDIANA HARBOR, INDIANA.

(b) Youngstown Sheet and Tube Company, and Inland Steel Company, Indiana Harbor Works, East Chicago, Ind.
(d) Experimental; for design.
(e) A 1:150 fixed-bed model of Indiana Harbor and sufficient area of Lake Michigan to permi reproduction of waves from north-northwest to southeast is being used. Effects of proposed harbor structures on wave action conditions in the entrance channel and in the harbor are being studied.

(1473) MODEL STUDIES OF FOLSOM DAM, AMERICAN RIVER, CALIFORNIA.

(b) The District Engineer, Sacramento District, Corps of Engineers, Sacramento, Calif.
(f) Testing completed.
(h) Final report in preparation.

(1474) OPERATING FORCES OF MITER-TYPE LOCK GATES.

(b) The Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study to collect basic data on operating forces of miter-type lock gates and to determine the effect of various elements upon these forces is being conducted in a 1:20 model. A lock chamber 110 ft wide is reproduced with provisions for varying the length up to 600 ft on each side of the gate. Forces required for operation of miter gates will be measured for variations of the following elements: gate leaves, speeds an accelerations of operation, submerged depths, recess shapes, bottom clearances, chamber lengths, and nonsynchronous operation of gate leaves. Variations in the type linkage driving the gate also will be investigated.

g) Tests indicate that with the Ohio River type linkage the peak torque occurs as the gates enter or leave the mitered position. Nonsynchronous operation of the gates resulted in a slight decrease in torque on the leading leaf and a lesser effect on the lagging leaf, as compared with synchronous operation. An increase in the speed of operation or depth of submergence increases the peak torque. Bottom clearances had little effect on torque values.

3) SIPHON ACTION AT PUMPING PLANTS.

b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
d) Experimental; applied research.
e) A general study is being made of the operating characteristics of siphons operated in connection with pumping plants. The test apparatus consists of 6-inch-diameter plastic tubing with a lift of 30 feet. The effect of various head-tailwater relationships on priming characteristics, the air demand required to break the siphonic action, and the effect of constriction or reduction in area of the discharge leg of the siphon are to be determined. Investigations also will concern: (1) effect of deflector blocks in the crown of the siphon; (2) effect of vents in the riverward leg to decrease the time of priming; (3) effect of length and slope of riverward leg; and (4) effect of tailwater elevation.
g) Comparison of results of tests with data procured from field observations on other size siphons indicates that data from the 6-in-tubing can be extrapolated to other sizes with a reasonable degree of accuracy.

4) MODEL STUDY OF STILLING BASIN, BUFORD DAM, CHATTAHOOCHEE RIVER, GEORGIA.

b) The District Engineer, Mobile District, Corps of Engineers, Mobile, Ala.
d) Experimental; for design.
e) A 1:25 model was used to verify the hydraulic design of the stilling basin and to determine the possibility of developing improvements thereto by means of the addition of baffle piers or revision of end-sill height.
f) Completed.
g) Tests indicated that, although flow conditions in the original design basin were generally satisfactory, improved performance would result from increasing the end-sill height by 2.5 feet. Addition of baffle piers was not considered necessary.
h) "Flood-control stilling basin, Buford Dam, Chattahoochee River, Georgia; hyrduulic model investigation." Waterways Experiment Station Technical Memorandum No. 2-350, Oct. 1952. (Available on loan.)

5) MODEL STUDY OF WAVE RUN-UP ON SHORE STRUCTURES.

b) The President, Beach Erosion Board, Corps of Engineers, Washington, D. C.
d) Experimental; for design.
e) Tests are being conducted, using a scale of 1:17, to investigate the relationship between water level, wave height, wave period and beach slope and wave run-up on selected types of shore structures used to prevent erosion caused by wave action.
g) Tests have shown that the volume of overtopping water and height of wave run-up vary with both wave height and length. The variation is discontinuous. The volume of overtopping water and height of wave run-up vary in cycles from minimum to maximum and increase as wave height and wave length increase.

6) MODEL STUDY OF EFFECTS OF INLETS ON ADJACENT BEACHES.

b) The President, Beach Erosion Board, Corps of Engineers, Washington, D. C.
d) Experimental; applied research.
e) To determine the effects of natural or artificial inlets on adjacent beaches for various conditions of waves, tides, rate of littoral drift, and other factors, tests are being made in a basin simulating an ocean and a lagoon separated by a barrier beach of sand that can be breached to reproduce the desired inlet.

(1737) MODEL STUDY OF CHAIN OF ROCKS PROJECT, MISSISSIPPI RIVER.

(b) The District Engineer, St. Louis District, Corps of Engineers, St. Louis, Missouri.
(d) Experimental; for design.
(e) The Chain of Rocks reach, a 7-mile-long series of rock ledges, is the principal cause of navigational difficulties in the 15 miles between the mouth of the Missouri River and the city of St. Louis. An improvement plan, involving a long canal from the vicinity of the mouth of the Missouri with a navigation lock at its downstream end, is being studied in a combination movable-bed fixed-bed type model with scales of 1:400 horizontally and 1:100 vertically. Means are being investigated of reducing the silting in the lower approach channel to the canal and of removing and preventing the rebuilding of a bar across the downstream canal entrance.
(g) Water-surface profiles for bankfull flow and for the crest of the 1947 flood were satisfactorily reproduced in the model, and the qualitative reproduction of silting that occurred in the lower approach channel of the canal during and after the 1947 flood was accomplished. Fixed-bed tests indicated that silting in the downstream entrance to the canal would obtain with each of three proposed alignments of spoil area on Cabaret Island. Efforts to flush out this deposited material by operation of the vertical-lift lock gates at stages of 20 feet and lower on the St. Louis gage were not successful. Flood heights, using the 1947 crest, were not raised appreciably with any of the spoil area alignments.

(1738) MODEL STUDY OF GREENUP LOCKS AND DAM, OHIO RIVER.

(b) The District Engineer, Huntington District, Corps of Engineers, Huntington, W. Va.
(d) Experimental; for design.
(e) A 1:120 model of the nonnavigable-type dam and twin parallel locks is being used to determine the best arrangements of locks and appurtenant walls, to study approach conditions under various flows and methods of operation of control gates, and to demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint.
(g) Results indicate that ports may be required in the upper guard wall to improve approach conditions.

(1739) MODEL STUDIES OF MARKLAND LOCKS AND DAM, OHIO RIVER.

(b) The District Engineer, Louisville District, Corps of Engineers, Louisville, Kentucky.
(d) Experimental; for design.
(e) A comprehensive 1:120 model of the nonnavigable-type dam and twin parallel locks, and a 1:25 section model of the spillway and stilling basin are being constructed to: (1) determine the best arrangements of locks and appurtenant walls; (2) study approach conditions under various flows and methods of operation of control gates; (3) demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint; (4) investigate the design of the spillway and stilling basin structures.

(1740) MODEL STUDY OF OUTLET STILLING BASIN, TUTTLE CREEK DAM, BIG BLUE RIVER, KANSAS.

(b) The District Engineer, Kansas City District, Corps of Engineers, Kansas City, Mo.
(d) Experimental; for design.
(e) A 1:25 model is being used to check the adequacy of design and effect improvements in flow in the outlet stilling basin with both partial and full operation of the two gate-controlled conduits. Special attention is being given to: (1) vibration tendencies of the vertical slide gates used to control flow at the upstream end of the conduits, and (2) necessity for outlet transitions at the junction of the conduit and stilling basin.
(g) The model tests indicated the possibility of shortening by 50 feet the dividing wall between the twin stilling basins, and raising the elevation of the stilling basins 5 ft. Use of outlet transitions at the ends of the conduits did not appear to improve flow conditions in the stilling basins and were considered unnecessary.

) MODEL STUDY OF SPILLWAY, GAVINS POINT DAM, MISSOURI RIVER, SOUTH DAKOTA.

) The District Engineer, Omaha District, Corps of Engineers, Omaha, Neb.
) Experimental; for design.
) A 1:60 model is being used to investigate the hydraulic performance of the spillway; to verify floor elevation and length of stilling basin required for the proper formation of a hydraulic jump; to determine the adequacy of the wall heights for the chute and stilling basin; and to observe the over-all hydraulic performance of the structure.

DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS.

2) TESTS OF SCOUR AROUND BRIDGE PIERS.

Cooperative with Rocky Mountain Hydraulic Laboratory. See page 75.

3) SCOUR AT BRIDGE PIERS AND ABUTMENTS.

Cooperative with Iowa Institute of Hydraulic Research. See page 41.

4) STUDY OF HIGHWAY INLET BOXES AND DISCHARGE PIPE SHAPES.

Cooperative with University of Illinois. See page 36.

5) SCALE MODEL STUDIES OF INLET BOXES.

Cooperative with University of Illinois. See page 36.

6) FULL SCALE GUTTER TESTS.

Cooperative with University of Illinois. See page 37.

1) MOVEMENT OF SEDIMENT IN HIGHWAY DRAINAGE SYSTEMS.

Cooperative with Iowa Institute of Hydraulic Research. See page 41.

3) MODEL STUDIES OF TAPERED INLETS FOR BOX CULVERTS ON STEEP GRADES.

Cooperative with Oregon State College. See page 70.

. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS, National Hydraulic Laboratory.

Inquiries concerning Projects Nos. 159, 160, 432, 433, 1214, 1216, 1477 to 1482, incl., and 1742, should be addressed to the Chief, National Hydraulic Laboratory, National Bureau of Standards, Washington 25, D. C.

9) MODEL LAWS FOR DENSITY CURRENTS.

b) Waterways Experiment Station, Corps of Engineers, Department of the Army.
d) Theoretical and experimental; basic and applied research.
e) To determine model laws for models involving the motion of stratified liquids. The two major problems are (1) the motion of a heavy liquid initially confined in a "lock" when released into a long channel containing a stationary lighter liquid, and (2) the motion of a heavy liquid from a "sea" into a long channel with either still or flowing lighter liquid.

(h) "Distorted models in density current phenomena." G. H. Keulegan, National Bureau of Standards Report No. 1188, Oct. 10, 1951.
"Effectiveness of salt barriers in rivers." G. H. Keulegan, National Bureau of Stan[dards] Report No. 1700, June 2, 1952.

(160) EFFECT OF STORM WINDS ON LAKE LEVELS.

(b) Laboratory project.
(d) Theoretical and experimental; basic research.
(e) To determine frictional forces of wind on lake surfaces and the resulting set-up.
(h) "The form factor in wind tide formulas." G. H. Keulegan, National Bureau of Standar[ds] Report No. 1835, Aug. 4, 1952.
"Hydrodynamics of gales on Lake Erie." G. H. Keulegan, National Bureau of Standards Journal of Research, RP2396, Feb. 1953.

(432) FROST CLOSURE OF ROOF VENTS OF PLUMBING DRAINAGE SYSTEMS.

(f) Completed.
(h) Paper in press.

(433) CAPACITIES OF PLUMBING STACKS.

(b) Housing and Home Finance Agency.
(f) Completed.
(h) Second paper in preparation.

(685) ORIFICE METERS.

(b) Cooperative with American Gas Association, American Society of Mechanical Engineers, a[nd] Bureau of Ships, Department of the Navy.
(c) Mr. Howard Bean, National Bureau of Standards, Washington 25, D. C.
(d) Experimental; applied research.
(e) To obtain information on installation requirements of orifices, flow nozzles, and vent[uri] tubes with special reference to (1) using shorter meter runs than now recommended; (2) the effects of globe and plug valves preceding an orifice, and (3) possible developme[nt] of a field method of evaluating pipe roughness.
(h) "Interim Report No. 1, Investigation of orifice meter installation requirements coveri[ng] tests made in 1949-50." (Available American Gas Association, 400 Lexington Avenue, New York 18, New York.)
Second interim report in preparation.

(1214) PHYSICS OF FLOW IN PLUMBING SYSTEMS.

(b) Laboratory project.
(e) Preparation of papers on results of experimental research.

(1216) RESEARCH ON PLUMBING SYSTEMS.

(b) The McPherson Foundation for Sanitary Research.
(f) Suspended.

(1217) OPEN CHANNELS WITH UNIFORMLY DISTRIBUTED FLOW.

(b) Laboratory project.
(d) Experimental; basic and applied research.
(e) To determine surface curves, velocity distribution, and friction laws for channels in which the inflow is uniformly distributed along the length of the channel.

TURBULENT EXPANSION OF JETS IN WATER.

Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research.
To determine experimentally the nature of turbulent expansion of jets in water with relation to Reynolds number, using jets of hot water, salt water, etc.

WIND WAVES.

Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research.
Includes mathematical and experimental studies of (1) wind tides (set-up), (2) growth of wind waves, and (3) surface traction of wind on wavy surfaces.
Paper in preparation.

ENERGY DISSIPATION IN STANDING WAVES.

Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research.
To determine significance of viscous boundary layer effects in wave phenomena.

POSITIVE WAVES IN DRY CHANNELS.

Office of Naval Research, Department of the Navy.
Experimental and theoretical; basic research.
To determine mathematically velocity and form of waves taking friction into account. To analyze the tip of the wave mathematically, and to determine form of wave experimentally as function of time and roughness. Attempt to determine particle trajectories at the tip of the wave experimentally.
"Hydraulic resistance effect upon the dam-break functions." R. F. Dressler, National Bureau of Standards, Journal of Research RP2356, Sept. 1952.

CALCULATION OF NON-LINEAR BREAKING OF WAVES.

Office of Naval Research, Department of the Navy.
Mathematical; basic research.
To obtain significant criteria for breaking of waves by numerical solution with computing machine using the exact non-linear boundary condition satisfied at the displaced surface.

INITIAL VELOCITY DISTRIBUTIONS IN SALT WATER WEDGE.

Laboratory project.
Experimental; basic research.
To determine velocities and particle trajectories during initial motion when a gate separating two bodies of liquids of different densities is suddenly opened.

MECHANISM OF TURBULENCE.

Office of Scientific Research, Air Research and Development Board.
Experimental.
To determine whether reproducible fundamental flow pattern occurring at initiation of turbulence can be demonstrated.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU.

Inquiries concerning Projects Nos. 1010 to 1015, incl., and 1743 to 1753 incl., should be addressed to Mr. William E. Hiatt, Hydrologic Services Division, U. S. Weather Bureau, Washington 25, D. C.

(1010) ELECTRONIC FLOOD ROUTING ANALOGUE.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) A basic circuit for an electronic analogue computer to solve flood wave problems has been developed and its application to the solution of local streamflow problems is bei studied at the following River Forecast Centers; Cincinnati, Ohio; Knoxville, Tenn.; St. Louis, Mo.; Kansas City, Mo.; Tulsa, Okla.; Portland, Oregon; Harrisburg, and Pitt burgh, Pa.
(h) "Application of electronic flow routing analogue." Max A. Kohler, Vol. 78, Separate N 135, Proc. American Society of Civil Engineers.

(1011) SHORT RANGE SNOW-MELT FORECASTING.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To develop relations between streamflow resulting from melting snow and appropriate meteorological parameters using a statistical approach.
(g) A reasonably adequate procedure has been established and is being refined and tested.

(1012) AUTOMATIC RADIO REPORTING RAIN GAGE.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) A simple telemetering device has been constructed for use with a standard recording ra gage. Limited field tests indicate satisfactory performance. Other telemetering unit are also being tested.

(1013) PRESSURE ACTIVATED RIVER GAGE.

(b) Laboratory project.
(d) Field investigation; development.
(e) Although a remote indicating and recording gage has been satisfactorily tested for accuracy in the laboratory, in service tests under field conditions its performance ha not been acceptable because of repeated rupture of the pressure element. Experiments will continue.

(1014) UTILIZATION OF SOIL MOISTURE DATA IN FORECASTING STREAMFLOW.

(b) Laboratory project.
(d) Field investigation.
(e) Standard electrical resistance soil moisture and temperature equipment has been installed in selected areas. After sufficient data has been obtained, statistical tests will be made to determine whether such data can be used to improve forecasts of runoff from rainfall.

(1015) MEASUREMENT OF EVAPORATION.

(b) Laboratory project.
(d) Theoretical and field investigation; applied research.
(e) Studies are directed toward the derivations of reliable procedures for estimating evaporation from reservoirs (existing and proposed) and land surfaces, utilizing readily available meteorological data and pan evaporation observations.

Final report on the Lake Hefner Project was published January 1953 and a similar project is now being conducted at Lake Mead. Both of these projects are cooperative involving the Bureau of Reclamation, Navy, Geological Survey, as well as the Weather Bureau. Additional inter-agency projects are being considered and plans are under way for cooperative evaporation pan studies in the vicinity of Washington, D. C.

DEVELOPMENT OF IMPROVED RIVER FORECASTING METHODS.

The Leland Stanford Jr. University, Stanford, Calif.
Experimental; applied research.
Investigate various methods of modifying the electronic streamflow routing analogue for use in river basins where the Muskingum storage equation does not give satisfactory results. Also, investigate relationship between observed soil moisture data and selected meteorological observations.

DEVELOPMENT OF RIVER FORECASTING METHODS.

River Forecast Centers for Ohio River Basin, Cincinnati; Susquehanna and Delaware River Basins, Harrisburg, Pa.; Lower Missouri River Basin, Kansas City, Mo.; Tennessee River Basin, Knoxville, Tenn.; Columbia River Basin, Portland, Ore.; Middle and Upper Miss. River Basin, St. Louis, Mo.; and Arkansas River Basin, Tulsa, Okla.
Experimental; applied research.
To develop modern river forecast procedures for all ranges of flow for various streams of each basin. Procedures include (1) rainfall-runoff relations involving consideration of the physics of soil moisture, vegetative reception, transpiration, evaporation and geological features of the basins; (2) snow melt forecasting relation involving consideration of the physics of snow and heat transfer; (3) unit hydrographs; (4) streamflow routing procedures; based upon adaptations of basic hydraulic principles.

WATER SUPPLY FORECASTS FOR WESTERN UNITED STATES.

Work conducted in field offices for River Forecast Center, Portland, Ore.; Water Supply Forecast Unit, Salt Lake City, Utah, and River Forecast Center, Kansas City, Mo.
Experimental; applied research.
The purpose of these investigations is the development of precipitation-runoff relations for water supply forecasting utilizing statistical methods to correlate precipitation during the winter with runoff during the melting season. Research directed along the path described in the following paper by M. A. Kohler and R. K. Linsley, Jr., "Recent developments in water supply forecasting from precipitation." Trans. Amer. Geophys. Union, Vol. 30, No. 3, pp. 427-436.
Water supply forecasts are prepared for over 300 points in the Western United States. These forecasts of water year flow are released in Monthly Water Supply Forecast Bulletins January through May. This research program is of a continuing nature designed to improve and extend the present forecasting service.

FLOOD REPORT - MISSOURI AND UPPER MISSISSIPPI RIVER BASINS - APRIL 1952.

Laboratory project.
Compilation and publication of hydrologic data.
It is proposed to present in a special report all hydrologic and meteorolotical data associated with the occurrence of this disaster.
Report to be published in the Technical Paper Series of the Weather Bureau in 1953.

PROBABLE MAXIMUM FLOOD-PRODUCING CONDITIONS FOR THE SNAKE RIVER ABOVE HELLS CANYON DAM SITE.

Bureau of Reclamation.
Applied research.

(e) Involves investigations of the optimum conditions for the probable maximum flood for t Snake River Basin above Hells Canyon Dam Site and four sub-basins, the Big Lost, Brune Payette, and Powder River Basins. These investigations include determination of the probable maximum rainstorm and its seasonal variation, the maximum amount of water st in the basin in the form of snow, and the maximum amounts of heat available during the spring and early summer for melting the snow.
(g) Investigations completed for all but Powder River Basin.
(h) Results to be published as Cooperative Studies Report No. 11, 1953.

(1748) CENTRAL VALLEY PROJECT.

(b) Bureau of Reclamation.
(d) Applied research.
(e) Development of a generalized procedure for quickly estimating the probable maximum pre cipitation over areas from 10 to 1,000 square miles on the west slopes of the Sierra Nevada from the Feather River Basin to the San Joaquin.
(g) Project still in data-collecting stage.

(1749) WEST COAST RAINFALL INTENSITY-FREQUENCY PROJECT.

(b) Corps of Engineers, Department of the Army.
(d) Applied research.
(e) Determination of 1-hour rainfall amounts expected to be equalled or exceeded once in 2 5, and 10 years in Washington, Oregon, and California. Also includes derivation of re lationships between the 1-hour intensities and those for 5, 10, 15, 30, and 120 minute
(g) Project still largely in data-collecting stage.

(1750) CRITICAL METEOROLOGICAL ANALYSIS OF MAJOR STORMS.

(b) Corps of Engineers, Department of the Army.
(d) Basic research.
(e) Detailed hour by hour analysis of all meteorological data available during major rainstorms.
(h) "Rainstorm of Sept. 9-10, 1952." George A. Lott, Monthly Weather Review, Vol. 80, No. 9, Sept. 1952.

(1751) MAXIMUM STATION PRECIPITATION.

(b) Corps of Engineers, Department of the Army, and Bureau of Reclamation.
(d) Analysis of data.
(e) Tabulations of maximum recorded 1, 2, 3, 6, 12, and 24-hour precipitation, for automatic recording rain gage stations, by states.
(g) Project completed for Florida. New England States, Oregon and California in process.
(h) U. S. Weather Bureau, Technical Paper No. 15, Part I: Utah; Part II: Idaho; Part III: Florida.

(1752) SEASONAL VARIATION OF STANDARD PROJECT STORM.

(b) Corps of Engineers, Department of the Army.
(d) Applied research for design.
(e) An attempt to present a seasonal variation of storm rainfall amounts over areas of 200 and 1,000 square miles which will give approximately uniform degree of design safety for all areas east of the 105th meridian.
(h) Hydrometeorological Report No. 29 (in process). Hydrometeorological Section, Division of Hydrologic Services, U. S. Weather Bureau.

(1753) SURVEY OF HURRICANES.

(b) Corps of Engineers, Department of the Army.
(d) Applied research.

Climatological analysis of 50 years of hurricanes affecting United States to establish frequencies of winds and pressures required as engineering design data.
Only one hurricane affecting United States between 1900 and 1949, according to estimates of central pressures, had minimum pressure below 27.00.
"Analysis of winds over Lake Okeechobee during tropical storm of August 26-27, 1949." Hydrometeorological Report No. 26, Hydrometeorological Section, Division of Climatological and Hydrologic Services, U. S. Weather Bureau, Jan. 1951.

DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY.

A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

Cooperative. See Project 194, page 129.

STAGE FALL-DISCHARGE RELATIONS FOR STEADY FLOW IN PRISMATIC CHANNELS.

Laboratory project.
Mr. W. D. Mitchell, U. S. Geological Survey, Champaign, Ill.
Experimental; applied research.
An analytical study of methods of determining discharge under variable slope and steady flow, based on laboratory observations reported in Univ. Illinois, Eng. Exp. Station, Bulletin 381.
Completed.
Report in preparation.

EFFECT OF REFORESTATION ON STREAM FLOW.

Laboratory project.
Mr. A. W. Harrington, U. S. Geological Survey, Albany, N. Y.
Field investigation; basic research.
To study effect on stream flow of growing trees on abandoned farm land. Observations of stream flow, precipitation, ground-water levels, and evaporation at three small reforested drainage basins and adjacent controls were begun in 1935.

SMALL RESERVOIRS IN ARID REGIONS.

Laboratory project.
Mr. H. V. Peterson, U. S. Geological Survey, Salt Lake City, Utah.
Field investigation; applied research.
To determine runoff, evaporation, seepage, and sedimentation in arid regions. Readings are being obtained on staff gages installed on a number of representative stock-watering reservoirs in western states.
Progress reports on file.

DISCHARGE THROUGH MULTIPLE OPENINGS.

Laboratory project.
Prof. C. E. Kindsvater, U. S. Geological Survey, Atlanta, Ga.
Field investigation; applied research.
Crest-stage gages are installed on upstream and downstream sides of all openings of selected bridge and valley crossings, so that study can be made of the drop through each opening and of the transverse water-surface profiles. Current-meter measurements made during the floods will be used to study relationships of discharge through each opening to the total discharge, the drop, and the conveyance.

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(691) COMPUTING PEAK DISCHARGES BY INDIRECT METHODS.

(b) Laboratory project.
(c) Mr. Tate Dalrymple, U. S. Geological Survey, Washington 25, D. C.
(d) Field investigation; applied research.
(e) Establishment of maximum stage gages on slope-reaches or suitable contracted openings computing flood discharges and comparing with measured discharge; to test slope-area method of computing flood discharge and to verify roughness coefficients.

(1219) ELECTRICAL LOGGING INSTRUMENTS FOR GROUND-WATER WELLS.

(b) Cooperative with State of Maryland.
(c) Mr. R. R. Bennett, U. S. Geological Survey, Baltimore, Md.
(d) Development.
(e) Development of geophysical unit for obtaining resistivity curves of electrical log, fluid velocity, conductivity, caliper, and temperature for deep well surveying - all combined in a single unit and mounted in station wagons.

(1220) RELATION OF GROUND WATER TO STREAM FLOW.

(b) Laboratory project.
(c) Mr. S. L. Schoff, U. S. Geological Survey, Washington 25, D. C.
(d) Field investigation.
(e) Network of 23 observation wells in basin of Pond Creek, Okla., begun in March 1948. Water level data are to be correlated with low-water stream flow.

(1221) STEADY STATE ELECTRIC FLOW NET MODELS.

(b) Cooperative with State of Maryland.
(c) Mr. R. R. Bennett, U. S. Geological Survey, Washington 25, D. C.
(d) Experimental.
(e) Preparation of electrical flow net models using coloidal carbon. Boundary conditions simulate those commonly found in nature. Object is to catalogue various types of nets for future reference.

(1222) INFILTRATION AND EVAPO-TRANSPIRATION STUDY.

(b) Cooperative with State of Maryland.
(c) Mr. W. C. Rasmussen, U. S. Geological Survey, Washington 25, D. C.
(d) Field investigation.
(e) Weekly measurement of wells, rain gages, soil moisture, runoff and pond storage in two drainage basins near Salisbury, Md., to measure all factors in hydrologic cycle to determine infiltration, evapo-transpiration and specific yield.

(1223) EVALUATION OF HYDROLOGIC CYCLE.

(b) Cooperative with State of Virginia.
(c) Mr. D. S. Wallace, U. S. Geological Survey, Charlottesville, Va.
(d) Field investigation.
(e) Establishment of gaging station and network of observation wells on headwaters of Hudson Creek, Louisa Co., Va., for correlation of water levels and stream flow.

(1225) STORM WATER INFILTRATION IN GROUND-WATER RECHARGE BASINS.

(b) Cooperative with Nassau County, N. Y.
(c) Mr. A. W. Harrington, U. S. Geological Survey, Mineola, L. I.
(d) Field investigation.
(e) Observations are made of precipitation, evaporation, ground-water levels and storm water inflow into artificial recharge basins, to determine rate of infiltration and amount of storm water available for ground-water recharge when collected in recharge basins, and to evaluate effectiveness of these basins.

) EVAPORATION FROM LAKES.

) Cooperative with Bureau of Reclamation, Navy Electronic Laboratory, Weather Bureau.
) Mr. R. W. Davenport, U. S. Geological Survey, Washington 25, D. C.
d) Field investigation.
) Evaporation by mass transfer and energy budget principles to be tested at Lake Hefner, Okla., in relation to evaporation computed from water budget, to develop techniques for determining evaporation from reservoir using meteorologic and limnologic data.
) Completed.
) Final report published.

7) STOCK-WATER RESERVOIR STUDIES.

b) Cooperative with Bureau of Reclamation.
c) Mr. R. C. Culler, U. S. Geological Survey, Salt Lake City, Utah.
d) Field investigation.
e) Development of techniques for determination of effects of stock-water reservoirs on water supply. Detailed surveys made of number, capacity and performance of reservoirs in the Cheyenne River Basin in Wyoming, will be analyzed to determine evaporation, transpiration, and seepage losses and their effect on flow of Cheyenne River.

9) GLACIER RUNOFF.

b) Laboratory project.
c) Mr. C. S. Heidel, U. S. Geological Survey, Helena, Mont.
d) Field investigation.
e) Study of recession and accretion of Grinnel Glacier, Mont. Glacier mapped annually for some years, storage rain gage and stream gaging station installed in 1949.

0) EFFECT OF LOGGING ON STREAM FLOW.

b) Cities of Tacoma and Seattle.
c) Mr. F. M. Veatch, U. S. Geological Survey, Tacoma, Wash.
d) Field investigation.
e) Operation of seven gaging stations on small streams in areas where logging operations are scheduled in several years. There are control basins where no timber will be cut.

1) CATHODIC PROTECTION OF BURIED PIPE AGAINST CORROSION.

b) Cooperative with State of Pennsylvania and State of Louisiana.
c) Mr. Max Noecker, U. S. Geological Survey, Pittsburgh, Pa., and Mr. R. P. Smith, U. S. Geological Survey, Jonesboro, La.
d) Field investigation.
e) Magnesium anodes are to be installed at several gaging stations where corrosion of pipe wells or intake pipes has required frequent replacement. Anodes and pipes are to be inspected annually to determine rate of loss of magnesium and to observe extent of corrosion.

2) VELOCITY VANE.

b) University of Florida Engineering Experiment Station.
c) Mr. N. D. Bourke, University of Florida, Gainesville, Fla.
d) Laboratory and field investigation.
e) Development of a vane to measure direction and rate of water movement in drainage canals in southern Florida. Field model now under test.

3) MAGNITUDE AND FREQUENCY OF FLOODS.

b) Cooperative with several state agencies.
c) Mr. Tate Dalrymple, U. S. Geological Survey, Washington 25, D. C.
d) Applied research.

(e) Analyses of flood records to determine magnitude and frequency of flood discharge at gaging stations, and at supplementary network of crest-stage gages on small streams, t determine techniques for establishing flood discharges on ungaged streams.

(1235) SEDIMENT CARRIED AS BED LOAD.

(b) Laboratory project.
(c) Mr. P. C. Benedict, U. S. Geological Survey, Lincoln, Neb.
(d) Field investigations; theoretical studies.
(e) Determination of the amount of sediment moving as bed load at three stations, evaluati of the several-bed-load formulas, and basic studies of bed-load movement.

(1483) FLOW THROUGH MULTIPLE BRIDGE OPENINGS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, U. S. Geological Survey, Atlanta, Ga.
(d) Experimental and theoretical; applied research.
(e) To obtain data on flow through multiple bridge openings in a model study; velocity distribution and division of flow.

(1485) EROSION AND DEPOSITION OF SEDIMENT.

(b) Laboratory project.
(c) Mr. P. C. Benedict, Lincoln, Neb.
(d) Field surveys; applied research.
(e) Studies of the effects of climate, soil types, geology, topography, and land use in rates of erosion.

(1486) BACKWATER FROM CHANNEL OBSTRUCTIONS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, U. S. Geological Survey, Atlanta, Ga.
(d) Experimental; applied research.
(e) Model study on backwater from large constrictions of stream channel, to include a wide range of prototype conditions.

(1487) FLOW THROUGH CONTRACTED OPENINGS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, U. S. Geological Survey, Atlanta, Ga.
(d) Experimental; applied research.
(e) To obtain data on model and prototype on flow through contracted openings.

(1488) ROUGHNESS COEFFICIENTS OF SAND BED STREAMS.

(b) Laboratory project.
(c) Mr. C. E. Ellsworth, U. S. Geological Survey, Austin, Texas, and Mr. D. D. Lewis, U. S. Geological Survey, Lincoln, Neb.
(d) Field survey; applied research.
(e) To determine channel coefficients for use in computing peak discharges by indirect methods in sand bed streams, extent of scour and fill.

(1489) MECHANICS OF SALT-WATER INTRUSION.

(b) Laboratory project.
(c) Mr. A. A. Garrett, U. S. Geological Survey, Sacramento, Calif.
(d) Field survey; applied research.
(e) To explore mechanics of salt-water intrusion; the shape of the contact between fresh and salt-water in the aquifer, and the change in shape with change in head of fresh water.

4) EFFECT OF CURRENT DEFLECTOR DEVICES ON FLOW PATTERN CONSTRICTIONS.

b) Cooperative with Georgia State Highway Department.
c) Mr. R. W. Carter, U. S. Geological Survey, Atlanta, Ga.
d) Experimental; applied research.
e) To determine the effect of current deflector devices on the flow pattern under highway bridges and their effect on the coefficient of discharge.

5) CHARACTERISTICS OF SAND CHANNEL STREAMS.

b) Laboratory project.
c) Mr. Tate Dalrymple, U. S. Geological Survey, Washington, D. C.
d) Field investigation; applied research.
e) The research is conducted at a 1,900 foot reach. The following factors are being investigated: variation of value of "n" with stage; accuracy and reliability of high-water marks recovered after a rise; accuracy of slope of water surface determined by present procedures; extent of scour and fill; reliability with which scoured depths can be determined by subsequent prodding; definition of the pattern of scour and fill during floods; shapes of vertical velocity curves; and quantity of suspended sediment in transport.

6) WATER LOSS FROM LAKE MEAD.

b) Cooperative with Bureau of Reclamation.
c) Mr. G. E. Harbeck, U. S. Geological Survey, Denver, Colo.
d) Field investigation.
e) Evaporation from Lake Mead is being determined using mass-transfer and energy budget techniques. The Cummings radiation integrator is being used to determine the areal variability in solar and atmospheric radiation.
f) Studies begun in March 1952, field observations to be ended in October 1953.

7) EVAPOTRANSPIRATION INVESTIGATION.

b) Cooperative with Bureau of Reclamation, Division of Hydrology.
c) Mr. G. E. Harbeck, U. S. Geological Survey, Denver, Colo.
d) Field investigation at site near Bruning, Nebr.
e) Tests are to be made by mass-transfer and energy budget techniques of evapotranspiration from grass land, with comparison with water-budget control.

8) RELATION OF GROUND WATER TO STREAMFLOW.

b) Laboratory project.
d) Field investigation; applied research.
e) Study of hydrologic cycle in small drainage basins, in Massachusetts, Virginia, New Jersey, Connecticut, North Carolina, Louisiana, Oklahoma, New York and Tennessee to determine the relationships between ground-water levels, runoff, evapotranspiration, and the geology.

9) INFILTRATION STUDIES.

b) Laboratory project.
c) Mr. Irwin Remson, Seabrook, N. J.
d) Field investigation; applied research.
e) Study of the movement of percolating waters between the land surface and the water table, and water-budget studies in connection with the waste disposal project at Seabrook Farms.

0) HYDRAULIC CHARACTERISTICS OF A RECHARGE WELL.

b) Laboratory project.
c) Mr. J. E. Upson, U. S. Geological Survey, Mineola, N. Y.
d) Field investigation; applied research.

(e) Investigation of recharging water levels in wells and in nearby streams under varying rates of discharge. Comparison of pumping water levels in same wells at similar discharge rates, and records to be analyzed to determine differences, if any.

(1761) DIRECT MEASUREMENT OF GROUND-WATER RECHARGE.

(b) Laboratory project.
(c) Mr. Wallace de Laguna, Brookhaven National Laboratory, N. Y.
(d) Experimental; field research.
(e) To observe the annual cycle of recharge to the water table and to measure the amount of recharge. A new type of lysimeter has been developed, to maintain ground water in lysimeter at same level as that in surrounding aquifer.

(1762) HYDRAULIC GEOMETRY OF ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Mr. Luna B. Leopold, U. S. Geological Survey, Washington 25, D. C.
(d) Field and basic research.
(e) Relation of discharge, width, depth, velocity, slope, roughness, and suspended sediment load to changes in channel shape at a station and downstream. Data on hydraulic characteristics obtained from discharge measurements made on natural streams by the U. S. Geological Survey. Numerous rivers studied with primary consideration given to several rivers in the western United States for which adequate suspended load data are available.
(f) Completed.
(h) "The hydraulic geometry of stream channels and some physiographic implications." Luna B. Leopold and Thomas Maddock, Geological Survey Professional Paper 252, 1952.

(1763) THE RIVER CHANNEL; BRANDYWINE CREEK, PENNSYLVANIA.

(b) Laboratory project.
(c) Mr. M. G. Wolman, U. S. Geological Survey, Washington 25, D. C.
(d) Field investigation; applied research.
(e) The applicability of previously described principles of hydraulic geometry to a small stream. Intensive study of some hydraulic and geologic variables on a watershed of 31 square miles. Includes measurements of water surface slope and computations of Manning "n". Attempt to relate roughness to coarse bed material.
(h) Report in preparation.

(1764) COMBINED PHYSIOGRAPHIC AND HYDRAULIC STUDIES.

(b) Laboratory project.
(c) Mr. Luna B. Leopold, U. S. Geological Survey, Washington 25, D. C.
(d) Field and office research.
(e) Longitudinal profiles of natural channels, relation to bed material, geologic history, and hydraulic characteristics. Problems in meanders and flood plain construction.

(1765) SONAR INVESTIGATIONS (EQUIPMENT DEVELOPMENT).

(b) Laboratory project.
(c) Dr. A. N. Sayre, U. S. Geological Survey, Washington, D. C.
(d) Development; theoretical laboratory.
(e) To adopt the sonar principle of the fathometer as method of delineating under-water sediments of moderate thickness (several hundred feet) and depth to underlying bedrock. Development work is presently in progress to modify and simplify the procedures of interpretation and use of the sonar technique for geophysical investigations on land.

DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION.

Inquiries concerning Projects Nos. 460, 463, 704, 705, 1022, 1023, 1026, 1028 to 1030, incl., 1236, 1237, 1239 to 1246, incl., 1248, 1252 to 1255, incl., 1257 to 1259, incl., 1261, 1262, 1264, 1266, 1491 to 1496, incl., 1498, 1499, 1501, 1502, and 1766 to 1777, incl., should be addressed to the Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colo.

HEART BUTTE DAM SPILLWAY AND OUTLET WORKS.

Laboratory project. Field tests on prototype.
Experimental; for design and model-prototype conformance tests.
A 1:21.5 model was used to study the critical features of the uncontrolled morning-glory spillway combined with outlet gates and tunnel, particularly the prevention of serious vortices and cavitation erosion in the spillway throat and transition.
Model study completed. Field tests continuing.
Field tests showed good agreement with model.
Reports are being prepared.
"Performance tests on the prototype and model--Heart Butte spillway and outlet works." A. J. Peterka, Summer Convention, A. S. C. E., June 1952. (Available on loan.)

DAVIS DAM SPILLWAY.

Laboratory project.
Experimental; for design.
A 1:72 model was used in the investigation of roller buckets, sloping aprons, and stilling basins to determine the most effective and economical design of the spillway, the possible retrogression of streambed in the future being taken into consideration. The model was used to test diversion scheme for construction purposes. An air model was used to test bellmouth shapes for low-level outlets.
Completed.
Type and proportions of spillway stilling device were determined; rectangular-type stilling basin proved most feasible for the receding tail water which could be expected.
Report in preparation.

CEDAR BLUFF DAM SPILLWAY.

"Hydraulic model studies of the overflow spillway--Cedar Bluff Dam--Missouri River Basin project." E. J. Rusho, Report No. Hyd-330, Jan. 1952. (Available on loan.)

HUNGRY HORSE DAM SPILLWAY.

Laboratory project.
Experimental; for design.
A 1:36 model of a morning-glory-type spillway was tested to develop satisfactory hydraulic characteristics of critical features such as the crest, elbows, tunnels, and stilling basins.
Completed.
The principal problems were in connection with the determination of a satisfactory crest shape and aeration to prevent cavitation erosion. In connection with design of the crest, a basic hydraulic investigation project was set up utilizing a circular, sharp-crested weir to determine the coordinates of the nappe of a morning-glory-type spillway discharge from basic data.
Report in preparation.

KEYHOLE DAM OUTLET WORKS.

Report in preparation.

(1023) FALCON DAM SPILLWAY.

(b) International Boundary and Water Commission.
(d) Experimental; for design.
(e) A 1:130 model of the Falcon Dam on the Rio Grande was tested to determine the hydraul performance of the spillway and the spillway channel leading to the river, together w the effect of small and large floods on the river channel below the dam, and the effe of floods on the powerhouses, both on the United States side and the Mexican side.
(f) Completed and report issued. Additional tests were then made because of necessary de sign changes.
(g) Spur-type walls were added below the stilling basin to prevent erosion; the shape of pier separating the spillway and intake was changed to reduce draw-down, and the trai ing walls were raised to prevent overtopping.
(h) "Hydraulic model studies of Falcon Dam." A. S. Reinhart, Report No. Hyd-276, July 19 (Available on loan.)
Report on additional studies is being prepared.

(1026) SHADEHILL DAM SPILLWAY.

(f) Completed.
(h) "Hydraulic model studies of the service spillway-Shadehill Dam--Missouri River Project." E. J. Rusho, Report No. Hyd-329, January 1952. (Available on loan.)
Report on model-prototype conformance is being prepared.

(1028) HYDRAULIC PERFORMANCE TESTS ON IRRIGATION WATER METERING DEVICES.

(b) Laboratory project.
(d) Experimental; for design and Master's thesis.
(e) Studies of metering devices proposed for use in canal turnouts and in irrigation pipe line distribution systems to determine their hydraulic characteristics for design pur poses. Among those being investigated are four sizes of Armco metergates, two sizes Denver screw lift gates, four sizes of Fresno venturi meters, and three sizes of a modified venturi-type meter used by the Consolidated Irrigation District of Californi
(f) Completed.
(g) Principal points of study are a calibration, the coefficients of discharge, pressure losses, adaptability of the devices for a wide range of application in open channel a well as closed conduit distribution systems.
(h) "Flow characteristics and limitations of Armco metergates." J. B. Summers, Report No Hyd-314. (Report available on loan.)
Separate reports on the Denver screw lift gates, Fresno meters, and the Consolidated Irrigation District meters are being prepared.

(1029) TIETON DAM SPILLWAY.

(f) Completed.
(h) "Hydraulic model studies for the rehabilitation of the Tieton Dam Spillway." D. Colga Report No. Hyd-343. (Available on loan.)

(1030) OCHOCO DAM SPILLWAY.

(f) Completed.
(h) "Hydraulic model studies--Ochoco Dam Spillway--Deschutes Project, Oregon." D. Colgate Report No. Hyd-339. (Available on loan.)

(1236) WILLOW CREEK DAM EMERGENCY SPILLWAY.

(f) Completed.
(h) Report in preparation.

) OLYMPUS DAM SPILLWAY.

) Completed.
) "Hydraulic model studies of Olympus Dam Spillway." G. L. Beichley, Report No. Hyd-278, April, 1952. (Available on loan.)

) CIRCULAR WEIR STUDIES.

) Laboratory project.
) Experimental; basic research and for design.
) A circular, sharp-crested weir was used to determine the under and upper nappe of the jet with varying heads, different velocities of approach, and varying degrees of vacuum under the nappe.
) Temporarily inactive.
) Shapes of upper and under nappe of jet with vacuums from 0 to 40 percent of head and negligible velocity of approach have been determined.
) "Determination of pressure-controlled profiles for morning-glory spillways." W. E. Wagner, Summer Convention A.S.C.E., June 1952.

) SOLDIER CANYON OUTLET WORKS.

) Completed.
) Report in preparation.

) WELLTON-MOHAWK CANAL STRUCTURES.

f) Completed.
) Report in preparation.

2) TIBER DAM SPILLWAY.

f) Completed.
) "Hydraulic model studies of the spillway--Tiber Dam--Missouri River Basin Project." E. J. Rusho, Report No. Hyd-288, March, 1952. (Available on loan.)

3) RECTANGULAR SEMIBELLMOUTH ENTRANCE STUDIES.

f) Completed.
h) Report in preparation.

4) WILLOW CREEK DAM SPILLWAY AND OUTLET WORKS.

f) Completed.
h) Report in preparation.

5) DISCHARGE MEASURING SYSTEM FOR ALVA B. ADAMS TUNNEL.

b) Laboratory project.
d) Experimental; for operation and field tests on completed structure.
e) A 1:10 scale hydraulic model of the tunnel near the entrance portal was built for the purpose of developing a satisfactory discharge measuring system.
f) Field test will continue. Model studies completed.
g) A curved weir was developed and calibrated. It provided an accurate means of measuring the discharge and had a low energy loss at the maximum discharge. Flow conditions immediately downstream of the gates were greatly improved. Field tests showed measuring device to be accurate and satisfactory.
h) Report in preparation.

6) CACHUMA DAM SPILLWAY.

f) Completed.
h) Report in preparation.

(1248) HIGH-VELOCITY TURNOUTS.

(b) Laboratory project.
(d) Experimental; for design.
(e) To verify, by laboratory tests, the formulae used in a general design procedure for vertical stilling-wells, both square and circular in section.
(f) Suspended.

(1252) CAVITATION-FREE OPERATION OF REGULATING GATES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A general study to (1) develop design criteria for cavitation-free operation of regulating gates in closed conduit irrigation distribution systems, and (2) to determine the number of pipe diameters of rubber-lined steel pipe required to protect a concrete pi irrigation line from cavitation pitting from a partially opened leaf-type valve.
(g) A method of computing the required back pressure to prevent cavitation was obtained by use of parameters which were affected by a flow pattern change due to cavitation and which indicated system efficiency.
(h) Report in preparation.

(1253) TRENTON DAM SPILLWAY.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:54 scale model was used in investigating the over-all hydraulic characteristics of the spillway. These characteristics included entrance to overflow section, spillway chute, stilling basin, and erosion downstream of the basin.
(f) Testing completed.
(g) Principal development to present is an end pier extension upstream. Its use is to minimize the troublesome flow contraction which causes an unequal flow distribution per fo width through the overflow section. This end pier extension reaches farther upstream the top than at the bottom, the leading edge being undercut toward the spillway crest.
(h) "Hydraulic model studies of the Trenton Dam Spillway." J. C. Schuster, Report No. Hyd 301.

(1254) VIBRATION--KEECHELUS DAM OUTLET WORKS TOWER.

(b) Laboratory project.
(d) Experimental; for field operation.
(e) A 1:15 scale model was used to investigate a serious vibration of the field structure reported by operating personnel. The results are to be used in rehabilitating the existing tower.
(f) Completed.
(g) Three possible causes of this vibration have been determined; vibration of the cylinder gates controlling flow from the tower, negative pressures occurring at entrance to the discharge conduit, and extreme turbulence within the outlet works tower. The latter is believed to be the principal cause of the reported vibration and the investigation is proceeding toward reducing this turbulence.
(h) Report in preparation.

(1255) PALISADES DAM RECTANGULAR REGULATING GATES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:19 model was used to develop a rectangular, downstream seal, regulating slide gate suitable for use at heads up to 240 feet and capable of discharging a smooth, even stream into closed or open conduit or on a spillway. Particular attention was directed to the gate slots using a 1:2 scale sectional model. The tests were extended to study the effect of an emergency gate of identical design placed immediately upstream from the regulating gate. Other tests will be made to determine the operating characteristi of the gate when discharging under water.

g) A practical gate was developed which discharged the desired smooth stream at a discharge coefficient of 0.95 when full open. A slot design was obtained which, when the gate discharges into the atmosphere at a 240 head, produces pressures no lower than minus 1 foot of water. The emergency gate operated satisfactorily when used for the control except at gate settings of 97 to 100 percent open where air must be admitted to relieve low pressures.
h) Report in preparation.

(7) SURGING-IRRIGATION WATER DISTRIBUTION SYSTEM.

b) Laboratory project.
d) Field investigation; for operation.
e) To determine the cause and remedy of water surface surging in open stands to be specifically applied to the Coachella Distribution System, California.
f) Completed.
g) Air carried into the system where the water falls from a weir into the downstream side of a pipe stand is a primary cause of the surging. Airtight lids for the stands, vented to limit negative pressures within the stand, stop or greatly reduce the surging. Pipe line vents, regulating gates, and circular weirs were much less effective than the lids. The height of water fall greatly affects the quantity of air entrained. A fall of only 1.5 feet carried air to 7 feet deep into the pool. The pool depths required to permit air separation were impractical. Numerous baffles, deflectors, and gratings were unsuccessful in attempts to break up the plunging flow so that air would not be carried too deep into the pool.
h) "Hydraulic and analytical studies of the causes and the control of surging in the Coachella Irrigation Distribution System." W. P. Simmons, Jr., R. E. Glover, and K. L. Fienup, Report No. Hyd-324. (Report available on loan.)

(8) PALISADES DAM DIVERSION SCHEME--OUTLET WORKS AND SPILLWAY.

b) Laboratory project.
d) Experimental; for design.
e) To develop a stilling basin suitable for the diversion scheme, a spillway design, and to study the over-all flow characteristics of the combined units of powerhouse, outlet works, and spillway.
g) Testing of the diversion scheme and the stilling basin has been completed. Development of the spillway is in progress. Diversion scheme will use the outlet works and power tunnel in free discharge onto a concrete apron which is utilized later for the outlet works. A stilling basin incorporating two 96-inch hollow-jet valves and six 9-foot by 7.5-foot slide gates was developed for controlling outlet works discharge.
h) "Hydraulic model study of the penstock and outlet diversion." J. C. Schuster, Interim Report No. Hyd-345.
Report covering entire model study being prepared.

(9) FLATIRON STILLING BASIN--POWER AND PUMPING PLANT--COLORADO-BIG THOMPSON PROJECT.

b) Laboratory project.
d) Experimental; for design.
e) To develop a stilling basin for the pump turbine bypass valve in the Flatiron Powerhouse.
f) Completed.
g) A unique stilling basin was developed for the limited space available. It included three concrete baffles, triangular in plan, a concrete cover surmounting and extending beyond the baffles, and a water passage beneath the baffles to relieve low pressures in the basin. This basin will adequately dissipate the energy from a submerged jet (500 cfs at 260-foot head) of a 42-inch tube valve to give a smooth water surface.
h) "Hydraulic model studies of the stilling basin for the pump-turbine bypass valve discharge at Flatiron Power and Pumping Plant." L. R. Thompson and W. C. Case, Report No. Hyd-328, April 30, 1952. (Available on loan.)

(1261) REPUBLIC DIVERSION DAM, HEADWORKS AND SLUICEWAY STRUCTURES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests on a 1:15 model of headworks and sluiceway structures were used to improve sediment-excluding characteristics. This is a continuation of the work begun under Superi Courtland Diversion Dam studies.
(f) Completed.
(g) Guide walls were found less effective than on previous studies due to lower discharges and velocities. A headworks incorporating vortex tube desanding apparatus was tested.
(h) Report in preparation.

(1262) SHEEP CREEK DIVERSION SEDIMENTATION BASIN.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests on a 1:9 model of a sedimentation basin are being conducted to determine the modifications required to improve the efficiency of the basin. Tests will also be made on prototype structure to determine additional data on model-prototype relationships for movable bed models.
(f) Suspended.

(1264) VORTEX TUBE.

(b) Laboratory project.
(d) Experimental; for design.
(e) A program of general testing is being made to obtain additional information for design criteria for a vortex tube desanding apparatus. A horizontal vane with a gradually expanding cross section is used to increase the velocity over the vortex tube in order to obtain better action in canals having low water velocities.
(f) Suspended.

(1266) DEVELOPMENT OF THE SALT VELOCITY METHOD OF WATER MEASUREMENT.

(b) Laboratory project.
(d) Experimental; development.
(e) Proposed developments include an electrically controlled volumetric injection apparatus for field test use, electrodes that are practical for field tests which will produce results of the desired accuracy, and a correlation between the original electrical conductivity of the water and the quantity and density of brine needed to produce the required increase in conductivity for detection by a low potential circuit (from 3 to 15 volts) containing a balanced bridge. A study of brine cloud behavior for varying brine density and varying Reynold's number will be made to aid in electrode design.

(1491) POLE HILL SIPHON STUDIES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A siphon was tested in the laboratory to develop an air inlet device which would permit the siphon to operate fully primed at less than full capacity.
(f) First stage of testing completed.
(g) An air intake device was developed which allowed the siphon to discharge as little as 1 cfs and as much as 7 cfs (the maximum discharge) and still remain primed. This was accomplished with relatively small variations in head.
(h) "A study of a discharge regulator for the Pole Hill Siphon--Colorado-Big Thompson Project." T. J. Rhone, Report No. Hyd-335, May 12, 1952. (Available on loan.)

(1492) SPILLWAY CREST AND BUCKET STUDIES.

(b) Laboratory project.
(d) Experimental and analytical.

e) Tests are being made on model spillways of various size to determine the scale effects of negative pressure crests, the effect of more than the design head on a spillway crest, and to establish general design procedures for obtaining a satisfactory roller-type bucket without the need for model tests.
g) Certain limiting bucket dimensions have been definitely established.

(3) HYDRAULIC JUMP TESTS.

b) Laboratory project.
d) Experimental and analytical.
e) Tests are being made on relatively large jumps, measuring velocities, and pressures in the jump along with profiles and other pertinent data, to determine basic characteristics of a jump, particularly as an energy dissipator.

(4) GLEN ANNE SPILLWAY.

f) Completed.
h) Report in preparation.

(5) YELLOWTAIL DAM SPILLWAY AND OUTLET WORKS.

b) Laboratory project.
d) Experimental; for design.
e) A 1:54 scale model of all discharge facilities and surrounding area was used to determine feasibility of entire lay-out, develop a low-cost tunnel spillway and energy-dissipating device, check the proposed powerhouse outlet works lay-out, and determine all inter-related discharge effects in river. A 1:28 scale model of the outlet works was used to develop a low-cost efficient stilling basin.
f) Completed.
g) Feasibility has been determined. Tunnel size was reduced, combination stilling basin and ski-jump bucket was developed, approach to spillway improved, outlet works and powerhouse lay-out improved, and an economical but efficient stilling basin developed.
h) Report in preparation.

(6) HYDRAULIC LABORATORY PROCEDURES.

b) Laboratory project.
d) Record of experience; applied research.
e) A manual for instruction purposes in theory and procedure for Hydraulic Laboratory personnel.
g) Bureau monograph is being prepared.

(8) WEIR STANDS--IRRIGATION WATER DISTRIBUTION SYSTEM.

b) Laboratory project.
d) Experimental; for design.
e) 1:2 models and a prototype size weir stand were built to determine the operating characteristics, weir calibration, and head losses--to be specifically applied to the Exeter and Saucelito Distribution System, California.
f) Completed.
g) Close agreement was obtained between the 1:2 model and the prototype structure. Tests have shown that the weir stand is a satisfactory measuring device when used in pipe line systems where there is no surging of the discharge. All sizes and shapes of weirs tested were accurate when the head was greater than 0.2 foot. The vertical approach of the water had very little effect on the shape of the jet or the profile of the water surface.
h) Report in preparation.

(1499) CANAL TURNOUT--METER LOCATION.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:2-1/2 model was used to determine how close an impeller-type irrigation meter can be installed in a 30-inch turnout downstream from a pipe elbow near the canal for acceptable meter accuracy.
(f) Completed.
(g) The meter can be installed within 7 pipe diameters of the pipe elbow. Laboratory results showed 9-percent higher meter accuracy in a turnout with 40 pipe diameters of straight pipe upstream from the meter than in a turnout with 7 pipe diameters. This difference in meter accuracy is because the velocity profile is different for a long and short turnout which is attributed to the pipe boundary effect. Field tests using 30-inch concrete pipe on a long and short turnout also showed a meter accuracy differance.
(h) Report in preparation.

(1501) STABLE CHANNEL STUDIES--SCOUR ON CURVES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A program of general testing is being made to obtain information which will correlate extent of scour with degree of curvature in canals.
(g) Design of equipment started.

(1502) STABLE CHANNEL STUDIES--TRACTIVE FORCES REQUIRED TO MOVE MATERIALS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A program of general testing is being made to determine critical tractive forces required to move given sizes of materials when they are found in normal mixtures. These tests are to be performed in conjunction with tests to determine extent of scour on curves in canals.
(g) Model is being constructed.

(1766) HYDRAULIC AND SOIL TESTS ON PROPOSED CANAL LINING MATERIAL FOR MADERA DISTRIBUTION SYSTEMS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A model study of the action of a proposed earth lining material, under the action of flowing water, was made. Various velocities were used in the testing program. To study the possibilities of creating a more stable channel, several types of sand-gravel blankets were tested.
(g) The material was found suitable for canal embankment but unsuitable for canal lining. The use of a sand-gravel blanket over the soil increased the stability of the section.
(h) Report in preparation.

(1767) MILBURN DIVERSION DAM, HEADWORKS AND SLUICEWAY STRUCTURES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests on a 1:16 scale model of the headworks and spillway structures are to be made to determine and improve the sediment-excluding characteristics of the structure.

(1768) BARTLEY DIVERSION DAM, HEADWORKS AND SLUICEWAY STRUCTURES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests on a 1:7 scale model of the headwork and sluiceway structures were made to improv the sediment-excluding characteristics of the sluiceway.

) Guided flow immediately upstream from the headworks and sluiceway obtained by installing curved parallel guide walls proved most effective for reducing bed-load sediment passing the headworks.
) Report in preparation.

) WEIR TURNOUT.

) Laboratory project.
) Experimental; for design.
) To develop a weir turnout, with emphasis on minimum structure dimensions, that will give a smooth head-on-weir water surface when the turnout is discharging (1) 5 cfs at 6-foot head and (2) 2 cfs at 1-foot head.

) AFTERBAY STILLING BASINS FOR TURBINE BYPASS FLOWS--POLE HILL FLATIRON POWER PLANTS.

) Laboratory project.
) Experimental; for design.
) A 1:9 and 1:8.8 scale model was used to develop a suitable afterbay stilling basin design to receive and distribute the turbulent discharge from the turbine bypass energy absorbers in order to prevent erosion damage to the afterbay channels.
) Completed.
) A stilling basin was developed that consisted of a short channel with an upward sloping floor at the downstream end and contained two large transverse baffles.
) "Hydraulic model studies of the stilling basins for the energy absorber discharges at Pole Hill and Flatiron Power Plants--Colorado-Big Thompson Project." W. P. Simmons, Jr. Report No. Hyd-353. (Available on loan.)

) TURNOUT AND METERING STRUCTURE--SAN DIEGO AQUEDUCT.

) Laboratory project.
) Experimental; for design.
) Studies were made of the flow distribution, the operating characteristics, and the losses incurred in the proposed turnout and metering structure to be added to the aqueduct when the second barrel is added.
) The flow distribution and operating characteristics were satisfactory. Minor changes were required to reduce the head losses to the required low values.
) Report in preparation.

) FLOAT-OPERATED REGULATING VALVES.

) Laboratory project.
) Experimental; for design.
) Tests are being made to determine the operating characteristics at relatively high heads of several standard commercial valve designs.

) WEBSTER DAM SPILLWAY.

) Laboratory project.
) Experimental; for design.
) A 1:54 model will be used to investigate the hydraulic performance of the spillway structure including: checking the entrance flow conditions; calibrating the free crest and crest with partial gate openings; checking the spreading characteristics of flows through the long chute; checking the stilling basin for elevation, length, etc.; and checking water surface profiles along training walls.

) KIRWIN DAM SPILLWAY AND STILLING BASIN.

) Laboratory project.
) Experimental; for design.
) A 1:48 model used to test the approach conditions, coefficient of discharge, flow distribution on concrete apron and the efficiency of the stilling basin.

(g) Approach conditions improved. Training walls realigned to secure better flow distrib tion in the stilling basin. Spur-type wing walls were added below the stilling basin to prevent erosion.

(1775) HIGH-HEAD TURNOUT WITH REGULATING VALVE AND IMPELLER-TYPE FLOW METER.

(b) Laboratory project.
(d) Experimental; for design.
(e) To develop an energy dissipator downstream from the regulating valve that will create a uniform flow distribution at the outlet of a vertical pipe with a propeller-type fl meter.

(1776) ADAMINABY TUNNEL JUNCTION SHAFT AND CYLINDER GATE.

(b) Snowy Mountains Hydroelectric Authority, Australia.
(d) Experimental; for design.
(e) Hydraulic model studies are being made of an 18-foot-diameter vertical shaft approximately 300 feet deep which supplies excess water from a river to a 14 mile long, 21-foot diameter tunnel connecting a storage and power reservoir. Water from the river flowing through the vertical shaft is controlled by a proposed 21-foot-diameter cylin gate at the junction of the shaft and tunnel. Two models are used (1) a 1:21.6 model of the inlet and a section of the vertical shaft and (2) a 1:18 model of the cylinder gate.
(g) Controlling the shaft pressure with the cylinder gate will prevent air entrainment.

(1777) SIPHON SPILLWAY STUDIES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A program of model-prototype testing of siphon spillways is being made to evaluate various entrance and exit conditions, effectiveness of regulating air supply on primir the influence of crest radii on priming qualities, adjustable crests, pressure and velocity distributions, and the failure of some prototype installations to operate in the manner for which they were designed.
(g) Model is being constructed.

U. S. DEPARTMENT OF THE NAVY, DAVID TAYLOR MODEL BASIN.

Inquiries concerning Projects Nos. 467, 470, 709, 710, 711, 1268, 1503, 1505 to 1507, incl., 1510 to 1512, incl., 1514, 1516, 1517, 1521, 1522, and 1778 to 1791, incl., should be addressed to The Commanding Officer and Director, David Taylor Model Basin, Washington 7, D. C.

(467) TURBULENCE MEASUREMENTS WITH HOT WIRES.

(b) Cooperative with Bureau of Ships.
(d) Basic research.
(e) Development of hot-wire technique for measuring turbulent velocity components in water This includes a review of the theory and application of hot-wire anemometry, investigations of the applicability of electrical circuits to the measurement of velocity fluctuations in water, measurement of turbulence parameters under different flow conditior and the correlation of these parameters with noise production.
(g) A dynamic calibration technique has been developed whereby surface film and dirt on th wire do not affect turbulence measurements although they do affect the sensitivity. This technique will permit the use of the hot-wire for quantitative measurements of fr stream turbulence. Since the calibration depends on vibrating the wire it cannot read be used directly near a wall or in a confined space.

) "Research on the development and propagation of hydrodynamic noise, progress report on the development of hot-wire method for velocity measurement in water." M. S. Macovsky, TMB Report 592, Oct. 1947.
"The measurement of turbulence in water." M. S. Macovsky, TMB Report 670, progress report prepared for presentation at the 75th Ballistics Conference, Oct. 1948.

) ELECTROLYTIC TANK STUDIES.

) Cooperative with Bureau of Ordnance.
) Basic research.
) Investigations using the method of electrical analogy to obtain pressure measurements on and about various bodies in a fluid.
) An electrolytic tank has been developed for obtaining the pressure distribution about cylindrical bodies. A single probe method is used to obtain potential differences on the body and a double probe method is used for obtaining the potential differences in the surrounding field. Refinement of instrumentation and techniques has made possible the determination of pressure coefficients at a body surface with an accuracy of better than 0.4 percent of the stagnation pressure. Plans are underway for adapting the present tank to other problems in potential flow.

) THEORY OF WAVE RESISTANCE.

) Cooperative with Bureau of Ships.
) Basic research.
) A mathematical study of the theory of wave resistance for the purpose of establishing methods for extending the theory to the analysis of ship resistance. Studies will include the general theory of waves in liquids and will encompass a review of existing theory and comparisons with existing experimental data.
g) A synopsis has been written on the application of theory to the calculations of wave resistance. Calculations were made to obtain general information about wave resistance of submerged bodies of revolution. The forms considered are ellipsoids, Rankine ovoids, and a simple family of streamlined bodies. A report is to be published.
h) "The wave resistance of bodies of revolution." G. P. Weinblum, TMB Report 758, May 1951. Report to be published.

) RESEARCH ON MAIN INJECTION SCOOPS AND OVERBOARD DISCHARGES.

b) Cooperative with Bureau of Ships.
d) Applied research; for design.
e) Investigations to determine the characteristics of a broad series of injection scoops and discharges to provide design data for use in design of future high-speed ships.
g) An analysis has been made to determine the important parameters and develop a means of mathematically describing the geometry of several series of injection scoops. A contract has been awarded to the Newport News Shipbuilding and Drydock Company for the conduct of an extensive experimental study to determine the effect of changes in scoop geometry on efficiency. Three different families of scoop shapes are to be tested.
h) "Comments and calculations on the problem of the condenser scoop." W. Spannhake, TMB Report No. 790, Oct. 1951.
"Research on main injection scoops and overboard discharge." J. P. Breslin and Wm. M. Ellsworth, TMB Report 793, Sept. 1951.
"Testing main injection scoops and overboard discharges in restricted channels." Avis Borden, TMB Report 801, Jan. 1952.

1) CAVITATION RESEARCH.

b) Cooperative with Bureau of Ships.
d) Basic research.
e) Research on the mechanism and effects of cavitation phenomena including the physics and analytical description of steady-state cavities in real and ideal fluids and investigations of the inception of cavitation, the growth and collapse processes of transient cavities, and the effects of cavitation on the forces on underwater bodies.

(g) A linearized theory has been developed for steady, two-dimensional cavity flows about slender bodies. The problem of calculating cavity shape and drag for arbitrary slender bodies has been reduced to one of quadratures.
(h) "Water tunnel surveys of steady-state cavitation." P. Eisenberg and H. L. Pond, TMB Report No. 668, Oct. 1948.
"Determination of critical pressures for the inception of cavitation - fresh and sea water as influenced by air entrainment." S. F. Crump, TMB Report 575, Oct. 1949.
"Effect of small errors in body shape and angle on pressure distribution and cavitation limits." P. Eisenberg, TMB Report 792, Oct. 1951.
"Steady, two-dimensional cavity flows about slender bodies." M. P. Tulin, TMB Report 834, to be published.

(1268) STUDIES OF THE INTERACTION OF APPENDAGES AND BODIES.

(b) Cooperative with Bureau of Ships.
(d) Hydrodynamics of submerged bodies.
(e) An investigation of potential flow and boundary layer phenomena associated with appenda body combinations in order to determine the nature of interference effects. The genera tion of lift and moments by fins in non-uniform flows is also to be studied. Theoretic investigations may suggest and be supplemented by appropriate experimental investigatio
(g) A preliminary theoretical investigation has been made.

(1503) BOUNDARY LAYER TRANSITION STUDY.

(b) Cooperative with Bureau of Ships.
(d) Basic research.
(e) A study of methods for stimulating predictable turbulent boundary layers to improve the reliability of model tests for resistance prediction. Tests are to be made with flat plates, ship models and bodies of revolution and will include investigations of the effects of size and arrangement of stimulators and the effect of pressure gradient.
(g) Theoretical studies have directed attention toward internal roughness stimulators. Design criteria are being developed by means of qualitative boundary layer measurements on flat plates using pin type stimulators.
(h) Discussions of turbulence stimulators, P. Eisenberg and M. P. Tulin, Proc. 1951 Fall Meeting, S.N.A.M.E., Washington, D. C.

(1505) EFFECT OF TRANSVERSE CURVATURE ON FRICTIONAL RESISTANCE.

(b) Cooperative with Bureau of Ships.
(d) Basic research.
(e) The effect of transverse curvature of the frictional resistance to motion of a body through a liquid is to be determined. Shear stress measurements and velocity profiles will be obtained at 10-foot intervals along a 150-foot length of towed cylinders. Results will be extended to determine flat plate resistance without surface and edge effects normally present.
(g) A theoretical analysis of the laminar flow case for slender cylinders has been made to determine significant parameters and the expected magnitude of the curvature effect. Equipment for the experimental phase has been designed and is under construction.
(h) "Effect of transverse curvature on frictional resistance." L. Landweber, TMB Report 689 March, 1949.
"The laminar flow about very sldnder cylinders in axial motion, including the effect of pressure gradients and unsteady motions." R. D. Cooper and M. P. Tulin, TMB Report 838, to be published.

(1506) STIMULATION OF TURBULENCE ON SHIP MODELS.

(b) Cooperative with Bureau of Ships.
(d) Basic research.

Development of a suitable technique for stimulating a turbulent boundary layer over the entire length of any ship model. Empirical studies will be conducted to evaluate the relative effectiveness of turbulence rods, trip wires, sand roughness and isolated studs. Their relative effectiveness will be judged by studying the model resistance curve and the character of the boundary layer flow as determined by dye-method, chemicals, and hot wire survey of the model wetted surface.

The work of the previous year was devoted to the study of the stimulating effect of studs. The evaluation of studs is still continuing. A report is under preparation which covers turbulence stimulation tests on BSRA Model and an evaluation of the effectiveness of the various stimulators.

"Turbulence stimulation in model tests." P. Eisenberg, Sixth International Conference of Ship Tank Superintendents, Sept. 1951.

SERIES 57 - RESISTANCE OF VARIOUS RELATED HULL FORMS.

Cooperative with Bureau of Ships and Maritime Commission.

Experimental testing.

The dependence of resistance upon the coefficients of hull forms for a practical range of single-screw ship forms is to be determined.

A method for generating a systematic series of forms has been accomplished. Further research into the basic parent form has been instituted in order to obtain near optimum parents. As a result of this development, series contours are being refaired and resistance measurements are being obtained for the initial program of 20 models as outlined in (h) below.

"A proposed new basis for the design of single-screw merchant ship forms and standard series lines." Dr. F. H. Todd and Captain F. X. Forrest, USN, Society of Naval Architects and Marine Engineers paper, 16 Nov. 1951.

GENERAL SEAWORTHINESS.

Cooperative with Bureau of Ships.

Experimental testing.

Studies to provide information leading to the design of more seakindly ships to meet operational requirements in rough seas. This includes tests to determine optimum shape of hull and erections for maximum speed in a seaway, the applicability of model seaworthiness tests to the prediction of full-scale performance, and the wave damping of basic ship forms. Theoretical studies will include a determination of the effect of pitch and heave on ahead motion, the interference effects between ocean waves and the ships own wave train, and other influences which tend to reduce ship speed.

SERIES SEAWORTHINESS.

Cooperative with Office of Naval Research.

Experimental testing.

Investigations to determine the effect of various hull form parameters on reduction of speed, ship motions, and dryness of decks for ships operating in waves. A standard series 57 model with block coefficient 0.60 is to be the parent model for the series of hull forms. Studies will include the effect of (1) bow sections, - U, V, and bulb; (2) bow flare; (3) free board; (4) plumb stern; (5) raked stern; (6) stern sections, - U, V, raised counter. Tests will be made in the 140-foot model basin using 5-foot models at several speed and wave conditions.

EFFECTIVENESS OF BILGE KEELS.

Cooperative with Bureau of Ships.

Experimental testing.

Measurements of the amplitudes of roll versus rolling moment and frequency at or near resonance for a ship model with and without bilge keels; the increase in resistance of a model due to rolling and roll-induced yawing; and the lift, drag, and torque developed by fins. Data will be used in arriving at criteria for the design of fin stabilizers.

(g) Roll tests have been made in the basin on a ship model with and without bilge keels. Also, wind tunnel measurements have been made to determine the effect of variation in fin stabilizers on lift, drag, and torque characteristics.

(1514) SINGLE-SCREW VESSEL MANEUVERING CHARACTERISTICS.

(b) Cooperative with Bureau of Ships.
(d) Experimental testing.
(e) Measurements of side forces on propeller, rudder, and hull of a single-screw ship mode during successive phases of starting, stopping, and backing maneuvers.
(g) A test program has been formulated.

(1516) STUDIES OF RESISTANCE PREDICTION METHODS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical research.
(e) The theoretical possibility of separating the viscous and wave drag for surface flows by means of wake surveys, has been demonstrated. Experiments are to be performaned on ship models to verify the practical possibility of using this method to improve resistance predictions.
(g) Instrumentation for the wake survey, including pitot rakes and traversing mechanisms with associate manometric system, is under construction.

(1517) MINIATURE MODEL BASIN.

(b) Cooperative with Bureau of Ships.
(d) Facility - theoretical investigations.
(e) To obtain data on the drag, side force, and vortex configurations of vibrating cylinde a special model basin facility was required. This consists of a miniature model basin with small towing carriage whereby cylinders may be towed over a range of speeds while oscillating with controllable amplitude and frequency. Measurements of the attendant forces are made by means of strain gage apparatus and vortex configurations may be studied by means of special photographic techniques.
(g) The miniature model basin and associate equipment has been constructed and preliminary tests have been made on a 1-inch diameter circular cylinder.

(1521) 36-INCH VARIABLE PRESSURE WATER TUNNEL.

(b) Cooperative with Bureau of Ships.
(d) New Facility.
(e) Design and construction of a 36-inch variable pressure water-tunnel for investigation of propulsion, cavitation, and noise characteristics of propellers as well as tests on sub surface bodies. Interchangeable test sections of open and closed jet type will be provided. The maximum design speed is 85 fps.
(g) Design studies are being made and construction is expected to start in 1953.

(1522) WAVEMAKER STUDIES.

(b) Cooperative with Bureau of Ships.
(d) Research and facility development.
(e) Theoretical and experimental studies of surface wave generators to develop criteria for the design and construction of a large-scale wavemaker installation. A program of research on wave absorbers is also underway. Prerequisite to this latter investigation i the development of practical means for evaluating the effectiveness of a given absorber
(g) A small pilot model of a pneumatic wavemaker has been developed and successfully operat for several months. Improvement has been made in the means of controlling amplitude an frequency of generated waves. A much larger pneumatic wavemaker has been constructed for installation in the 140-foot model basin. A method of making measurements and dete mining wave absorbtion characteristics therefrom has been developed analytically. The accuracy with which wave height can be determined has been improved by the development of an electronic wave-height recorder which operates on a change of capacitance princip

HYDRODYNAMIC NOISE.

Cooperative with Bureau of Ships.
Basic research.
Investigations of the characteristics of underwater noise associated with various hydrodynamic phenomena such as cavitation, bubble oscillation, turbulence, and splashing. Measurements of the noise radiated by a turbulent jet have been made and compared to existing theory. Preliminary studies have been made of noise produced by cavitation, splashing, and oscillating air bubbles.
"Measurements of noise radiated by sub-sonic air jets." H. Fitzpatrick and R. Lee, TMB Report 828, to be published.

THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS.

Cooperative with Bureau of Ships.
Theoretical.
A theoretical and experimental investigation of the velocity profiles and surface shearing stresses in three-dimensional turbulent boundary layers. The axisymmetric case will firwt be considered and then extension made to actual ship forms. Surface shearing stresses are to be measured by the heat transfer techniques described in N.A.C.A., TM 1284 and 1285.
"A method for calculating the turbulent boundary layer in a pressure gradient." P. S. Granville, TMB Report 752, May 1951.

BUBBLE FLOW STUDIES.

Cooperative with Bureau of Ships.
Experimental and theoretical.
Studies of bubble drag and virtual mass, and the kinematic behavior of bubbles as a function of size, pressure gradient, density, viscosity and surface tension of the media. Experiments were made to determine the shape and drag of individual air bubbles rising freely in various liquids. Theoretical analyses are being made to determine the effect of varying pressure gradients on the motion of bubbles in a fluid.
"The drag and shape of air bubbles moving in liquids." B. Rosenberg, TMB Report 727, Sept. 1950.
"An experimental investigation of the drag and shape of air bubbles rising in various liquids." W. L. Haberman and Rose K. Morton, TMB Report 802. (To be published.)

ROTATING-ARM AND MANEUVERING BASIN.

Cooperative with Bureau of Ships.
New facility.
Design and construction of a circular basin of 260-foot diameter with a rotating arm whose radius can be varied from 18 to 120 feet. To be used for towing tests of surface and sub-surface models. Also, design and construction of a maneuvering basin 350 feet long and 230 feet wide, equipped with traveling bridge and towing carriages, and wavemakers for the purpose of making maneuvering tests on ship models.
Functional specifications for the facility have been prepared.

SHIP MOTIONS.

Cooperative with Bureau of Ships.
Basic research.
Determination of ship motions in a regular seaway when coupling exists between heave and pitch. The work is to be based on the linear theory and is a continuation of work on uncoupled motion. It is intended to extend the applicability of the linear theory to a larger number of vessels of various type.
"On the motions of ships at sea." G. Weinblum and M. St. Denis, Trans. of S.N.A.M.E., 1950.
"On sustained sea speed." M. St. Denis, Trans. of S.N.A.M.E., 1951.

(1783) MATHEMATICAL SHIP LINES.

(b) Cooperative with Bureau of Ships.
(d) Theoretical research.
(e) Development of a suitable method for the mathematical determination of ship lines whi can be applied to a wide variety of ship forms especially to those of modern design.
(g) A preliminary study has been made which indicates that a solution should be sought through mathematical fairing by waterlines (Benson) instead of by sections (Taylor).

(1784) RESEARCH ON UNSTEADY FLOW PROBLEMS - UNSTEADY EFFECTS OF STABILITY DERIVATIVES.

(b) Cooperative with Bureau of Ships.
(d) Theoretical and experimental.
(e) Studies of the effect of oscillation frequency and amplitude, speed of advance, and geometry on the stability derivatives of an oscillating body in a fluid.
(g) The effect of the various parameters has been studied with a spheroid of 7 to 1 finen ratio. It was shown that unsteady effects may be of importance especially when combi with non-linearity.

(1785) RESEARCH ON UNSTEADY FLOW PROBLEMS - GENERAL THEORY.

(b) Cooperative with Bureau of Ships.
(d) Theoretical research.
(e) A generalized theoretical study of the field of time-dependent hydrodynamic phenomena including accelerationless flows with unit unsteadiness.
(g) Flows with d'Alembert type unsteadiness, unsteady jet problems, decay of vorticity, ar d'Alembert flows have been studied. It was shown the dimensionless parameter which describes the unsteadiness of general fluid motion reduces to the conventional Strouha number (or dimensionless frequency ratio) for oscillatory flows under certain conditic
(h) "Generalization of the dimensionless frequency parameter in unsteady flows." V. G. Szebehely, TMB Report 833. (To be published.)
"Measures of unsteadiness." V. G. Szebehely, presented before the Virginia Academy of Science. Abstracted in the Virginia Journal of Science, May 1952.

(1786) RESEARCH ON UNSTEADY FLOW PROBLEMS - SLAMMING.

(b) Cooperative with Bureau of Ships.
(d) Theoretical research.
(e) Computations and measurements of the maximum pressure distribution and impact forces c the bottoms of slamming ships for the purpose of developing design criteria to effect their reduction.
(g) Studies were made to determine hydrodynamic impact forces on bodies of simple shape. An extension will be made to include bodies whose shape more closely approximates that of actual ship forms.
(h) "Preliminary experimental investigation of slamming." V. G. Szebehely and S. H. Brook TMB Report 812, July 1952.
"Hydrodynamics of slamming ships." V. G. Szebehely, TMB Report 823, July 1952.
"Hydrodynamic approach to the slamming of ships." V. G. Szebehely, presented at the Second Midwestern Conference on Fluid Mechanics, 1952.

(1787) LOW TURBULENCE WIND TUNNEL.

(b) Cooperative with Bureau of Ships.
(d) Test facility.
(e) Design and construction of a low turbulence wind tunnel to be used for boundary layer studies in connection with frictional resistance research. The tunnel features a flexible wall, rectangular test-section, 15 feet long and approximately 2 by 4 feet in cross-section. A Reynold's number of about 2×10^7 (based on test-section length) wil be obtained at design speed.
(g) The aerodynamic and structural design phase has been completed and construction is underway.

WAX TECHNIQUES.

Laboratory project.
Experimental testing.
Development of a wax composition and manufacturing techniques for the manufacture of ship models up to 30 feet on waterline length.
Numerous blends of natural and synthetic waxes have been investigated. Of the blends tested a successful compound has been developed for the manufacture of 20-foot models. Work is underway to develop a wax blend which will permit the construction of 30-foot models. A satisfactory manufacturing technique has been developed.
Report in preparation.

PRESSURE DISTRIBUTION ON SHIP MODELS.

Cooperative with Bureau of Ships.
Experimental; design.
Measurements of pressure distribution and resistance with photographs of wave profiles and flow lines for a series of ship models. Data are to be used for the design of turbulent boundary layer stimulators and the improvement of resistance prediction technique.
Piezometer orifices have been installed over the surface of a wax model of a merchant ship. A special multiple-tube, circular manometer has been designed and built for use in obtaining a large number of simultaneous pressure measurements.

PROPELLER THEORY, ARBITRARY DISTRIBUTION OF CIRCULATION.

Cooperative with Bureau of Ships.
Theoretical; applied research.
Studies of moderately loaded propellers with a finite number of blades and an arbitrary distribution of circulation. The theory is based on the velocity potential of helical vortices with numerical representation of the velocity field by means of "induction factors." Application is made to: (1) determination of the induced velocity components for given values of loading coefficient, advance coefficient and circulation distribution, and (2) determination of the circulation distribution and induced velocity components when the geometry of the propeller, the polar curves of the sections and the advance coefficient are specified.
Problems have been solved both for a free-running and for a wake-operating propeller.
Paper presented at meeting of Society of Naval Architects and Marine Engineers, Nov. 1952.

PROPELLER THEORY, OPTIMUM DISTRIBUTION OF CIRCULATION.

Cooperative with Bureau of Ships.
Theoretical research.
Study to determine the optimum distribution of circulation for a moderately loaded propeller which operates in a radially varying wake. Previously only an approximate solution has been developed.
An exact solution is under development which will provide a means both of determining the degree of accuracy of the numerically simple approximate solution and improving upon it. Thus far, however, the accurate solution appears complicated in numerical application.

U. S. DEPARTMENT OF THE NAVY, NAVAL BOILER AND TURBINE LABORATORY.

Inquiries concerning Projects Nos. 1523 and 1524 should be addressed to Mr. James W. Murdock, Instrument Division, U. S. Naval Boiler and Turbine Laboratory, Philadelphia Naval Base, Philadelphia 12, Pa.

(1523) HIGH PRECISION POWER INSTRUMENTS (I-11).

(b) Bureau of Ships and Office of Naval Research, Department of the Navy.
(d) Experimental; applied research.
(e) For improvement of fluid flow measurement. (1) Tests underway to determine influence of approach conditions on orifice meters. Various fittings placed 6 to 60 pipe diamet before orifices. (2) Determination of expansion effects of steam, particularly in low superheat regions; involves introduction of low superheat steam through proper approac to orifices having beta ratios of 0.30 to 0.87.
(g) Results indicate that (1) length of straight pipe required before orifice meter is reducible to less than 50% of that presently stipulated without appreciably affecting accuracy of measurement; (2) expansion factors for steam are in general agreement with those now specified except at low superheats where empirical equations must be modifie
(h) "Progress on globe valve series."
Test I-11 Interim Report No. 4, 26 Nov. 1951.
"Experimental evaluation of expansion factors for steam." J. W. Murdock and C. J. Fol A.S.M.E.

(1524) DETERMINATION OF HYDRAULIC CHARACTERISTICS OF SHIP PIPING SYSTEM COMPONENTS (I-25).

(b) Bureau of Ships, Department of the Navy.
(d) Field investigation; design.
(e) Study of design arrangement for accurate prediction of pressures in copper-nickel pipi systems. (1) Runs conducted to determine friction factors of 2-1/2", 4", 6" IPS CuNi tubing. (2) K factors for 125 psi Navy and commercial valves, tees, and ells.
(g) (1) Friction factors agree with ASME (Moody's factors). (2) K values with special Nav fittings are lower than with standard equipment.
(h) "Pressure drop determinations of component parts of piping systems - 4" and 2-1/2" IPS fittings." Test I-25 Interim Report No. 24, 16 July 1952. (Summary Interim Reports I Test I-25 Interim Report No. 34, 31 October 1952. (Summary Interim Reports 25-33.) Bureau of Ships, Department of the Navy.

U. S. DEPARTMENT OF THE NAVY, NAVAL ENGINEERING EXPERIMENT STATION.

nquiries concerning Projects Nos. 472, 1525 and 1528, should be addressed to Captain Fred W. Walton, Director, Bureau of Ships, Department of the Navy, Washington 25, D. C

(472) SEA WATER CORROSION AND EROSION STUDIES; CONDENSER TUBES, PIPING AND VALVES.

(b) Bureau of Ships.
(d) Experimental; applied research.
(e) Sea water corrosion tests of various alloys in the form of 5/8 inch O.D. condenser tube which were started in 1949 are continuing. At present 23 alloys have been included in the investigation. The tests are made at 10 ft/sec. Interest in the 90-10 copper-nickel alloys as a substitute for the 70-30 copper-nickel alloys is still high. Tubes of aluminum alloy, aluminum bronzes, aluminum brass, and titanium are currently under test. Tubes of stainless steels are being investigated because of interest for applica tion in closed-cycle system.. Experimental condensers containing tubes of nickel and nickel-base alloys are available for test as soon as space becomes available.
Piping systems containing branches of various alloys are being tested in sea water at 15 ft/sec. The alloys include several varieties of 70-30 and 90-10 copper-nickel alloy aluminum, aluminum bronzes, aluminum brass, Hastelloy C, titanium red brass, hydraulic bronze (continuous cast), black and galvanized wrought iron, and plastic (fibrous glass impregnated with resin). Various types and designs of fittings and valves are include An independent study is being made of various alloys for valve stems for salt water service.

) Test results obtained for the 90-10 copper-nickel alloy containing high iron led to the inclusion of this material in Military Specification MIL-T15005(Ships), Amendment - 5, for condenser tubes. The performance of aluminum alloy tubes under test since November 1950 has been surprisingly good. The tubes are of the clad type with aluminum alloy 2S on the outside and .005"-.007" cladding of 72S on the inside. The test unit had to be electrically insulated from the copper-nickel alloy salt water supply line for satisfactory performance.
Tests have continued with some materials as long as four years, and definite trends have been indicated. Corrosion-erosion attack of fittings, branch connections and valves (especially throttled valves), as well as that of the downstream pipe, was dependent on the materials of construction and the degree of water turbulence as influenced by design. The nature of attack in the experimental systems has paralled that found in service. The relative resistance of the various materials has been fairly well established for most of the alloys, and tests of some of them have been discontinued. The branches being continued in test at present consist of 90-10 copper-nickel alloys, 70-30 copper-nickel with .5% iron, aluminum brass, aluminum bronzes, steel and wrought iron. Steps have been taken to include pipes of titanium in the test.

h) "Second progress report on comparative tests of condenser tube materials." EES Report 4A(2)966845 of 31 July 1952.
"Summary report on the investigation of materials and design features for salt water piping systems in connection with a development program being conducted by Gibbs and Cox, Inc." EES Report 4B(7)17X1603 of 10 Nov. 1952.
"Corrosion resisting characteristics of iron-modified 90-10 cupro-nickel alloy." W. C. Stewart and F. L. LaQue, Corrosion, Vol. 8, No. 8, Aug. 1952, pp 259-277.

5) NOISE ATTENUATION TESTS OF FLEXIBLE PIPE COUPLINGS.

b) Bureau of Ships.
d) Investigative.
e) Investigation of the noise propagation, resistance to vibration and burst strength characteristics of flexible pipe couplings suitable for isolating naval machinery particularly submarine auxiliary machinery. Although various sizes of pipe couplings are being investigated, emphasis is now being placed on the noise isolation characteristics of 3, 4, and 5 inch hose. Not only are the couplings subjected to noise tests to determine their attenuation properties, but also the noise generated by the couplings and coupling configurations under various flow conditions.
g) Active results have been obtained to show noise attenuation characteristics of various couplings at pressures up to 50 psi. Modifications of apparatus have been completed to make them suitable for 1000 psi under static conditions. Flow tests can be conducted under pressures up to 200 psi. A type of coupling employing non-proprietary hose and reuseable end fittings is being further investigated to determine its attenuation at higher pressures.

8) HYDRAULIC PUMPS AND POWER TRANSMISSION.

b) Bureau of Ships.
d) Investigative.
e) All available pumps that would be suitable for hydraulic power transmissions are being investigated with the view of finding the quietest unit. The pumps are installed on a standardized testing base using the same prime mover. They are run through various capacity and speed ranges with a view of obtaining the variability of noise with capacity and speed. The pumps vary in capacity from 6 gallons per minute to 30 gallons per minute for speed ranges between 450 rpm and 1800 rpm. The hydraulic system is a closed cycle fitted with suitable flow meters, temperature control devices, coolers, heat exchangers, etc. Pumps mnnufactured by DeLaval, Dudco, Dennison, Vickers and Waterbury Tool are being evaluated. Two pumps (Deri and Keelevite) have been received from England and will be tested shortly.
h) A report on results for four pumps has been submitted.
A report on four other pumps is nearly completed.

U. S. DEPARTMENT OF THE NAVY, NAVAL ORDNANCE TEST STATION.

Inquiries concerning Projects Nos. 1530, 1531, 1533, 1792, and 1793, should be addres to The Commander, U. S. Naval Ordnance Test Station, Pasadena Annex, 3202 East Foothi Blvd., Pasadena 8, Calif. Attn: Code P8001.

(1530) TREATISE ON WATER ENTRY RESEARCH.

(b) Laboratory project.
(d) Theoretical; basic research.
(e) To prepare a comprehensive treatise on the theory of water entry impact. This treati will contain appropriate references to previous work and will present recent work in analytic and pictorial detail so that it can serve as a standard reference textbook o water entry impact.
(g) Manuscript ready for reviewers by about 31 Dec. 1952.
(h) "Pressure distribution on a sphere due to vertical impact on a plane water surface." Robert H. Korkegi, Tech. Memo. No. 656, 8 July 1952.

(1531) MECHANISM OF CAVITATION.

(b) Laboratory project.
(d) Experimental and theoretical; basic research.
(e) Continuation of work at California Institute of Technology under sponsorship of Shell Fellowship Committee and Office of Naval Research on the rate of growth of vapor bubbl in superheated water. The growth of vapor bubbles by heating water is analogous to th cavitation produced by flow past missiles. Thus such a study on vapor bubbles is appr priately a cavitation study in the field of hydrodynamics.
Highly-magnified multi-flash photographs of bubbles near the equilibrium point will be obtained and compared to theoretical calculations on the equilibrium size of vapor bubbles. The effects of air content and surface tension on the equilibrium size of va bubbles will also be considered.
(g) Items being considered are: (1) extension of the theoretical calculations on the equilibrium size for bubble growth to include the effects of air content and solid impurities in water, (2) techniques for producing vapor bubbles which will allow the use of greater magnification with the photographic equipment.

(1533) PRESSURE-TIME MEASUREMENTS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) A measurement of the pressure transient at various points on the surface of various geometric shapes during water entry. A pressure gage was developed to record extremel fast response to transients. It has a rise time of one to two microseconds in respons to a step forcing function.
(g) Reliable records for a 12-in. sphere were obtained at the stagnation point for vertica entry at 23.5 fps. In addition, pressure records have been obtained at positions 10°, 20°, and 30° from the stagnation point.
(h) "Laboratory measurements of pressure vs time at water impact." C. S. Nisewanger, Tech. Memo. No. 614, 21 Jan. 1952.

(1792) LINEARIZED THEORY OF OBLIQUE WATER IMPACT.

(b) Laboratory project.
(d) Theoretical; basic research.

The analysis is a linearization of the problem of water impact, in which the nonlinear boundary condition on the unknown free surface is replaced by a linear condition on an assumed known (horizontal) water surface: i.e., the free surface deformation due to the splash is neglected. Such linearization makes water impact a boundary value problem of the third kind. So that this may be solved by the methods of classical potential theory, (which require the coordinate system to be orthogonal), the actual growing wetted surface of an impacting body is approximated by a continuously changing half- ellipsoid of size appropriate to each instant of the impact stage. Furthermore, so that orthogonality relations (employing ellipsoidal harmonics) may be used to determine the constants in the solution of the governing (Laplace) equation, the actual problem solved is that of a full ellipsoid moving in a fluid extending to infinity in all directions. In the final results only the lower half of the ellipsoidal surface enters into the force calculations. Lastly, linearization of the water impact problem allows the velocity potential to be written as a linear combination of two "components", one applying to the translatory motion and the other to the vertical motion. The hydrodynamic force on the impacting solid is obtained as the time derivative of the momentum associated with the apparent mass of the solid.

) Completed.

) This project developed out of an effort to apply results contained in "The impact of a body on a water surface at an arbitrary angle." L. Trilling, Jour. of Applied Physics, Vol. 21, No. 2, pp. 161-170, Feb. 1950. Trilling's analysis has been corrected and a numerical example computed. As a side result the theory has been placed on a rigorous mathematical foundation. Unfortunately, computations based on the theory do not appear to be borne out by experiment, and new work which may provide closer agreement between the two is contemplated.

) WHIP AND UNDERPRESSURE STUDIES.

) Laboratory project.

) Experimental; basic research.

) Low atmospheric pressures acting on the under side of a missile during oblique water entry are known to affect the whip (change in angular velocity in vertical plane at water entry) of the missile by tending to give it a nose-down pitch velocity. This in turn affects the water-entry and subsequent underwater trajectory behavior of the missile and also gives rise to inconsistencies in modeling studies. Therefore it is important that the individual contributions to the whip by the underpressure and hydrodynamical forces be determined in order to relate hydrodynamical theory to experimental work.

) In studies on 2-inch-diameter models the contribution of this "underpressure effect" is being studied on a missile having a nose configuration consisting of a full-diameter flat disc immediately followed by a full-diameter cylindrical section. The air pressure above the water surface is varied. Several launchings have been made at each air pressure and the water-entry whips obtained.

The data indicate that the underpeessure greatly influences the whip and is itself very sensitive to change in air pressure. At 0.1 atmospheres air pressure the whip at half submergence of the nose plate is about -85° per sec. and at full submergence about -120° per sec. The whip becomes increasingly negative with increase in air pressure and at 1.5 atmospheres the whip at half-submergence of the plate is about -325° per sec. and at full submergence about -470° per sec. The data indicate that not only must the underpressure effect be taken into consideration in water-entry modeling studies but also the air pressure which affects it.

) "Effect of underpressure on the water-entry whip of a 22.4-in. diameter missile with plate-cylinder head." J. G. Waugh, G. G. Mosteller, and R. W. Ager.

U. S. DEPARTMENT OF THE NAVY, OFFICE OF NAVAL RESEARCH.

For sponsored projects see the following:

SEE VALLEY AUTHORITY, Hydraulic Data Branch.

Inquiries concerning all TVA Projects should be addressed to Mr. Albert S. Fry, Hydraulic Data Branch, Tennessee Valley Authority, Knoxville, Tenn.

Unless otherwise noted work is being done for Tennessee Valley Authority, Hydraulic Laboratory Section.

FONTANA DAM, SPILLWAY MODEL STUDIES.

Experimental; for design.
Tests on 1:100 and 1:51 models were made to develop spillway structures that would dissipate the energy of flood overflows without damage to the dam or adjacent structures. A spillway utilizing two diversion tunnels used during construction with buckets to spread the discharge, and a small emergency spillway were also developed.
"Fontana Project hydraulic model studies." Technical Monograph No. 68.

FONTANA DAM, LOW-LEVEL OUTLET, HOWELL-BUNGER VALVE MODEL STUDIES.

Experimental; for design.
Tests on a 1:42.35 model were made to develop a structure that would safely and efficiently dissipate part of the energy in the Howell-Bunger valve discharge.
Structures were developed which gave satisfactory flow conditions in the 15-foot diameter tunnel below the valve area. These structures were designed to keep to a minimum the air required when the valve is discharging.
"Fontana Project hydraulic model studies." Technical Monograph No. 68.

FONTANA DAM, LOW-LEVEL OUTLET, OUTLET STRUCTURE MODEL STUDIES.

Experimental; for design.
Tests on a 1:100 model were made to develop a structure that would perform satisfactorily under all operating conditions.
A comparatively simple outlet structure was developed.
"Fontana Project hydraulic model studies." Technical Monograph No. 68.

FONTANA DAM, CAVITATION STUDIES.

Experimental; for design.
To develop specifications for permissible variation in tunnel alignment so as to prevent cavitation damage to the walls of the Fontana spillway tunnels.
"Fontana Project hydraulic model studies." Technical Monograph No. 68.

HALES BAR DAM, SPILLWAY MODEL STUDIES.

Experimental; for design.
Tests were made on a 1:34.76 model of the spillway to develop a modification of the existing apron to prevent erosion and assist in reconstruction of the dam.
Final report issued.

(728) SOUTH HOLSTON AND WATAUGA DAMS, SPILLWAY MODEL STUDIES.

(d) Experimental; for design.
(e) Tests on 1:100 and 1:51 models were made to develop a morning-glory spillway to hand flood overflows.
(g) Proper location of piers on crest were determined, and a deflector in the vertical s to deflect flow to outside of bend at bottom was developed.
(h) Report in preparation.

(730) SOUTH HOLSTON DAM, SPILLWAY OUTLET MODEL STUDIES.

(d) Experimental; for design.
(e) Tests on a 1:51 model were made to develop an outlet structure to dissipate the ener from the morning-glory spillway and the Howell-Bunger valve sluiceway without damage the tunnel or outlet structures.
(h) Report in preparation.

(731) SOUTH HOLSTON DAM, SURGE TANK MODEL STUDY.

(d) Experimental; for design.
(e) A 1:50 model of the penstock and surge chamber was used to determine (1) the orifice size and characteristic shape to produce favorable pressure and water surface elevat changes for the best governor operation; (2) the maximum and minimum water surface e vations to be expected in the surge chamber; and (3) the operational characteristics the selected design.
(g) With the proper orifice between the riser and the surge chamber as satisfactory resu can be obtained as with the differential riser type of surge tank.
(h) Report in preparation.

(732) WATAUGA DAM, BED LOAD STUDY.

(d) Experimental; for design.
(e) A fixed-bed 1:70 model of the river near the powerhouse was tested to determine whet bed load moved by the spillway discharge would be deposited in the powerhouse tailra and, if so, how it could be prevented.
(g) A small wall located along the upstream edge of the tailrace channel was found suffi to keep the bed load from depositing in the draft tubes and the tailrace.
(h) Report in preparation.

(735) TURBINE DISCHARGE RATINGS.

(d) Field tests; applied research.
(e) Measurements of turbine discharges are being made to rectify discrepancies and incre accuracies in reported discharges. On tributary rivers current meter measurements a made below the dams. On the main river discharges are determined for individual uni by making velocity traverses in the turbine intakes.
(g) Equipment for turbine discharge measurements has been tested and method found to be sound.

(736) APALACHIA DAM, SPILLWAY RATING.

(d) Experimental; operation.
(e) Model tests, checked by field measurements, are to be used in determining the dischar ratings for all anticipated operating conditions. Discharge tables for operating pur poses will be prepared.
(f) Model studies completed.

(738) CHEROKEE DAM, SPILLWAY RATING.

(d) Experimental; operation.

Model tests, checked by field measurements, are to be used in determining the spillway discharge ratings for all anticipated operating conditions. Discharge tables for operating purposes will be prepared.
Model studies completed.

CHEROKEE DAM, SLUICE RATING.

Field investigation; operation.
Measurement of discharges and differential pressures in the sluices, supplemented by model test data, will be used to establish the discharge ratings for the eight sluices. Tables of discharge for any gate opening at any headwater elevation within the operating range are to be prepared.

DOUGLAS DAM, SPILLWAY RATING.

Experimental; operation.
Model tests, checked by field measurements, are to be used in determining the spillway discharge ratings for all anticipated operating conditions. Discharge tables for operating purposes will be prepared.
Model studies completed.

DOUGLAS DAM, SLUICE RATING.

Field investigation; operation.
Measurement of discharges and differential pressures in the sluices, supplemented by model test data, will be used to establish the discharge ratings for the eight sluices. Tables of discharge for any gate opening at any headwater elevation within the operating range are to be prepared.

FONTANA DAM, LOW-LEVEL OUTLET RATING.

Field investigation; operation.
Field measurements of discharges and pressures in the Howell-Bunger control valve were used to compile discharge-valve opening data within the expected operating range.
"Characteristics of fixed-dispersion cone valves." Rex A. Elder and Gale B. Dougherty, Proc. Sep. No. 153, A.S.C.E., Sept. 1952.

FONTANA DAM, LOW-LEVEL OUTLET, AIR DEMAND STUDIES.

Field investigation; operation.
Measurements of air demanded by the 84-inch Howell-Bunger valve were made through its entire range of openings and heads.
The results, when plotted as air demand versus water discharge, gave a family of curves varying with head but of unpredictable shape. A constant ratio of air to water exists at each valve opening position.
"Characteristics of fixed-dispersion cone valves." Rex A. Elder and Gale B. Dougherty, Proc. Sep. No. 153, A.S.C.E., Sept. 1952.

FONTANA DAM, SLUICE RATING.

Field investigation; operation.
Field measurement of discharges and differential pressures in the sluices, supplemented by model test data, will be used to establish the discharge ratings for the six sluices. Tables of discharge for any gate opening at any headwater elevation within the operating range are to be prepared.

FORT LOUDOUN DAM, SPILLWAY RATING.

Experimental and field investigation; operation.
Model tests, checked by field measurements, are to be used in determining the discharge ratings for all anticipated operating conditions. Discharge tables for operating purposes will be prepared.
Model studies completed.

(753) OCOEE NO. 3 DAM, SPILLWAY RATING.

(d) Experimental and field investigation; operation.
(e) Model tests, checked by field measurements, are to be used in determining the discharg ratings for all anticipated operating conditions.
(f) Model studies completed.
(h) Discharge tables issued.

(758) CHEROKEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements of pressure in sluices are being obtained to be compared with the pressur measured during the model tests.

(759) DOUGLAS DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements of pressure in sluices are being obtained to be compared with the pressur measured during the model tests.

(760) FONTANA DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Plaster surface impressions of carefully located sections are taken after each extende period of tunnel operation to obtain evidence of damage. Entire tunnel is examined fo erosion, cavitation damage, or structural failure.
(g) Inspections made in Sept. 1946, Oct. 1949, and May 1950.

(761) KENTUCKY DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements are made of lateral pressures on the face of the spillway piers and on th submerged baffle piers on the spillway apron to be compared with the results of the mo tests.

(762) SOUTH HOLSTON DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped to allow testing in a manner similar to that used in the model studies which established the design. A check on the model accuracy can thus be obtained.
(g) Initial tests made in Feb. 1950.

(763) HIWASSEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements of pressure in sluices are being obtained for comparison with pressures measured in model tests.

(1038) HALES BAR DAM, SPILLWAY APPROACH STUDIES.

(d) Experimental; for design.
(e) Tests are made on a 1:65 model to determine effect of the remains of cofferdam structures upstream of the spillway on the spillway discharge and to determine amount of th obstructions which should be removed.
(f) Model tests completed.
(h) Report in preparation.

CHANNEL STUDIES BELOW HALES BAR DAM.

Experimental; for design.
Tests are conducted on a 1:65 model to study effect of channel alignment on spillway discharge and navigation conditions, and effect of lock location and spillway gate operation on navigation conditions.
Final report issued.

HALES BAR DAM, MISCELLANEOUS STRUCTURES STUDIES.

Experimental; for design.
Tests were made on a 1:65 model to determine location of trash boom and head-water gage intake for a new powerhouse.
Report in preparation.

BOONE DAM, SPILLWAY MODEL STUDIES.

Experimental; for design.
Tests are made on a 1:50 model to determine proper dimensions for bucket-type spillway and associated training walls.
The tests proved that for certain anticipated operating conditions for the bucket-type spillway can be advantageously used.
Report in preparation.

WATAUGA DAM, PROTOTYPE CHECK TESTS.

Field investigation; applied research.
Outlet tunnel surfaces are inspected after completion and after extended periods of operation to determine erosion, cavitation damage, or structural failure.
Initial inspection in Dec. 1949.

HOWELL-BUNGER VALVE DISCHARGE COEFFICIENT.

Field investigation; applied research.
Tests made to determine discharge, pressure at base of valve, and dimensions of valves, and all available data analyzed to determine coefficient based on net flow area through body of valve.
Coefficient is about 0.9 at maximum discharge and increases slightly with size. Maximum discharge does not occur at maximum opening.
"Characteristics of fixed-dispersion cone valves." Rex A. Elder and Gale B. Dougherty, Proc. Sep. No. 153, A.S.C.E., Sept. 1952.

STEAM PLANT AIR POLLUTION STUDIES.

Field investigation; design and operation.
To obtain information for use in studies of air pollution and its control. Measurements of air temperatures, wind velocities, and atmospheric sulphur dioxide are being obtained in the Johnsonville Steam Plant area. Air temperatures and wind velocities are being taken in the Widows Creek, Shawnee, and Kingston Steam Plant areas. Equipment is being installed to measure sulphur dioxide concentrations in the Widows Creek area and air temperature, wind velocities, and wind directions in the Gallatin and John Sevier Steam Plant areas.

FORT PATRICK HENRY DAM, SPILLWAY MODEL STUDIES.

Experimental; for design.
Tests are being conducted on a 1:50 scale and a 1:112.5 scale model to determine the apron design, training wall dimensions, and other related data.

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(g) An apron using a single row of rectangular baffle blocks was developed on the 1:50 sca model. This apron was then used in the 1:112.5 scale model and the necessary appurter structures developed. Of main interest in the developed design was the lack of traini walls. Studies to determine the effect of vegetative growth on the island areas below the spillway showed which areas must be kept free of growth and which may be allowed t grow up.
(h) Report in preparation.

(1535) DEVELOPMENT OF ERODIBLE BED MATERIAL FOR USE IN MODEL TESTING.

(d) Experimental; developmental.
(e) An erodible material that will start to move at model velocities comparable to the ant cipated velocity at which the prototype material will erode is needed when erosion tes are to be made for areas in which steep banks or cliffs exist. Experiments are under way to develop such a material.
(g) Limited success has been achieved. Experiments are continuing.

(1536) VHF RADIO GAGES FOR REPORTING RAINFALL AND RIVER STAGES.

(d) Experimental; development.
(e) To change from the present HF to VHF bands new equipment is being developed. When the change-over is complete all stations will be automatically transmitted and received.
(g) Standard FM tone modulated 169 - 173 Mc. radio equipment has been modified to transmit pulsed signals produced in a specially designed electro-mechanical converter unit (keyer). This keyer can be directly operated for river stage measurement by the conve tional float system. By use of an electrical servo system, rainfall caught in a standard weighing type gage can be transmitted to the keyer unit. Standard VHF radio station transmitter-receiver units have been modified for use as automatic repeater units A printing type recorder operated by a standard VHF, FM receiver suitably modified, records and prints all transmitted signals on a 5 inch tape. All transmitting units are supplied with at least 3 days emergency power in case of AC power failure. Suitab signals indicate when any gage is on emergency power. A complete system of one of eac type gage and two repeater units has been successfully operated. Additional installation of 39 more gages and 6 other receiving systems is to be carried out during the ne two years.

(1794) WATTS BAR LOCK PROTOTYPE TESTS.

(d) Field investigation; applied research.
(e) The protytype installation was equipped with piezometers to allow checking of culvert and port pressures and discharges. The culverts and ports were designed from model studies. Thus, measurement on the prototype would provide model-prototype verificatio data.
(f) Complete field tests were conducted in May 1952. Reduction of data is being completed

(1795) HALES BAR DAM, PROPOSED LOCK LOCATION STUDIES.

(d) Experimental; for design.
(e) To determine the most expeditious location for the proposed 110 by 600 foot lock, test are being made on a 1:65 scale model. Effect of changes is determined by measurement bow and stern forces on model tows and by measurement of wave heights in the navigatio channel.

(1796) KINGSTON STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDIES.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets draw water from and discharge into Watts Bar Reservoir (Tennessee River). During the warmer portions of the year this reservoir becomes stratified and the inflowing waters pass through the reservoir as density curren By means of theoretical considerations and field observations, the proper location and shapes for the intakes and outlets are to be determined and the probable intake temperatures calculated.

GALLATIN STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDY.

Theoretical and field investigation; design.
The condenser water intakes and outlets are to draw water from and discharge into the proposed Old Hickory Reservoir (Cumberland River). The entire setup is to be analyzed to determine the type of flow conditions to be expected in the reservoir; the temperatures to be expected at the inlets; and the best design for the inlets and outlet structures.

JOHN SEVIER STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDY.

Theoretical and field investigation; design.
The condenser water is to be drawn from the Holston River at a point below three multipurpose storage dams and one power dam. By theoretical considerations and a study of past temperature records for this and other similar rivers, the anticipated water temperatures at the site are to be determined.
Completed.
A temperature duration curve and an expected daily maximum temperature curve were prepared.

LININGS FOR STEAM PLANT DISTILLED WATER STORAGE WELLS.

Experimental; design.
Tests were made to determine the adequacy of "Insul-Mastic" and "Tuffalt" for use in lining steam plant distilled water storage wells. These were made under conditions which simulated those that occur in actual plant operation.
Both materials were found to be incapable of standing the normal operating conditions.
Final report issued.

WIDOWS CREEK STEAM PLANT - DIRECTIONAL DUST COLLECTORS.

Field investigation; design and operation.
To obtain information on the sources of dust in the steam plant area, three direction dust collectors were designed and installed. The collected material is analyzed for amount of catch and mineral constituents.

Hydraulic Investigations Section.

DETERMINATION OF SEDIMENT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.

Field investigation; basic research.
To provide data for estimating effective life of storage reservoirs, and loss of soil from the land. Samples of water were collected periodically at stream gaging stations in the watershed, analyzed to determine the sediment content, and correlated with river discharge to determine the suspended sediment load at each station.
Report in preparation.

EVAPORATION IN THE TENNESSEE BASIN.

Field investigation; applied research.
To provide data for estimating reservoir losses and derive a general rule, applicable to the Basin, permitting computation of evaporation from pans at six locations in Basin together with standard meteorological readings.

RESERVOIR RIM INVESTIGATIONS.

Field investigation; basic research.
To determine the leakage, through rims of new reservoirs, and to check conditions for other reservoirs. Ground water levels are observed and post-impoundage levels compared with pre-impoundage records; stream flow from rim areas is measured to determine whether any increase has occurred after creation of a reservoir.
Preliminary report prepared for internal use. No serious leakage conditions have been found.

(768) PRECIPITATION IN TENNESSEE RIVER BASIN.

(d) Field investigation; basic research.
(e) A comprehensive study of rainfall and other weather phenomena for purposes of water di patching and improvements in water control; storm studies as related to maximum preci tation, rainfall-runoff, spillway design and operation, etc.
(h) Monthly bulletin, "Precipitation in Tennessee River Basin." Also annual summary.

(769) RESERVOIR AND STREAM TEMPERATURES.

(d) Field investigation; basic research.
(e) Study of water utilization and water movement as concerns industrial plant locations a stream pollution. Variations in temperature from surface to bottom in reservoirs thr out the year are determined by soundings, and by continuous recording gages in natura streams.

(771) GALLERY DRAINAGE IN LARGE DAMS.

(d) Field investigation; design.
(e) Weirs are placed in main galleries and drainage measured as check on tightness and sta bility.
(h) Reports prepared annually for internal use.

(778) EFFECT OF ALTITUDE UPON RAINFALL.

(d) Field investigation; basic research.
(e) At four locations, rainfall data have been or are being collected. The stations are arranged in series at varying elevations, up one side of a ridge and down the other, s that exposure as well as altitude will be reflected in the result.
(f) Completed.
(g) One study showed definite increase of rainfall with altitude; two studies showed a decrease near the ridge top because of updraft and carry-over effects, and in the fourth study, made in an area of low relief, the topography had no effect except when the rai producing air masses were critically unstable for an additional lift of a few hundred feet.
(h) Three studies reported in 1949 annual issue of "Precipitation in Tennessee River Basir

<u>Special Investigations Unit.</u>

(783) WHITE AND RICHLAND CREEKS--DETERMINATION OF ROUGHNESS COEFFICIENT.

(d) Field investigation; basic research.
(e) Determinations being made in several river reaches of known discharge to extend knowledge of relation between roughness coefficient and physical characteristics of rivers

(785) SEDIMENTATION OF EXISTING RESERVOIRS.

(d) Field investigation; basic research.
(e) Selected ranges in reservoirs are probed and sounded, volumetric samples are collected and analyzed, quantity and distribution of sediment are computed to determine depositi by stream, probable life of reservoir, effect of sediment storage on navigation channe and sedimentation of downstream reservoirs, and probable sedimentation in future reservoirs.
(h) Reservoir sedimentation data summaries, on forms adopted by the Federal Inter-Agency River Basin Committee, Sub-committee on sedimentation have been completed and distribu to member agencies.

(786) WATER TRAVEL IN NATURAL STREAMS.

(d) Field investigations; applied research.
(e) Sanitary and chemical changes in water during passage downstream are determined. A given mass of water is identified by electrical conductivity or chemical titration.

) MOVEMENT OF WATER THROUGH LARGE RESERVOIRS.

) Field investigation; applied research.
) Because of slow water travel, samples are collected by traverse through lake.
) Water entering a reservoir does not intermix with the rest of the reservoir, but remains as a density current as a result of the difference in temperature between the inflowing water and that in the reservoir. During certain seasons of the year, in Watts Bar Reservoir the cold water released from Norris Reservoir passes upstream along the bottom of the Emory River arm of the former reservoir.

) WIND VELOCITIES AND DIRECTIONS--WHITETOP MOUNTAIN.

) Completed.
) Monthly abstracts in "Precipitation in Tennessee River Basin."

) RESERVOIR SEDIMENT DENSITY SAMPLER.

) Cooperative with Federal Inter-Agency River Basin Committee, Subcommittee on Sedimentation.
) Experimental; applied research, design, operation, development.
) A device is being developed for making in-place density measurements of deposited reservoir sediment. Principle is that shielding of a radioisotope varies with mass between source and metering point. Strontium 90 has been selected as the radioactive source. Proposals have been requested from manufacturers for construction and testing of a pilot model.

Hydrology Section.

) RUNOFF-SILT INVESTIGATIONS ON SMALL WATERSHEDS.

) Field investigation; basic and applied research.
) To evaluate hydrologically existing or changed land-use practices or management. Data are obtained on rainfall, runoff, and soil loss, and in some instances include ground-water levels and soil moisture.
) Progress report for Henderson County runoff-erosion project and final report on Copper Basin experimental watersheds are in preparation.

) MAXIMUM POSSIBLE PRECIPITATION IN TENNESSEE VALLEY.

) Cooperative with U. S. Weather Bureau.
) Theoretical; applied research.
) Hydrometeorological analysis of large storms with upward adjustments of controlling factors to maximum limits as applied to the Tennessee Valley and subdivisions.
) Results to be published as one of current series of hydrometeorological reports by the U. S. Weather Bureau and cooperating agencies.

) MONTHLY EVALUATION OF GROUND-WATER STORAGE.

) Theoretical; operation.
) By analysis of current records of stream discharge, the volumes of runoff in ground-water and channel storage are determined for use in operation of multi-purpose reservoirs.
) Results reported monthly within the organization.

Procedures Development Section.

) RAIN GAGE LOCATION STUDIES--SOUTH CHICKAMAUGA CREEK WATERSHED.

) Field investigation; applied research.
) A study to learn the most suitable location and necessary density of rain gages to obtain an accurate record, particularly for river forecasting purposes, in a basin having numerous parallel ridges. Three recording and 13 standard rain gages, in addition to 3 existing standard rain gages, are being established in the South Chickamauga Creek watershed, having a drainage area of 428 square miles.
) Daily observations beginning December 1, 1952.

UNIVERSITY OF BRITISH COLUMBIA, Hydraulics Laboratory.

(1044) FRASER RIVER MODEL.

(b) Cooperative with Department of Public Works of Canada, and National Research Council Canada.
(c) Mr. J. H. Parkin, National Research Council, Ottawa, Canada.
(d) Experimental project to assist in problems of river regulation and control. Flume studies on bed-load movement are being carried out concurrently in the Hydraulics Laboratory to determine scour trends around groins and training walls.
(e) An erodible-bed tidal model to study methods of maintaining stable navigational chann with a minimum of dredging and river regulation. Horizontal scale, 1 in 600; vertica scale, 1 in 70. The model represents the entire lower Fraser River from the Strait o Georgia to the head of tidewater at Sumas and includes Pitt Lake, which is tidal. Th actual tides and variable river discharges can be simulated. Sand injection, automatically controlled, is a function of river discharge. The bed consists of natural river sand.
(h) Progress and technical reports submitted periodically.
"An automatic recording tide gauge for the Fraser River Model." Ian D. Smith, HY-103
"A brief report on the controls and indicators of the Fraser River Model." E. S. Pretious and I. D. Smith, Hy-111.

(1802) FISHWAY MODEL EXPERIMENTS.

(b) Cooperative with Dominion Department of Fisheries.
(c) Mr. C. H. Clay, Dominion Department of Fisheries, 1110 West Georgia St., Vancouver, B. C., Canada.
(d) Tests on designs of roughened rock cuts to act as baffles of a Denil-type fishway in which no formal construction would be needed.
(e) Tests were made on 1:6 model constructed of wood and concrete and placed in a glass ar steel flume.
(f) Completed.
(h) Report prepared by Dominion Department of Fisheries.

ÉCOLE POLYTECHNIQUE DE MONTREAL, Hydraulics Laboratory.

Inquiries concerning Projects Nos. 266, 268, and 1803 should be addressed to Prof. Raymond Boucher, École Polytechnique, Montreal 18, Canada.

(266) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.

(b) Laboratory project.
(d) Experimental; applied research.
(e) To establish a comparison between the discharge capacities of different spillway desig Studies are made on concrete models of existing and recommended spillway profiles. Pressure distribution on spillway faces and coefficients of discharge are determined f various heads up to the designed head. The effect of gate piers of various design is also investigated. Eight different profiles have been studied, including two modifica tions of the Creager profile upstream of crest line.

(268) CALIBRATION TESTS OF A SHARP-CRESTED PARABOLIC WEIR.

(b) Laboratory project.
(d) Experimental; applied research.
(e) To obtain the head-discharge curves and head-discharge coefficient curves for a sharp-crested parabolic weir (21-inch maximum width by 18-inch maximum height) having a capa city of 3 cfs. The influence of viscosity is also being investigated. This weir is t be used in a flume for model testing and open channel studies.

) NEW METHOD OF UTILIZING THE WATER HAMMER FOR THE DETECTION OF LEAKS IN PIPES.

) Laboratory project.
) Prof. Andre Leclerc, École Polytechnique de Montreal, Montreal 18, Canada.
) Experimental; applied research.
) To develop a very sensitive recorder for pressure waves in pipes to be used for the location of leaks in distribution systems. The sensing element is made of a cylinder tapped to the pipe. The wire wound around the cylinder acts as a strain gauge in the measurement of the pressure variation produced in the pipe by water hammer. A cathode-ray oscillograph is now being developed to register the deformations of that cylindrical strain gauge.
) Suspended.

) MODEL STUDY OF LAC BETSY LOGWAY.

) Montreal Engineering Company Limited.
) Experimental; for design.
) Tests were conducted on a 1:10 scale model for the purpose of designing a transition, between a rectangular intake and a trapezoidal log flume, that would give the best flow of pulp wood logs without spilling or piling up.
) Completed.
) Report in preparation.

NAL RESEARCH COUNCIL, Division of Mechanical Engineering.

Inquiries concerning Projects Nos. 1287, and 1803 to 1805, incl., should be addressed to the Director, Division of Mechanical Engineering, National Research Council, Ottawa, Canada.

) FRASER RIVER MODEL.

See page 186.

) MODEL STUDIES OF SPILLWAY FOR DAM ON THE MAYO RIVER.

) Department of Resources and Development.
) Experimental; for design.
) The 1:50 model used in the tests to determine the capacity, height of side walls and turbulence was used to determine the extent of erosion likely to occur at the bottom of the spillway. Two designs of bucket designed to throw the water clear of the end of the spillway were tested.
) Completed.
) A simple stepped bucket was designed which spread the water over a considerable area and reduced the possibility of scouring the river bed at the end of the spillway.

) MODEL STUDIES OF RECTANGULAR CONDUIT SPILLWAY.

) tadler, Hurter Company, Montreal, Canada.
) Experimental; for design.
) A 1:20 scale-model of a rectangular conduit spillway designed for inclusion in a concrete dam was tested to determine the discharge capacity and operating characteristics under the designed operating head of 20 ft. Modifications were necessary to increase the discharge capacity and to improve the flow conditions near the control gate.
) Completed.
) The tests showed that relatively small changes in the design would improve the discharge capacity by 14% at the designed head and reduce the turbulence in the conduit with no change in the size or location of the control gate.

(1805) MODEL STUDIES ON OPEN CHANNEL SPILLWAY.

(b) Montreal Engineering Company, Limited, Montreal, Canada.
(d) Experimental; for design.
(e) A 1:25 scale-model of a small spillway and power plant was used to study a number of design features of the spillway and the effect of its operation on the power plant.
(f) Completed.
(g) A number of minor improvements were made to the design, which reduced turbulence in th spillway and scouring below the point of discharge.

(1806) ST. LAWRENCE RIVER MODEL.

(b) Laboratory project.
(d) Experimental; for design and operation.
(e) A 1:500 by 1:50 scale model of the St. Lawrence River between the towns of Prescott an Cardinal has been constructed to study the effect of engineering works to be made in connection with the proposed seaway.
(f) The model has been completed and verification tests commenced.
(g) The tests to date have shown that a great deal of roughness must be added to channels in a model of this distortion.

QUEEN'S UNIVERSITY, Hydraulics Laboratory.

(1807) STUDY OF CUBE TIPPED PITOT TUBE.

(b) Laboratory project.
(c) Prof. R. J. Kennedy, Dept. of Civil Engineering, Queen's University, Kingston, Ontario Canada.
(d) Experimental.
(e) To investigate the constants necessary for an impact orifice on one face and static orifice on another.

UNIVERSITY OF TORONTO, Deoartment of Mechanical Engineering.

Inquiries concerning Projects Nos. 1807 to 1811, incl., should be addressed to Prof. G. Ross Lord, University of Toronto, Toronto 5, Canada.

(1289) DISCHARGE CHARACTERISTICS OF WEIR TYPE SPILLWAYS.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto, Toronto 5, Canada.
(d) Experimental; applied research for Master's thesis.
(e) A long term research carried out with a view to systematizing discharge characteristic for spillways having various pier spacings and proportions.

(1808) EROSION NEAR PIERS OF PULPWOOD HOLDING BOOMS.

(b) Quebec North Shore Paper Company.
(d) Experimental; design.
(e) Various pier shapes and many devices were investigated with a view to minimizing erosi around the piers of a proposed holding boom. The piers are to be placed in a large river and have a maximum height of 60 feet.
(f) Completed.
(h) Reported to sponsor.

) DESIGN OF HOLDING BOOMS.

) Quebec North Shore Paper Company.
) Experimental; for design.
) The proper spacing of piers and location of holding boom was studied by means of a scale model. Small wax candles were used to represent pulpwood. The pier loading was obtained by means of spring balances.
) Completed.
) Reported to sponsor.

) THE FLOW OF SOLIDS SUSPENDED IN LIQUIDS IN PIPES.

) Laboratory project.
) Experimental; applied research for Master's thesis.
) Tests are being carried out using pulpwood obtained from paper mills. It is hoped to carry on this investigation for a three year period.

) SCOUR PREVENTION AT IRRIGATION CANAL OUTLETS.

) Laboratory project.
) Experimental; applied research for Master's thesis.
) Tests were performed to develop suitable scour prevention devices to be placed at the outlets of irrigation canals, when these canals discharge into erodable open channels.
) Completed.

) TAILRACE TUNNEL - OPEN CHANNEL TRANSITION FOR CUBATAO UNDERGROUND PLANT.

) Sao Paulo Light and Power Company.
) Experimental; design.
) A transition was designed between the concrete lined tailrace tunnels of an underground plant and the ensuing open channel section in earth. The design was complicated by the inclusion of a flood spillway tunnel discharging at high veloctty during certain periods of the year.
) Completed.
) Reported to sponsor.

U. S. GOVERNMENT PRINTING OFFICE: O—1953

(Continued from page 2 of cover)

answering a number of questions regarding the adequacy of stack venting of plumbing fixtures for one- and two-story dwellings. Diagrams, tables, and graphs show the various components of a stack-vented system and provide pressure and trap-seal data.

Order NBS Building Materials and Structures Report 118, Stack Venting of Plumbing Fixtures, 21 pages. Price: 15 cents.

Hydraulic Research in the United States

Guides to projects conducted by various hydraulic and hydrologic laboratories in the United States and Canada during 1951 and 1952. Project reports cover work done at 66 private or State laboratories in the United States, 34 Federal laboratories, and five Canadian laboratories. These publications outline individual projects on nearly 200 subjects in the field and includes lists of committees working in the field and of foreign publications and translations available on loan.

Order:
- NBS Miscellaneous Publication 201, Hydraulic Research in the United States, 1951, 190 pages. Price: $1.25.
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NATIONAL BUREAU OF STANDARDS • A. V. Astin, Director

Report of the Thirty-Eighth National Conference on Weights and Measures

Attended by Representatives from Various States

Sponsored by the National Bureau of Standards
Washington, D. C., May 19, 20, 21, and 22, 1953

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*Mr. Levy was unable to be present, due to illness.

reflects the appointments made by the President of the Conference, changes which have occurred from expiration of term or other cause, and the elections by the several committees of chairmen, and in one case secretary, for the ensuing year. The remaining term of office for each committee member, in years, is shown by the figure in parentheses following each entry.)

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REPORT OF THE THIRTY-EIGHTH NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

SPONSORED BY THE NATIONAL BUREAU OF STANDARDS, AND HELD AT THE WARDMAN PARK HOTEL, WASHINGTON, D. C., MAY 19, 20, 21, AND 22, 1953

FIRST SESSION—MORNING OF TUESDAY, MAY 19, 1953

(A. V. Astin, President, and D. G. Nelson, Vice President, presiding)

The invocation was delivered by the Conference Chaplain, R. W. Searles, Deputy County Sealer of Weights and Measures, Medina County, Ohio.

ADDRESS BY HON. CRAIG R. SHEAFFER, ASSISTANT SECRETARY OF COMMERCE FOR DOMESTIC AFFAIRS

It is my privilege, in behalf of the Department of Commerce, to welcome this 38th National Conference to Washington.

Your varied membership contains representatives of government, science, and industry. Your endeavors go far back in history.

In fact, Moses is a charter member of your fraternity. For, in giving the law to the children of Israel, the Bible says, he declared: "Thou shalt have a perfect and just weight, a perfect and just measure shalt thou have that thy days may be lengthened in the land."

Yet with an experience dating back to antiquity, custodians of weights and measures are not content to rest on their laurels. One of the finest things about your group is that you are steadily improving services and continually seeking new developments in your important field.

As the Assistant Secretary of Commerce for Domestic Affairs, I am proud of the fine record of the National Bureau of Standards in weights and measures. You will find that the Bureau is always eager to help municipal, county, and state officials—and manufacturers, processors, and businessmen—with problems in this particular area of public service.

Right now some papers and magazines are describing the new Administration as a probusiness administration. It is that and more.

President Eisenhower has tapped the talents of the business community, as he has drawn into government executives from agriculture, labor, the professions, and other segments of society. They are working together as a team. They are endeavoring to decide each issue on the basis of what is best for all Americans.

Let me assure you that former businessmen in government have a genuine appreciation of the value of your particular services. The determination of quantity is basic to business. Often it is the method by which profit or loss is established. Whether a manufacturer is buying steel by the ton or a drug firm is selling medicine by the grain, business depends upon the accuracy of measurement.

Your particular field always has been one in which science, business and government mingle. Society today is a projection of your experience—all three elements profoundly affect modern life.

However, there are some people who are antagonistic to business and who are trying to give the false impression that a probusiness administration necessarily must be an antiscience administration.

No accusation could be more inaccurate. Anyone who believes that misrepresentation has not even tried to ascertain the facts.

American business has always had a deep respect for science. It has employed science to improve production and to discover new materials, new technologies, and new ways of doing things out of which have come new and better goods, and, in many cases, new and lower prices so that markets could be broadened and the wants of more people satisfied.

In fact, the scientist's best friend is the businessman, in or out of government. For not only does business utilize science in industry and pay it well, but the taxes of business and the donations of business play a leading role in the support of governmental and institutional science.

Business and science are partners, working together to bring to mankind all the modern blessings of research, invention, and innovation. It is particularly fitting, therefore, that our Government has provided that the National Bureau of Standards operate within the Department of Commerce.

The total annual expenditures today for research alone are more than three and a half billion dollars. From measurement—your field—comes greater understanding in science. From the laboratories come weapons on which national security depends. But from the laboratories, too, are coming new ideas for peacetime progress and universal happiness.

Any person over 50 years of age was alive before a successful auto or airplane was developed. But the partnership of technology and industry has developed the automotive engine so well that it has produced the greatest economic impact in all history.

Who at the turn of the century could have foreseen the fabulous number of jobs about to be created in this country? Who could have foreseen the striking increase in the standards of living of the American people?

Today a million workers make autos or auto parts. A million and a half sell or service them. Three out of every four families in America own cars.

In comparison with the rest of the world our progress has been remarkable. Let us hope that our children will live to see the day when the standards of living in other countries rise to the level that we have attained.

This is capable of achievement, and the whole world will benefit, but if we permit, through lack of foresight, our standards of living to be lowered to the levels existing in other countries, we, in effect, will be guilty of a sin against the rest of the world.

The manner in which business and science have teamed up and worked together in this country throughout our history, and particularly since the turn of the century, has made possible a way of life still unbelievable to many in far countries who have only heard about it and have never seen or enjoyed it.

Some may have the feeling that the gains in our standard of living have been purely materialistic, but walking hand in hand with materialistic gains have been notable gains in spiritual values. When we were a poor, struggling nation, our first thought was to better our position. That accomplished, the American people have never shirked when disaster struck at home or abroad.

This spirit of charitableness, coupled with our resources, has been exemplified by our prompt aid to famine areas, the Tokyo catastrophe, and to many others right down the years to the recent Winnipeg flood.

A purely materialistic population would think only of themselves, but the individual American, regardless of his political or religious faith, has helped all over the world when help was needed by the suffering. He has willingly dug down into his own pocket to do so, and if he had great wealth, he created or supported a foundation for doing the same thing on a larger scale.

The world of electricity and chemistry has been pouring out all sorts of new products in the last 15 years. These new inventions did not originate in garrets. The bulk of them flowed from laboratories financed by highly successful business.

One of the prime reasons why businessmen at all levels of government want more efficiency and less waste is so that, as taxes are lessened, more money can be diverted to support new explorations in science.

In the field of oil and petrochemicals, for example, we not only can expect improved cracking processes for fuels but all sorts of new developments in fertilizers, insecticides, fumigants, and weed-eradicators, so that eventually the one half of the world's population now on an inadequate diet may have more food. A full stomach is one of the best bulwarks against the spread of Communism.

This is only one area in which business is financing science in the operation of Aladdin's Lamp. This is one more proof of the ties that bind them.

I am proud to stand with my fellow businessmen who, in government and in private life, are doing their best to increase the efficiency of the Federal government and to build and sustain the economic health of America.

We want less government interference with legitimate business and fewer government burdens piled on taxpayers' shoulders. We want private enterprise given a better chance to exert its dynamic power.

This determination to encourage free, competitive enterprise is a noble motive, exercised in the interest of all the people. For economic prosperity means more jobs, more modern conveniences, more money for worthy causes, more national happiness, more tasks for weighing and measuring, more opportunities for science to progress beyond known horizons.

On the military strength, stemming from American economic might, are based the hopes of captives and the security of the free.

So, I gladly welcome you here today to listen to the experts, who will discuss the many problems of the halls of government, the laboratory and the market place. I welcome you as each contributes his special knowledge and wisdom in advancing our free nation.

Let this conference—this pooling of business, science and government talents—be symbolic of our generation, a partnership of dedicated men and women seeking to make a better world for ourselves and our children.

(R. W. Searles, Conference Chaplain, conducted an appropriate memorial service for departed members.)

REPORT ON THE ACTIVITIES OF THE NATIONAL BUREAU OF STANDARDS, BY A. V. ASTIN

I appreciate very much the opportunity of making a report on the activities of the National Bureau of Standards and hope to touch briefly on a few of the highlights.

The Constitution of the United States gives the Congress power to fix the standard of weights and measures and has assigned, in turn, to the Bureau responsibility for developing and maintaining the standards for physical measurement. There is no regulatory authority assigned with this responsibility. That has been reserved to the states and municipalities—the local governments which most of you represent. The Congress, however, assigned to the Bureau the activity of cooperating with the states in securing uniformity in weights and measures laws and methods of inspection. That authorization provides the primary justification for this national conference and for the other activities of the Bureau's Office of Weights and Measures of which your friend, Mr. W. S. Bussey, is the Chief.

The Bureau's work in the development of standards and physical measurements is an interesting and never-ending activity since standards must be provided in all areas of science and engineering where measurements are important. When the Bureau was established 52 years ago there were relatively few standards with which we were concerned. The very appreciable development and expansion of science and technology since that time is shown by the fact that there are now several hundred different standards that concern us, such as those in mechanics, atomic physics, electronics, and radio as well as the many branches of chemistry.

I would like to cite a few examples of recent achievements. In the microwave region of the radio frequency we have been concerned with standards for a variety of measurements. We have recently completed the development of a precise calorimeter whch permits the accurate calibration of radio power measuring devices operating at frequencies of nine million cycles per second. We have also put into operation a new instrument for measuring the magnetic properties of materials in the radio frequencies.

In the heat measuring field we have been working to extend the standards for temperature measurements both for the very high and the very low temperatures. During the past year we have put into operation equipment and techniques for temperature measurements within a few thousandths of a degree of absolute zero.

Standards for color measurement provide an important and interesting field of investigation. Quite recently we provided a new set of improved color standards for the petroleum refining industry in an area where we had formerly been dependent on rather unsatisfactory standards which had to be imported from other countries.

Even in the older and more familiar standards areas, such as length and mass measurements, we are continually striving to improve the accuracy with which calibrations can be carried out. Last year I told you of work leading to the possible adoption of an optical standard for length measurement. This fall there will be an important international meeting in Paris to ascertain some of the possibilities of this approach to a new international standard. In mass measurement there is a pressing need in many fields of science to have means of reliably weighing minute quantities of materials. We have developed a set of microweight standards with which masses of a millionth of a gram can be detected.

In order for the Bureau to carry out its work in developing new standards and improving old ones, it is necessary to conduct a strong basic research program. This program provides fundamental information on the properties of materials and methods of measurement from which the new standards and calibration techniques can be derived. Although the Bureau's initial primary purpose is the development and maintenance of the standards for physical measurement and the determination of physical constants and properties of materials, we have several additional important and substantial activities. These include the development of methods of testing materials, mechanisms and structures as well as conducting tests on such things for other Government agencies; the development of standards of practice, codes and specifications; the development of devices to serve special needs of other Government agencies; and the rendering of scientific and technical advisory services to other Government agencies. The bulk of the Bureau's current activities now falls in these latter categories.

Much of this work is classified security information and so it should not be discussed. I would, however, like to refer briefly to a few achievements in the non-standards field. Some very notable advances have been made in the field of semiconductor research. This is the area from whence that fascinating new tool, the transistor, stems. You have probably all read a great deal about this tiny device made of germanium which will do many of the jobs which ordinary radio tubes do and may ultimately lead to a widescale replacement of such tubes in the electronics industry. Since the transistor is very tiny and consumes minute quantities of power, the implications of this impending development are considerable.

There are, however, many difficulties in the further development and utilization of the transistor. The germanium has to be so carefully refined and treated that this may impose a serious limitation on the ultimate utilization of transistors. In our laboratories we have found that semiconducting materials with rectifying and transistor-like properties can be obtained from combinations of other metals, particularly combinations of indium and antimony. The possibilities of this type of development are very considerable since it opens up a wide range of new materials with interesting and perhaps better properties for possible utilization in electronics.

A new process for plating nickel was developed by the Bureau and is now being offered to commercial users by industry. Basic patents were issued to National Bureau of Standards chemists and assigned to the Secretary of Commerce. This process does not use an electrical current but depends entirely on chemical action. Coatings of uniform thickness can be applied to the insides of tubes and tanks, and in corners and sharp angles which are very difficult to cover by the usual electroplating techniques. A number of industrial organizations are now exploring extensively its commercial possibilities and its large-scale utilization.

Related closely to this, the Bureau has also developed a novel method of electroforming aluminum. This is particularly important for application to such things as waveguides which are used in the radar and microwave radio field.

Another NBS achievement has stemmed from its work on a major installation on Cheyenne Mountain, Colorado. There we have a number of transmitters located on a peak which rises abruptly above the Colorado plains. East of the mountain are a series of radio receiving stations extending as far as Arkansas. In observations taken from this set-up we are accumulating much new and important information on the characteristics of the propagation of radio waves in the very high frequency and ultrahigh frequency range. These are the frequency ranges which are used in your FM radio and television transmitters and receivers.

At the National Bureau of Standards we are very much concerned with the development of new and improved instruments, since instruments are the devices by which we study the properties of materials and by which we make calibrations. A notable instrument achievement from our laboratories in the past year was the development of a new type of ultrasonic flowmeter. Much work has been done over many years to measure the flow of liquids and gases through a variety of media. The new NBS method consists of directing sound waves through the flowing fluid and receiving the sound waves a short distance along the flow path with a barium titanate receiver. A barium titanate transmitter is also used to generate the sound waves. By rapidly converting the transmitter to a receiver and vice versa we can measure a change in velocity of the propagation of sound due to the velocity of flow of the liquid. This change in velocity provides an accurate measure of the flow of a fluid. Furthermore, it is not necessary to disturb the flow of the fluid by inserting an obstruction into the stream. The barium titanate transducers need not make direct contact with the fluid. It appears that this technique may have considerable utilization not only in the physical sciences but also in the biological sciences. Physiologists are interested in using this technique to study the properties of the flow of blood since with this instrument one can measure the velocity of flow in arteries and veins without penetrating them.

Last year I told you about the very successful operation of our large automatic high-speed digital computing machine. This was put into operation just about three years ago and for the past two and one-half years it has been on a 24-hour day, seven days per week schedule, solving a variety of problems of considerable importance to defense agencies and also for a number of basic research investigations. During the past year we have had regularly scheduled operation on another computing machine in our mathematical laboratories at the University of California at Los Angeles. The machine here at Washington is called SEAC, meaning Standards Eastern Automatic Computer; the one at Los Angeles is called the SWAC, meaning Standards Western Automatic Computer. When you visit our laboratories tomorrow, I think you will have an opportunity to see and inspect our SEAC.

Another type of relatively novel activity for a physical science laboratory is the utilization of modern statistical techniques in the design of experiments. We have a very strong statistical engineering laboratory. This staff is assisting us in many of the operations throughout the Bureau, enabling us to get more and better data with less effort. The members of this statistical laboratory are very much concerned with some of the activities of interest to the members of this Conference and undoubtedly they have ideas, suggestions, and techniques which would be helpful to you in many of your operations.

Although the examples just given are but a small part of the total activities of the Bureau, I hope they are sufficient to give some illustration of the nature of our achievements during the past year.

You may be interested in a brief reference to the so-called vital statistics. Our total budgetary operation is at about a $50,000,000 annual level. This is substantially what it was when I reported to you last year. This total budget includes 85 percent which comes to us from other agencies of the Government in payment for jobs which they want us to do for them. The remaining 15 percent, or around $8,000,000, is provided directly to us by the Congress for our basic activities. Our current staff totals about 4,800. This represents an increase of about 300 over a year ago and this increase is mainly in our field stations and represents an effort to staff to the level requested by the defense agencies. About 4,000 of our staff are working here in Washington. The other 800 are in our field stations, the largest one being at Corona, California, which is about 50 miles east of Los Angeles. There we are doing work in applied electronics for the Department of Defense.

Last year I told you that we were getting ready to start construction of a major radio laboratory in Boulder, Colorado. Construction of this laboratory, which will cost about $4,000,000, started last July and it is expected that it will be ready for occupancy about next March. Probably at this time next year the Bureau will be in the process of moving a substantial part of its radio engineering staff to that location.

Members of this conference are probably interested in the testing and calibration activities of the National Bureau of Standards. During the past fiscal year we completed over 300,000 individual tests and calibrations. Most of these were carried out for other Government agencies in connection with Government procurement, the largest single item being the sample testing of cement purchased by the Government. On this project we sampled some 15,000,000 barrels of cement and made tests from the samples selected.

Other representative examples of our testing and calibration services include tests on 4,500 light bulbs in connection with Government procurement and the calibration of 8,900 gage blocks. The latter were primarily for industry. Here it is interesting to point out that the gage block provides a basis for our mass production industry since these gages are used to insure the accuracy of dimensions necessary for the interchangeability of component parts. We also carried out over 1,800 calibrations on radioactive materials. Included in this were calibrations on about 860 radon samples taken from workers in radioactive plants. In addition, we distributed to other laboratories both in industries and universities some 33,000 standard samples. These are the materials whose accurately known chemical or physical properties provide a reference for control purposes in industrial operations.

Finally, I would like to report on some of the activities of the Office of Weights and Measures where we have attempted to fulfill numerous requests for assistance from members of this conference and others.

Following the adoption of a resolution by the 37th National Conference last year requesting the National Bureau of Standards to institute an investigation of methods of determining truck axle loads, steps were taken to initiate the work as quickly as possible in the hope that some progress could be made during the following year.

The first phase of the work, a survey of methods currently in use and under development, was undertaken. Members of our staff discussed the problem in motion weighing of vehicles and visited the installation for motion weighing on Shirley Highway in Virginia. Arrangements are currently being made to inspect several commercial installations and from these inspections and discussions by members of our staff we hope to conclude shortly the survey part of this investigation. Plans are now being made to increase our activities on this program and to carry out jointly with the Bureau of Public Roads and the trucking industry an active development program.

Since the 37th National Conference, we have lost the services of David V. Smith, Railroad Track Scale Inspector, who, after over 27 years of faithful service, retired because of physical disability on December 30, 1952. On October 6 Allen A. Williams reported for duty as a trainee in the railway track scale program. Mr. Williams' initial training was completed about a month ago, and he has been placed in charge of our testing equipment No. 2. Both of our track scale testing units now are operating on full-time schedules. Charles H. Oakley is in charge of Unit No. 1. Each of the 19 master track scales was calibrated at least once during the past year, and commercial track scales have been tested as time permitted. In many instances we have been gratified by the cooperation of State and local weights and measures officials in this program. We feel sincerely that considerable benefits to the Bureau, to the weights and measures officials, and to scale owners can be derived from such cooperation.

The Bureau has had a representative present at every State and Regional annual conference of weights and measures officials during the past year. Through these meetings we are able to maintain contact with the State and local officials and to keep informed as to the activities, progress, and requirements of the many jurisdictions. In addition we have made official visits to a number of State and local offices.

It is encouraging that improvement in weights and measures administration and enforcement throughout the Nation has continued during this year. Many jurisdictions have obtained additional and substantial testing equipment, and many States, counties, and cities have employed additional personnel. Legislative improvements have been made in several of the States.

Particular recognition goes to the State of Colorado where, on March 31, a comprehensive weights and measures law was signed by Governor Dan Thornton. The Colorado enactment is essentially the same as Form II of the Model Law on Weights and Measures, which is recommended by this Conference. We are very glad that Colorado is represented at this National Conference. I know all of you will want to become acquainted with the Colorado official who will be introduced to you during the roll call of the States.

An amendment to the Kansas Law was enacted. This amendment includes most of the package commodity sections of the Model Law.

The progress of the States in adopting the specifications, tolerances, and regulations for commercial weighing and measuring devices, as recommended by the National Conference and as published in NBS Handbook 44, has continued and is encouraging. Since the last Conference, four States have officially adopted these codes by promulgation and one by legislative enactment. These five States are Idaho, Illinois, New Hampshire, Washington, and Wisconsin. Twenty-one other States previously have adopted these requirements—they are Alabama, Florida, Georgia, Indiana, Kansas, Louisiana, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, North Dakota, Oklahoma, Oregon, Pennsylvania, Texas, Vermont, Virginia, West Virginia, and Wyoming. This brings the number of States that have promulgated these provisions to 26, and leaves only 22 States and the District of Columbia that have not revised their codes since Handbook 44 was published in 1949. We hope that progress in this regard will continue and that these 22 States will join the effort toward uniformity.

The State of New Hampshire has promulgated another recommendation of this Conference. That is the Model Regulation for Package Marking Requirements, which was tentatively adopted by the Conference last year.

Two publications of importance to all weights and measures officials and to allied commercial interests have been issued by the Bureau since the 37th Conference. The Report of the 37th National Conference became available during April of this year, as NBS Miscellaneous Publication 206. All of those who registered at the 37th Conference have been sent copies of this report.

A major publication, which has been planned for many years, is now available for distribution. It is the Weights and Measures Case Reference Book, designated NBS Circular 540. A few copies are available at the registration desk for your inspection. This document can be purchased for $1.25 from the Superintendent of Documents.

As the title implies, the case reference book is intended as an index to and digest of weights and measures decisions of record. The material is presented in lay language and furnishes condensed legal principles as expounded by the Courts. Weights and measures officials should find this new publication useful as a field manual. Information on any specific item in the book may be found through the comprehensive index. The case reference book was designed and composed as a ready guide to decisions cognate to certain definite and specific situations in weights and measures administration and enforcement. This new publication, used in conjunction with NBS Circular 501, "Federal and State Weights and Measures Laws," will furnish the official with extensive information in this field.

On the inside back cover of the program of this Conference you will find listed a number of weights and measures documents published by the National Bureau of Standards. These also are available for your inspection at the registration desk, where they may be either purchased directly or ordered for later delivery.

It is our desire to publish such material as is required by you, and as will be of definite assistance to you. We solicit your recommendations to this effect.

In order that we may continue to progress I would like to offer for your consideration and especially for the consideration of the various

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standing committees, a suggestion as to extending the activity and effectiveness of these committees. The one additional component in possible committee activity which seems to be desirable is leadership in bringing about official adoption by the several States of committee recommendations. It is my belief that members of each standing committee could furnish this leadership. For example, the standing Committee on Legislation could study the various State laws, suggest amendments or revisions thereto, and work with the State administrators towards successful enactment of Conference recommendations. The Specifications and Tolerances Committee could increase its activity toward the encouragement of adoption by the States of the requirements recommended by the Conference. The Committee on Methods of Sale of Commodities could follow its recommendations to successful promulgation and enforcement in the several States. Activity of this nature would extend the benefits of committee research and recommendations.

In closing I extend to each of you an invitation to call freely on the National Bureau of Standards for assistance in the solution of your technical problems. We know that your work is of fundamental importance to the stability and strength of the Nation's commerce. Therefore, we are at your service. Please accept my sincere wishes for both profitable and enjoyable sessions during this 38th National Conference on Weights and Measures.

REMARKS OF J. W. SAYBOLT, BUSINESS COUNSELLOR ON WEIGHTS AND MEASURES

I wish to make just a comment or two which express my own thoughts and which I believe will be concurred in by practically everyone in this group.

Mr. President, I was first introduced to the activities of the weights and measures group in 1924 and at that time began a realization of the very deep importance and value of weights and measures work to the consumer, the seller, the manufacturer, the buyer, and to civilization as a whole, and I have endeavored in the 29 years following that date to add in a small way my efforts to publicizing, on the positive side, the value of the work of this organization.

The point which has appealed to me for a considerable length of time, for years, is the deep value to those who administer weights and measures to have the supreme—I use the word objectively—the supreme guidance of the intelligence, technical knowledge, understanding and loyalty of those gentlemen in the National Bureau of Standards. It is a matter of gratification to us that the Department of Commerce, represented by Mr. Sheaffer, and the Bureau, represented by its Director, guide and lead us in an intelligent propagation and formation of laws and regulations for the conduct of this work.

Custom over the years has indicated that the Director of the Bureau does not only become ex officio, but officially by elective action, President of this association. As this group carries on its work it is our hope that that situation will remain unchanged, and may I add in conclusion, Dr. Astin, that it is our hope that you will remain as President for many, many years to come.

APPOINTMENT OF COMMITTEES

(The President made the following committee appointments:)

COMMITTEES SERVING DURING THE 38TH NATIONAL CONFERENCE

Committee on Nominations: C. A. Baker, New York, Chairman; Nalls Berryman, Florida; E. R. Fisher, Rhode Island; J. T. Kennedy, District of Columbia; R. S. Ackerman, Minneapolis, Minn.; C. M. Fuller, Los Angeles County, Calif.; Tom Webb, Nashville, Tenn.

Committee on Resolutions: J. E. Mahoney, Maryland, Chairman; C. D. Baucom, North Carolina; M. O. Nickon, Dearborn, Mich.; J. M. O'Neil, Cambridge, Mass.; A. O. Oslund, Union City, N. J.; W. H. Roberts, Vigo County, Ind.; J. C. Goll, N. Dak.

STANDING COMMITTEES

Committee on Legislation: Nalls Berryman, Florida, 5-year term, to succeed C. A. Baker, New York, whose term expired.

Committee om Methods of Sale of Commodities: E. C. Westwood, Salt Lake City, Utah, 5-year term, to succeed I. M. Levy, Chicago, Ill., whose term expired.

Committee on Specifications and Tolerances: R. D. Thompson, Virginia, 5-year term, to succeed J. P. McBride, Massachusetts, whose term expired.

Committee on Trading by Weight: G. L. Johnson, Kentucky, 2-year term, to succeed J. J. Levitt, Illinois, who retired and T. C. Beck, Oklahoma, 5-year term, to succeed J. H. Meek, Virginia, whose term expired.

Committee on Weights and Measures Education: C. A. Lyon, New Hampshire, 5-year term, to succeed J. T. Kennedy, District of Columbia, whose term expired.

HONORARY LIFE MEMBERSHIP CARD PRESENTED TO RALPH W. SMITH

Mr. Louis E. Witt: Last year the Thirty-seventh National Conference on Weights and Measures elected one of its prominent and longtime members to honorary life membership. This action was without precedent in the annals of the Conference, but the unusual award was conferred upon a distinguished and outstanding weights and measures man, Ralph W. Smith.

Mr. Smith's distinguished service to the National Conference on Weights and Measures and his lasting contributions to this body and to the weights and measures movement in general need not be recounted at this time since these things are well known to all present.

I am privileged to present to you, Mr. Smith, this engraved gold card, authorized by the Executive Committee, as evidence of your honorary life membership in the National Conference on Weights and Measures.

(Mr. Smith responded and expressed his appreciation for the honor so bestowed.)

ROLL CALL OF STATES

The Chairman called the roll of States. Delegates from 39 States and the District of Columbia responded. Delegates and their ladies were introduced individually.

ROLL CALL OF STATE AND REGIONAL WEIGHTS AND MEASURES ASSOCIATIONS

The Chairman called the roll of State and Regional Associations of Weights and Measures Officials. Representatives of all 19 Associations on record responded.

(Written reports from many States and Associations were duplicated and distributed at the Conference.)

(The Conference was recessed until 2 p. m.)

SECOND SESSION—AFTERNOON OF TUESDAY, MAY 19, 1953

(R. D. Thompson, Vice President, presiding)

PREPACKAGED FOODS

By G. F. Austin, Jr., *Deputy Sealer of Weights and Measures, Detroit, Michigan*

The importance of check-weighing or check-measuring packages of commodities, which are put up by the packer or merchant in advance of sale, is one phase of our activities, as weights and measures officials, which scarcely can be overestimated. It is true that much of this work is being done; however, it is also evident that many weights and measures officials pay very little attention to factory-filled packages of nationally advertised commodities. Perhaps the main reason for this is the somewhat perplexing problem which might arise as to how to obtain the necessary tare weights of the packages to facilitate the procedure. That is one of the things I will discuss.

It would seem that the initial approach to this subject should be to relate and put emphasis on one basic and pertinent fact. That fact is, in every jurisdiction throughout the country, there are literally thousands of manufacturers and packers of various types of commodities who, for one reason or other, are not included in the regular routine inspection itinerary of weights and measures departments. Mainly, this situation can be attributed to the very limited personnel to be found in most departments whose present numerous and important duties preclude doing extensive work in this particular field. However, it is somewhat obvious that, if each of us did take more time, we could cover this neglected field more efficiently and more economically than is the case presently. Actually, we would find dividends resulting therefrom. In supervising this matter at the source, we would find more adequate facilities and means for determining the tare weights for various packages. More packages could be examined with less effort and in shorter time. Then, too, each manufacturer or packer would be alerted more fully and frequently to any irregularities and to their responsibilities, insofar as weights and measures requirements are concerned. A united effort, using this approach to the problem, demands full consideration by each and every one of us. Remember that, if all departments cooperated effectively in this matter, we would not have to resort entirely to the more difficult way of accomplishing the desired end.

One field testing procedure involves an extremely laborious effort to obtain the vital preliminary information relative to the tare weights of millions of packages. In Detroit, we resort to both of these approaches and we do make a real effort in both directions.

When we plan to inspect manufacturers' packages in the retail stores, we start our preparations months in advance by collecting a widespread assortment of cans, bottles, paper containers, etc. We obtain at least six or more containers of each commodity. The containers, when emptied, are used to establish an average tare schedule. Next, and of extreme importance, when we collect these containers and before establishing a mean or average weight of same, we make sure that each container is complete in every detail; that is, containers should be complete with closures; labels should be complete; the containers thoroughly cleaned, etc.

Proceeding from this point, consideration must be given to the material of which these containers are made. The metal containers lend themselves to the establishment of a mean tare weight, as do the paper containers. However, you will find that the glass containers' weights vary slightly more. These variations are not sufficient to invalidate their use for the checking purposes. Keep in mind that this type of survey should be predicated in most respects on the average, rather than on the individual unit weights. When you have established the list of mean tare weights for each of the containers on which you are able to get advance information, you then are ready to go into the field to make the survey.

As a starting point, in instances where the manufacturer or packer is not located in your jurisdiction, the most desirable place would be in the warehouses of the wholesale grocer or the chain store operator. There you are most likely to find an abundance of the commodities for which you already have an established list of mean tare weights. Ordinarily, you will find these people very cooperative and interested in your program, and many times they extend their interest to the point of opening up packages of commodities other than those you have on your prepared list, thereby enlarging the scope of your initial program and providing you with additional mean tare weights.

For the purpose of this survey, the use of an over-and-under type scale with $\frac{1}{16}$-oz graduations on the chart is recommended. Another suggestion would be to have some specially-prepared report forms for this type work, similar to figure 1. This form contains columns for such information as name of commodity, trade name, name of manufacturer, content statement, weight of container, whether the container is made of glass, tin, cardboard or paper, place of inspection, and also a column to indicate whether the content statement is correct as to form. From time to time, you may find it desirable to take your

Date ______

COMMODITY		TRADE NAME	NAME OF MANUFACTURER	CONTENT MARKING	WGT. OF CONT.	SIZE OF CONTAINER OD in inches	G. T. C.	PLACE OF INSPECTION	CONTENT STATEMENT
	A								
	O								
	S								
	A								
	O								
	S								
	A								
	O								
	S								
	A								
	O								
	S								
	A								
	O								
	S								

FIGURE 1.

over and under reading from the chart in the units of 1/16 oz, 1/8 oz, or 1/4 oz; so, for the purpose of recording such information, a space is provided at the extreme left-hand side. The need for the use of one or the other of these units is predicated principally on the utility of such information when computing the average weights of the packages. Directly opposite this space, there are three lines provided to record the variable for each unit checked. One line "A" for the approved, one line "O" for those overweight, and one line "S" for those that are shortweight. At the far end of these lines, you will find a column to indicate the number of units checked in each of the categories, "Approved," "Over," and "Short." The end space is also used to record the "average" finding on those particular packages. One column, you will observe, is headed "G," "T," "C." These letters were used for the sake of brevity. They represent the material of which a particular container is made—glass, tin, and cardboard or paper, respectively.

In addition to this phase of our special program activities relating to prepackaged merchandise, there are five other principal phases:

> The checking of prepackaged meats, frozen foods, wholesale meat deliveries, wholesale packages of fruit and vegetables, and packaged milk in cartons.

The prepackaged meat problem, like that of frozen foods, is of fairly recent vintage, dating back but a few years. It is interesting to recall that, in the early stages of this development, when prepackaged meats were making their bow, the industry made great demands for shrinkage tolerances. In the course of events that followed, a poll was taken on this subject by a weights and measures official. The replies definitely indicated that all city and by far the majority of State and county weights and measures officials were opposed to the establishment of such tolerances. In addition, supporting our general idea in this matter, we were fortunate in having a representative from the National Association of Retail Grocers address our 35th National Conference. This man made the following remarks in the course of his talk:

> Most of you in session here are quite naturally interested in prepackaged perishables from your own perspective of weights and measures. While I realize that I am "sticking my neck out" by dealing with this phase of a subject on which you are so well informed, nevertheless I am going to air some of my views and reveal certain weaknesses prevalent under this new method of packaging. May I say in advance, however, that, while our store has its own share of problems, prepackaging and otherwise, the following are not among them:
>
> (1) *Short weight and overcharging.*—The "bugaboos" can be largely overcome by first fixing prices a cent or two per pound higher and allowing 1/4 oz. for shrinkage, provided needs beyond two days are not anticipated.
>
> (2) *Tare allowance.*—Some merchants apparently overlook the fact that only the net contents can be priced to the consumer. They should be reminded otherwise.
>
> (3) *Proper refrigeration of smoked meats.*—There is a tendency to display these atop the case or in mass floor displays, with a resultant shrinkage of 10 percent or more in a matter of days. This practice should be discouraged. All smoked meats except those of old cure should be kept under refrigeration.

These announced opinions represent some of the early answers to the frantic demands of industry for shrinkage tolerances. Time has proved this was not the real answer to the situation. Since then, as you no doubt have observed, great forward strides have been made by the packers of these commodities. They have eliminated most of the difficulties which were present at the beginning of this enterprise. Today, with the use of new and improved packaging materials, with improved packaging know-how, and the continued improvement being made in refrigerated self-service display equipment, they seem to have the situation fairly well in hand. Other progressive steps which contributed to this improvement were the advent of the special prepackaging scales, selecting people to do the scaling on the basis of their greater aptitude for this type of work, and the special training given the people to prepare them for the job. For recording this type of work, we recommend a form similar to figure 2.

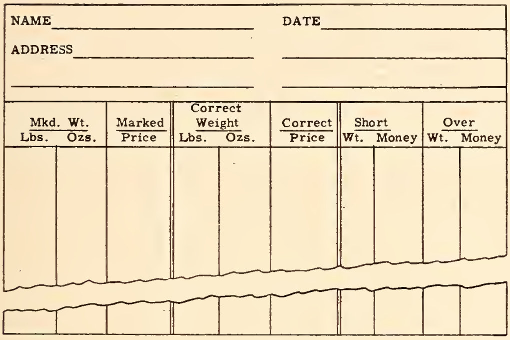

FIGURE 2.

With the weight problem fairly well out of the way, the matter of proper labeling them became a controversial issue. At first, most all labeling indicated only the net weight and the total price of the package. This did not provide the purchaser with a ready answer as to how much he was paying per pound. Fundamentally, at least, this was not a weight or measure problem, but, inasmuch as it was closely allied to the subject of consumer protection, much was made of it in our circles, with the result that some jurisdictions developed new laws and regulations which required, in addition to the net weight and total price, the price per pound quotation. Now, with laws or no laws to this effect, the industry generally has adopted this form of labeling. In addition, these labels usually carry a code which shows the day of the week the package was prepared. This information helps the merchant maintain a better control over the weight situation.

The method used by weights and measures inspectors to check-weigh this type of merchandise varies somewhat in different jurisdictions. For the most part, nearly all demand that the average net weight be correct, allowing in some instances a variation of ⅛ or ¼ oz. plus or minus on an individual package. This seems reasonable. There is a controversial point which might bear some discussion. That is the question of whether to use a duplicate dry container as a counterblance for the wrappings or the wrapping of the particular package, which may be saturated in one degree or other with the natural moisture which has separated from the commodity. It seems that the latter procedure should be adhered to, for the reason that, if we did not employ this method, the door would be left wide open for packers of dried fruits, beans, etc., to claim the same advantage. They, too, have a similar problem. This inevitably would terminate into a chaotic situation.

Other problems in this same field are meats and poultry in cans. This matter, which borders on the subject of short weight, frequently is brought to our attention, and, here, reference is made to the volume of liquid, in the form of gravy or meat juices contained in such packages, and included in the net content declaration. This particular matter was discussed on a limited basis at one of our previous Conferences, and a statement was made by Mr. Queen of the Food and Drug Administration as follows:

> No regulations have been promulgated under the Federal Act stipulating allowances that will be made in the "labeled weight and the actual drained chicken weight on whole chicken" in which a liquid substance has been used as a packing medium. We would regard the use of an excessive amount of such a packing medium in canned whole chickens as an adulteration and amenable to the general adulteration provision of the Federal Act. . . . In the case of whole chicken in gravy, when labeled as such, we would not object to a declaration of the combined weight of the chicken and gravy as the net weight of the packaged product. Such a product would, of course, be subject to the considerations noted above in respect to adulteration. In accordance with Food Inspection Decision 144, issued May 11, 1912, we hold that the chicken should, as nearly as is practical, fill the container, and that the gravy should occupy only the space that would otherwise be unfilled.

Problems of this kind, no doubt, will plague us for some time, but this mention is made of the canned meats and poultry simply to illustrate one of the many complicated situations prevalent in connection with the prepackaging of foodstuffs. In this respect, it is hoped that the development of closer controls will make for considerable improvement and thereby lessen this particular difficulty. Frozen foods, in many respects, also need our close supervision, and, with the cooperation of the Food and Drug Administration, it is quite likely that most of these varied problems will be diminished considerably.

The check-weighing of wholesale meat deliveries is done in the shipping rooms of the packers and jobbers, and, in addition, on deliveries being made from delivery trucks which have established routes. Much of this weighing is done on the customer's scales at time of sale.

Fresh fruits and vegetables in bags, crates, and boxes are check-weighed at the large fruit and vegetable terminals, and also in the warehouses of the large grocery outlets. For this purpose, we have a five-foot folding tripod with detachable lifting arm having a leverage ratio of 3 to 1, a 100-pound, ¼ pound-graduation, dial scale with a hook attached, and a few feet of rope.

Packaged milk in cartons also receives our close attention. We have devised a rather unique procedure by which to handle this matter, which will be brought to your attention later in the program, when another speaker will present a paper on the subject.

The percentage of time allotted to any of the various phases of our special project investigational work depends principally on the conditions which we find to prevail from time to time.

In the course of this talk, I have attempted to cover the whole field of prepackaged commodities. Now, and in conclusion, I would like again to focus your thoughts on one of the initial items, the matter of the factory-filled packages of nationally advertised commodities, by taking the liberty of repeating what I term to be the quintessence of this subject; namely, if each of us did take more time in the check-weighing and check-measuring of manufacturers' packaged commodities in the factories or packing plants, we could save an enormous amount of time and trouble, and indirectly accomplish this Herculean task more efficiently and economically.

Mr. Mundy: In my jurisdiction we find it most difficult to determine the tare weight of any particular package without opening the package and thus reducing the profit of the merchant whose establishment we are checking. I feel that our attention should be focused upon some definite policy with regard to tare weights of containers and that this policy should be recommended by this Conference.

In Virginia, one of our problems concerns smoked meats. I believe that hams and bacons should be packed in cases and that the tare weights should be indicated on the outside of such cases.

Mr. J. M. Galloway: In Indiana, our greatest problem seems to be items packaged at the retail store. Much of this difficulty is caused by the large turnover of labor in these retail outlets. I believe one solution to the retail problem would be an extensive educational and training program, participated in by all personnel who actually prepack and label food items.

Mr. Thomas: All weights and measures men are very much interested in this problem. Since it is a matter of concern to all of us, I believe a general discussion on methods of procedure would be beneficial.

Mr. Mundy: In the City of Richmond we endeavor to checkweigh prepackaged goods in a comprehensive manner; in fact, during the past year we weighed more than 73,000 packages of merchandise. We have discovered that a merchant cannot prepackage goods adequately and accurately on a conventional computing scale. Our method of operation in this field includes the weighing of the items, the finding of the tare weights, and the proving of the net contents.

Mr. Slough: We must realize that the average super market has from 50 to 80 thousand packaged items in the store. Many of these items are not packaged locally and those too should be checked. One method of operation under a limited budget would include the careful weighing—gross, tare, net—of every food item purchased for consumption by weights and measures officers and their families. A department employing six people would cover the field fairly well during 1 year.

REPORT OF COMMITTEE ON TRADING BY WEIGHT, PRESENTED BY J. FRED TRUE, CHAIRMAN

Your Committee on Trading by Weight has made a survey of the States to try to find out how much interest and how much opposition there is in the trading by weight movement. We find that a number of States have no interest in a change, also that a number of States have been on a weight basis for several years. A number of items which have a legal weight per bushel are always weighed, and the term bushel is used to indicate a given amount of weight. There are some items which actually are sold by the bushel measure. In these cases, the bushel is used as a measure.

We sent a letter to each State inquiring about the interest in their jurisdiction, also asking them to check the legal weights of a number of items, such as the farm grains, which move in volume. We made no attempt to check every item, because some of the items are not important to most of the States.

The following quotation is from the Agriculture Research Administration of the United States Department of Agriculture, Washington, D. C.:

Unit of Measure. In the interest of economy and greater uniformity in the handling of grain, an effort should be made to measure the merits and evaluate the problems involved in shifting trade in grain from "bushels" to 100-pound units. The investigation should include a study of legal obstacles, institutional changes, and statistical data adjustments required in event such change was instituted.

Following are statements received from various States:

Alabama: There is a definite trend in Alabama to get away from the bushel and use weight instead. The majority of sales and a considerable number of the quotations on the products shown on your list are by weight instead of the bushel. When the bushel is abandoned entirely and weight alone employed, it will be much better for all of us, as there are quite a few varying weights per bushel among the States.

Arizona: In reply to your letter of March 12, the State of Arizona uses weight instead of dry measure in the sale of all commodities.

California: The California law provided for weights per bushel for the following: flax seed, oats, rye, wheat, Indian corn (shelled), barley, and buckwheat.

Georgia: You ask in your letter if there was a move in Georgia to do away with the bushel measure and use weight instead. If there has been any move to this effect, it has not been brought to my attention.

Idaho: The State of Idaho already has done away with the bushel measure and uses the weight system entirely.

Illinois: There seems to be no interest in our State to do away with the bushel and use weight instead.

Indiana: I do not believe there is much widespread interest in Indiana to do away with the established weight per bushel. About the only exception would be in the case of ear corn. Grain dealers frequently express the opinion they would like to see this provision eliminated from the law and that all sales be made on the basis of hundredweight. For some reason or other, they have not introduced a bill, to my knowledge, which would repeal the weight-per-bushel provisions for ear corn.

There is nothing in our law which prevents the buying and selling of commodities, for which bushel weights have been established, on a hundredweight basis. In fact, many of the commodities listed are now sold on a hundredweight basis. Notable among these are corn meal, middlings, salt, etc. In some sections of the State ear corn is being bought and sold on a hundredweight basis.

Louisiana: In reply to your letter of March 12, regarding the bushel or dry measures in this State, beg to state that with a very few exceptions practically all commodities are sold by weight.

Maine: At the present time, as far as we know, there is no effort to do away with the weight by bushel in this State.

Maryland: This is to advise that the legal weight per bushel of the various commodities were repealed when the new weights and measures law was enacted by the General Assembly in 1950. Such legal weights were not re-enacted.

Massachusetts: Our law provides that all fruits, nuts, vegetables, and grain shall be sold at retail by avoirdupois weight or numerical count unless the same are contained in original standard containers.

Michigan: Your letter of March 12 asked, "Is there any interest in your State to do away with the bushel and use weight instead?" Speaking for Michigan, there is some sentiment for selling such commodities by weight instead of by the bushel. I think it would be a very desirable objective for our Conference.

Minnesota: In reply to your inquiry relative to any movement or interest displayed in Minnesota to sell by weight in place of volume, the answer is in the affirmative.

The enclosed bushel list is indicative of this fact. All commodities appearing on this list must be sold by weight when bushel reference is made. For example, if one were to purchase a bushel of potatoes, there must be sixty (60) pounds delivered; of tomatoes, the weight shall be fifty (50) pounds.

It follows then, that insofar as reference to the bushel or fraction thereof, the weight as given on the bushel list must prevail; therefore, the bushel has lost its identity and said commodities must be sold by weight.

New Hampshire: I am definitely in favor of doing away with the bushel and selling entirely by weight.

New Jersey: With the exception of certain seeds, New Jersey long ago abandoned the use of dry measures for quantity determinations in relation to fruit and vegetable commodities.

New York: Formerly Section 190 of the New York State law set up a list of weights per bushel for a number of commodities, but in 1939 this Section was repealed and a new Section 190 was enacted which reads,

> Sec. 190. Sales of fruits, vegetables, grains and nuts. Except when sold in the original container, fruits, vegetables, grains and nuts shall be sold at retail by avoirdupois weight or numerical count.

Nevada: * * * dry measure, such as bushel, peck, etc., is not or never has been used as a basis of measurement in the sale of any commodities, to my knowledge. In lieu thereof, such products are sold by weight, or in some cases, numerical count.

Ohio: You may be interested in knowing that the Sealers' Association is sponsoring a Bill which would delete the weight per bushel of ear corn and corn meal.

We would like to have gone further and included wheat and oats but the grain industry feels that the custom of buying and selling by the bushel of these two grains is still too imbedded to make this change now.

Oregon: As Oregon laws do not permit sale by bushel weights we are not returning your mimeographed copy of legal weights.

Pennsylvania: I am very much interested in eliminating the use of dry measures in the State of Pennsylvania; however, up to the present time we have not been able to have our laws changed to this effect. Until such time as we can convince the General Assembly that this is the worst method of sale for dry commodities, we must permit the use of dry measures.

South Carolina: In reply to your question if any interest is being taken in this State to abolish the bushel measure, we have given the matter some consideration, but so far our General Assembly has not repealed this Section of the law.

Utah: Our weights and measures law does not establish legal weights per bushel of any commodity.

Any commodity which is in an enclosed package is required to be labeled with the net weight in the package.

The bushel, however, is used a great deal in sale of fruit and vegetables, established by common practice for many years. I do not know of any expressed interest toward doing away with the use of the bushel in this respect and replacing therefor the use of weight.

Virginia: I have your letter of March 12 in regard to the Committee on Trading by Weight, and hope that the Committee will be maintained. It seems to me we should work along the lines that we have been and develop new ways of bringing about these changes.

It might be beneficial if those in charge of the inspection of grains and those in charge of weights and measures would cooperate in the formation of an association to discuss the benefits of trading by weight. I am offering this as a suggestion for your report.

I insist that a committee still continue to work on this matter, as I believe it is a worthy cause, even though the ultimate objectives will take many years.

Vermont: With reference to your inquiry regarding interest shown in this State to the doing away with the so-called "dry measure," we have drifted away from the use of dry measure in nearly all transactions in this jurisdiction. Of course, the table of equivalent weights is used to some extent, but there is practically no use of dry measure as such.

Washington: I have filled in a few items that are required in our State; however, the interest here is very keen to do away with the bushel and use weight instead.

Wisconsin: There is no interest in this State to do away with bushel weights at this time. However, I strongly suggest that we get away from bushel weights on such items as apples, peaches, pears, etc., which are packed in standard containers.

It does not appear logical that we require 44 pounds of apples in a standard bushel when it is impossible to get this weight into the standard basket when all varieties, sizes, and ages of apples are concerned.

We recommend that the Committee be continued to give encouragement and help to this movement wherever possible. Trading by weight has many advantages. We feel that all State departments should encourage trading in all commodities by weight.

Mr. Kalechman: I believe our first work in this direction should be with the U. S. Government. Merchandise packed in a standard bushel container must be sold as a bushel, regardless of weight. In the State of Connecticut if a bushel is packed in any other container, it must, of course, be sold by weight. I think that the U. S. Government should be asked to cooperate with this Conference toward a goal of selling by weight only.

Mr. True: A bushel by volume may weigh anything, depending upon the commodity. Some States require that a bushel or basket of apples weigh 48 pounds. As you know, many times it is difficult to get 48 pounds of apples into a standard bushel container. In selling by volume the method of packing is very important.

Mr. Blickley: Since different varieties of apples weigh differently, it would be almost impossible to set a true weight per bushel for all varieties of apples.

Mr. Gray: The State of Nebraska has a law requiring 48 pounds to the bushel for apples. I think many States have similar laws. We found it difficult to enforce this requirement until we got a legal opinion from our City Attorney that, regardless of the fact that the apples were in a U. S. standard bushel marked "1 U. S. Standard Bushel," the State requirement was not met unless the basket contained 48 pounds of apples. Based on this opinion we instituted proceedings against one retailer and, after many hours of consultation they agreed that they would stamp on each basket the minimum weight of the apples contained.

(The Report of the Committee on Trading by Weight was adopted by the Conference.)

PRE-PACKAGED-ICE-CREAM MEASURE-CONTAINERS

By D. H. Williams, *International Association of Ice Cream Manufacturers*

The matter of a weights and measures problem in the half-gallon ice cream container became apparent about two years ago. At that time, sealers of weights and measures found it very difficult to measure the volumetric capacity of the half-gallon rectangular container due to the variety of dimensions and the bulge in the face panels of these containers found in commerce. In addition, it was found by subsequent displacement measurements that the actual volume of ice cream in over 400 half-gallon packages tested from 119 to 129 cubic inches, the liquid half gallon being 115.5 cubic inches. This variation in contents not only fell outside the tolerances of the proposed code, but it contributed to a texture quality defect in the ice cream caused by the container's distortion inducing overrun variations.

At the 36th National Conference on Weights and Measures a resolution was passed, as you recall, that this carton, a measure-container, should be filled without apparent distortion. A distortion problem was created by the inherent properties of container design which allowed a natural bulge in the face panels of the container.

The Simplified Practice Committee of the International Association of Ice Cream Manufacturers and representatives of the Paraffined Carton Association went to work to see what could be done to resolve this distortion factor. It should be made clear at the outset that this problem was investigated jointly by the three interests, the ice cream industry, the carton industry, and the National Conference through its Committee on Specifications and Tolerances. Basically, the half-gallon container was an industry problem, to be worked out by the industries involved, with the assistance of the National Conference. The approach was a lengthy series of displacement tests. Half-gallon containers, filled with hardened ice cream, were immersed in cold brine and the displacement measured volumetrically. This displacement procedure, while recognized by Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, was not acceptable to weights and measures officials, since it was not adaptable for use by sealers in the field.

Our problem then was two-fold. We had to develop a test which regulatory people could use under field conditions to determine accurately the volumetric contents of the container, and carton dimensions would have to be agreed upon which would provide a tolerance for the degree of bulge in the face panels. A later development, with which you are not so directly concerned but which facilitates your work nevertheless, was the standardization of container sizes to a limited number. The latter phase of the work has progressed to the point where the Commodity Standards Division of the Department of Commerce has distributed a proposed Simplified Practice Recommendation for two styles only of rectangular half-gallon containers. Already, several hundred acceptances for this proposal have been received from the industry, and the latest word received from the Commodity Standards Division indicated that no disapprovals had been received.

To return to the original problem, Mr. Holmes, and Dr. Skelton of the Ice Cream Association devised a type of caliper instrument with which they measured hundreds of assembled empty cartons to determine the average bulge or distortion due to assembling the carton. At this point conferences were held with the Specifications and Tolerances Committee for their guidance and approval. Acting on their recommendation that these cartons be tested by filling with water while under support, a formula was developed which could be used to determine the dimensions of a supporting collar or form that would take into consideration a tolerance for normal distortion in the container due to assembling. The formula agreed upon was that the inside dimension of the supporting form is based on center-of-score to center-of-score measurement, plus two thicknesses of stock, plus $\frac{1}{16}$ inch.

Using this formula, our industry committee made up sample cartons and proceeded to test them by filling with water. This procedure was adopted by the 37th National Conference last year and is written up and illustrated in the printed Report of the 37th National Conference which all of you have seen by now. Once the testing procedure was accepted, adjustments in carton height could be made so that the volumetric contents fell within the tolerances prescribed in the Tentative Code for Pre-Packaged–Ice-Cream Measure-Containers. These adjustments were made where necessary and the result, with standardization as the ultimate objective, was the development of the number 1 or "Squat" type and the number 2 or "Tall" type rectangular half-gallon container. The dimensions of these two containers are, respectively:

No. 1. $3\frac{1}{2} \times 4\frac{13}{16} \times 6\frac{47}{64}$ inches.
No. 2. $3 \times 5 \times 7\frac{19}{32}$ inches.

Both of these containers have a cubic capacity sufficient, under the conditions of the test approved by the 37th National Conference, to fall within the tolerances prescribed by the Conference, and published as correction sheets to the National Bureau of Standards Handbook 44.

The inside dimensions of the restraining forms for use with the two styles of containers, if the containers are made of board having a thickness of 0.024 inch, are, respectively:

No. 1. $3\frac{39}{64} \times 4\frac{59}{64} \times 4$ inches.
No. 2. $3\frac{7}{64} \times 5\frac{7}{64} \times 6$ inches.

Arrangements have been made by representatives of the Paraffined Carton Association to have the restraining forms fabricated and made available to weights and measures officials who wish to purchase them. Quotations for these forms are available from Mr. Raynor Holmes, Bloomer Brothers Company, Newark, New York. Mr. Holmes is in the room today and will be available for any questions you may wish to direct to him either now or at the conclusion of the meeting.

In just a very brief summary I want to review the progress which was made in developing a satisfactory half-gallon rectangular ice-cream container.

1. Normal distortion, i. e., that due to assembly of the container, was determined.
2. A test procedure was agreed upon.
3. Formula was developed for the determination of the dimensions of the supporting collar or form.
4. Container dimensions were determined from statistics taken from the volumetric testing of hundreds of containers.

Finally, we have offered a standardization of two containers to the industry. Individual acceptances from the ice cream and carton industries, and weights and measures officials over the country are being received at the Department of Commerce today. As a result of this work we feel that we have gone a very long way in assuring uniformity of contents and fair measure in the half-gallon rectangular container.

(Mr. Holmes commented on the development and availability of restraining forms to be used in testing pre-packaged–ice-cream measure-containers.)

PAPER MILK CONTAINERS

By D. M. Turnbull, *Deputy Sealer of Weights and Measures, Seattle, Washington*

The typical weights and measures department of our average American community is confronted with a great variety of complex problems. Often, because of limited personnel, it is necessary to employ certain so-called short cuts in the field of supervision. The weights and measures official must inspect the many and varied types of weighing and measuring devices and must also maintain a constant surveillance over the countless products that are packaged and sold by weight or measure. He must, of necessity, devise methods of control by spot check that are both speedy and effective, as it would be patently impossible to inspect each individual commodity in his jurisdiction.

Changes in American methods of merchandising quite often necessitate changes in our weights and measures approach. Years ago one would have believed that the milk bottle, long an institution, was an irreplaceable article in our daily living. Now, and with all indications of staying, the paper container, or carton, is supplementing the bottle in the delivery of milk. What no doubt has proved to be a vast improvement in the industry has at times presented a somewhat difficult problem to the weights and measures official. The transparent glass milk bottle presented a comparatively minor problem, as all the inspector had to do was see that each approved bottle was filled to the proper level—generally ¼ inch below the cap seat. Each bottle was, in effect, a liquid measure in itself; but, with the paper container, a sealed unit, there is no "fill line." Thus the question: "How can I determine whether this carton of milk contains full measure?"

This question has assumed national importance. Jurisdictions throughout the country now are asking the same question and are trying to find a satisfactory method of constant measurement control of this vast industry.

The gravimetric system is a practical answer to the problem of checking dairy products prepared and sold in paper containers. This method simply establishes the weight of a commodity sold by liquid measure. Check-weighing is done in the field and has proved to be an excellent means of control in our work in Seattle. When the inspector goes into a grocery store for the purpose of checking the computing scales, he can check-weigh a number of cartons of milk quickly and thereby employ a constant supervision of the industry, and still not spend an excessive amount of time in so doing.

We use the following sample form in recording the weights of each firm's products in the various sizes marketed:

Commodity	Weight of Container	Liquid Test Measure and Slicker	Net Weight of Commodity	Gross Weight of Commodity

In the first column under "Commodity" we list each product in its various sizes, and on our keenly-sensitive even-balance scales we establish the weight of each size container, making sure to include the small tab used as an opening device by some manufacturers. We then weigh the liquid test measure and slicker plate by balancing off against accurate test weights on the opposite platter. The scale then being in balance, we fill the test measure with the commodity involved and again bring the scale to balance by adding weights to the other platter, the amount of weight added being the net weight of the commodity. The weight of the container and tab added to the net weight of the commodity gives us the gross weight to be used in the field. This figure is checked once again by actually "balancing off" a container holding the exact liquid measure against test weights. For purposes of accuracy, all weights are determined very accurately. However, in the field, merchants' scales often are used and when, perhaps, it is not possible to read closer than a quarter ounce, we find it satisfactory to read the scale plus or minus.

At this point it might be well to stress the importance of using extreme care in the entire procedure of gravimetric checking. Precision should be exercised in the process of determining the commodity weights. The inspector must watch constantly for changes in design or weight of the material used in the paper container. These changes could be made by the manufacturer without notification. The maker of the container conceivably could alter the weight of his product using more or less wax in the coating which, by changing the tare weight, would change the gross weights arrived at by calculations in the laboratory.

The inspector also must be alert to recognize variations of butterfat content which would cause slight differences of weight in establishing his net commodity weights. He must also establish these weights under constant temperature—taking into account expansion of the butterfat content of the commodity he is weighing. Changes of this nature, if not recognized by the inspector, would make his method of constant measurement control worthless.

Whenever it becomes necessary to correct discrepancies found in the field through the courts, there is but one course to follow. The product must be proved short liquid measure, weight no longer being a factor. Evidence of short weight in a charge of short measure very likely would not be admitted in the courts. In the event a large stock of a certain dairy product was found exorbitantly short by gravimetric check, a representative number of containers could be checked against certified liquid measures. If this test bore out the gravimetric result, the evidence doubtless would be admitted as proving the entire lot short measure. This case is comparable to a short weight delivery of coal. The inspector can determine the cubic content of the bin and, knowing the number of cubic feet in a ton of that particular coal, can come very close to computing the weight deficit. However, in presenting a case in court, the burden of proving short weight rests on the inspector. Obviously that would necessitate actually weighing the coal in question.

The gravimetric system of check-weighing is a ready method of indicating a condition and as such has proved invaluable to the official in his effort to protect the buying public.

Mr. Saybolt: From a tolerance standpoint, it seems to me that paper milk containers should be required to maintain the same degree of accuracy as are glass milk bottles.

Mr. Crawford: The only truly accurate way of determining the quanity of contents in a paper milk container is through a volumetric test.

Mr. Howard: In Miami, Florida, we have found that we can control the volumetric content of paper milk containers by checkweighing them. We have obtained the tare weights of the cartons from the manufacturers and have determined the weight of the milk ourselves.

Mr. J. P. Leonard: I believe the place to control this problem is in the plant where the containers are filled. One principal cause of short measure is overspeeding the filling machine.

Mr. Arrandale: I would like to inquire as to the possibility of requiring and enforcing "fill line" provisions on paper milk containers.

Mr. Crawford: It would be impossible to put a mark on a container and enforce that mark as a fill line when such container is not rigid and is not constructed to be a measure.

Mr. Andre: I think our prime purpose is to see that the consumers get a full quart of milk. I would like to say for our company, and I think the paper container industry generally, that we are willing to operate within reasonable tolerances.

Mr. Kellogg: I believe milk cartons are filled at about 50° F. I would like to know whether or not temperature changes are accounted for in these checking procedures.

Mr. Turnbull: Since the coefficient of expansion of butterfat is only 0.00064, any expansion or contraction would be negligible.

Mr. Walton: In Dallas, Texas, we have taken the attitude that the paper milk container is merely a container and that the machine itself is the measuring device. We have no specifications, tolerances, or regulations dealing specifically with milk filling machines, but we do consider them to be measuring devices and we endeavor to regulate them accordingly. In the early history of milk in paper containers one of the greatest difficulties was caused by leaking cartons. That condition has been improved, and we now have very little trouble with short measure resulting from leaking cartons. We believe it is impossible to consider the paper container as a liquid measure. As you know, the carton bulges after it has contained milk for any length of time.

We require that paper milk containers be properly labeled just as any other packaged food item.

Mr. Mundy: Mr. Walton, how do you handle a complaint from a housewife who claims that she has received short measure in a paper milk container?

Mr. Walton: We make a volumetric check on the contents of the carton in question. If a shortage is found, we determine the code on the particular carton—a code which informs us as to the date that that carton was filled. We then go to the retail outlets and endeavor to locate other cartons with identical code. These cartons are checked gravimetrically in the retail store. We check the cartons filled on the particular day and also those filled the previous day and the day following. If any shortage is found, we go directly to the creamery and attempt to determine there what caused the shortage.

HIGHWAY TRUCK WEIGHING

By J. E. Nicholas, *General Manager, Indiana Motor Truck Association, Indianapolis, Indiana*

I propose to put before you one of the trucking industry's greatest problems of the present time. How can there be accurate and uniform weighing of trucks nationwide? This is the problem of America's second largest industry, second only to agriculture, with one of ten pay checks now coming from the trucking industry. Trucks are moving 75 percent of the freight tonnage moved in this country.

Let's face the problem of highway truck weighing. In Indiana over 900,000 trucks are weighed annually by the State Police Department alone. Our State Police Department has adopted the best known techniques for truck weighing through cooperation with our Division of Weights and Measures and our Highway Department. They have seen to it that State-owned platform scales were properly installed in Indiana.

Overloaded vehicles are now running less than 0.8 percent and most of these violations are of minor axle-weight overloading resulting from misloading, shifting of cargo, or error in scales at the point of loading where the vehicle was checked before going onto the highway.

We find that there are hundreds of commercial scales in our State where the approaches are not proper for multiple-draft weighing and I am sure the same conditions that exist in our State exist in many other States, and mind you—merchandise is bought and sold daily over these scales and every time a purchase or sale is made somebody receives improper weight. These are the scales that grains, feeds, and coal are bought and sold over day after day. And, these are the same scales, available in every community, that are often used for checking motor vehicles before they go out on the highway. We often find that even new scales installed for weighing trucks by the multiple-draft procedure are inaccurate.

It is time that uniform methods were adopted in the various States for the weighing of motor trucks and more specifically—multiple-draft weighing. Over the years standards for single-draft weighing have been established and well received. Research papers on multiple-draft weighing of motor trucks, with some very basic recommendations, were delivered as far back as the 28th National Conference on Weights and Measures on June 2, 1938, by C. L. Richard of your National Bureau of Standards.

Mr. Richard's paper showed that errors as great as 3.2 percent were possible when the approaches to scales were not of zero grade. He also showed that such things as brakes being applied while the vehicle was being weighed seriously affected the obtaining of true weights. If the report of Mr. Richard had been heeded and the States had adopted standards for multiple-draft weighing installations and standards for single-draft weighing installations, the opinion of many people would be greatly changed concerning scales and their use.

Actually I think the American public and the American businessman are being cheated by not having scales approved in two brackets. One classification of scale should be that where the approaches are not of zero grade. This type of scale should be approved only for single-draft weighing. Another classification should be that where the approaches are of zero grade and the scale properly installed. This scale, and this scale only, should be approved for multiple-draft weighing, if the American public is to be treated fairly.

Now let me get into the subject of weighing trucks on loadometers. Following this paper is a copy of a communication from Captain Kermit E. Lewis to Arthur M. Thurston, Superintendent of the Indiana State Police. The subject of this report is: "Weighing Techniques For Specially Designed Trailer Equipment." This particular piece of equipment was a tandem of very rigid nature and contained a load of acid. The more rigid the vehicle the greater the chance for error.

Let me say that experience shows that less rigid vehicles weighed by a single pair of loadometers under one side and then under the other side of the vehicle will just give you a lesser amount of error because of a lesser amount of torsional pressure delivered to the rear wheels of the semitrailer resting on two scales.

Those present at this experiment were representatives of the State Highway Department, State Police Department, trucking company owning the truck, Standard and Sinclair Oil Companies and Dr. R. G. Sturm, a physicist of Purdue University.

What brought about this investigation was that weighing with two loadometers upset simple arithmetic. We knew what the tandem tractor-trailer unit weighed empty. We knew the volume of the load of acid and therefore the weight of it. We added the weight figures and the gross was under the legal limit. Yet, the unit was seized by State Police, using two portable scales, because it was 7,000 pounds overweight, according to them. We showed the State Police our arithmetic so they agreed to an investigation. And the result of that is this report attached. We found out not only what was wrong but we also learned that the error is less when four loadometers are used instead of just two. The error in this case, with only two loadometers, was 10 percent. With four loadometers, the error was within the 0.5-percent tolerance.

This report has been circulated by various national groups since November 1, 1949, yet I understand there are States that are still improperly using the loadometer. Drivers are being convicted in courts today for being a very few pounds over the weight law and there is a serious doubt in my mind if they actually are overweight.

We in the trucking industry, big and little operators alike, expect to be regulated. But, we feel we have the right to expect that all the machinery used in this regulation, whether it be a law or an administrator, or even the weighing scales, be fair and be exact, and that procedures and practices be uniform.

November 1, 1949

From: Kermit E. Lewis, Staff Captain.

To: Arthur M. Thurston, Superintendent.

Subject: Weighing Techniques for Specially esigned Trailer Equipment.

Superintendent, on Oct. 4, 1949, Lieutenant Smith, Marion Lawless of the State Highway Commission and myself went to the Lafayette Post to witness and supervise the test weighing of an acid truck that was owned by the Ecoff Trucking Company. Present at the weighing were Mr. David Ecoff, owner of the Ecoff Trucking Company, his attorney, Mr. Genther, representatives of the Standard and Sinclair Oil Companies, and Dr. Rolland G. Sturm, a physicist from Purdue University, who did the over-all job of supervising the weight check. This weighing demonstration was conducted to determine if our normal weighing techniques were accurate when using two loadometers, weighing first one side of a tandem group, then the other, then adding the sum of these two weights to determine the weight of the tandem group.

We have had several recent discussions with Mr. Ecoff and arranged this test weight because it has developed that the weights obtained by the use of the two loadometers and the techniques heretofore described were not consistent with the weights registered upon platform scales.

At the test, the truck weighed was a tank semitrailer designed especially for carrying acids. The tank is made of ⅜-inch armor plate and was loaded to capacity in such a manner that no surging of the acid fore and aft was possible. The results of the tests and techniques used are as follows:

USING TWO LOADOMETERS

Two loadometers were placed under each wheel of the steering axle and the following weights recorded:

Right steering wheel	3, 800
Left steering wheel	3, 580
Making total for steering axle	7, 380

Next only two loadometers were used and our normal operation procedure followed in weighing the truck. First we placed two loadometers underneath the right wheels on the drive tandem group and the following weights were recorded:

Right front	8, 960
Right back	9, 250
Total	18, 210

Next the two scales were removed from underneath the right wheels and placed under the left tandem drive wheels and the following weights recorded:

Left front	8, 120
Left back	8, 275
Total	16, 395

Therefore:

Right side of drive tandem	18, 210
Left side of drive tandem	16, 395
Total weight of drive tandem	34, 605

Using same technique the trailer tandem axle weights are recorded as follows:

Right front trailer tandem	8, 670
Right back trailer tandem	9, 320
Total weight of trailer tandem	17, 990
Left front trailer tandem	8, 780
Left back trailer tandem	8, 565
Total weight of trailer tandem	17, 345

Therefore:

Right side of trailer tandem	17, 990
Left side of trailer tandem	17, 345
Total	35, 335

Therefore the total over-all gross weight using the two loadometer technique is:

Steering axle	7, 380
Drive tandem group	34, 605
Trailer tandem group	35, 335
Gross weight	77, 320

USING FOUR LOADOMETERS

Using four loadometers placing one under each wheel of the tandem groups. The following weights recorded:
Steering axle remains constant at 7,380 lbs.

DRIVE TANDEMS

Left front drive tandem	7, 440
Left back drive tandem	7, 070
Total	14, 510
Right front drive tandem	8, 245
Right back drive tandem	8, 430
Total	16, 675

Therefore:

	14, 510
	16, 675
Total for drive tandem	31, 185

TRAILER TANDEM

Left front trailer tandem	7, 845
Left rear trailer tandem	7, 355
Total	15, 200
Right front trailer tandem	8, 280
Right rear trailer tandem	7, 895
Total	16, 175

Therefore:

	15, 200
	16, 175
Total tandem axle	31, 375

Therefore:

Steering axle	7, 380
Drive tandem group	31, 185
Trailer tandem group	31, 375
Gross	69, 940

USING 50 FOOT PLATFORM SCALES

The truck was then driven to the city scales in Lafayette and the following weights recorded:

Gross weight	70, 260
Steering axle	7, 680
Steering and drive tandem	38, 880

Therefore:

Gross	70, 260
	−38, 880
Trailer tandem	31, 380

There was one observation, that was noted, there was a very slight variation in the weights noted when the vehicle was driven forward upon the scales and the weights recorded in comparison to the weight recorded when the vehicle was backed upon the scale. This variation was slight enough, however, to be negligible; also there was a very slight variation in the weights recorded when the vehicle was driven upon the scales and the brakes released. This weight difference at any time did not vary more than 15 pounds. These unusual variations in weight were explained by Dr. Sturm as being caused by friction in the unusual rocker arm type spring suspension and the shifting fore and aft of the center of gravity.

Many extremely interesting points were noted in these weighings; for instance, we took the gross weight of 70,260 pounds as determined by the city scales, subtracted from it the weight of the steering axle plus the tandem drive group of 38,880, which left us the indicated weight of 31,380 pounds for the trailer tandem group.

The weight of the trailer tandem group as determined by the four loadometers was 31,375 pounds, making only a difference of 5 pounds between the weights of our loadometers and the weights by platform scales.

The conclusions that can be drawn by this series of tests are these:

1. The loadometer itself is an extremely accurate scale. This is further borne out by the attached laboratory tests made on a loadometer by Purdue University.

2. When weighing trucks constructed as these acid trucks are, accurate weights cannot be determined by our normal weighing techniques whereby only two loadometers are used under one side of the vehicle at a time.

3. Loadometers can be used to accurately weigh these special type pieces of equipment or any type vehicle if four loadometers are used or if the loadometers are recessed within the pavement so there will be no deviation from the horizontal roadway surface.

4. The weights obtained by platform scales and the use of our loadometers are comparable for all practical purposes.

TABULATION OF WEIGHTS EMPLOYING VARIOUS WEIGHING TECHNIQUES

	Steering axle	Drive tandem	Trailer tandem	Gross
Using 2 loadometers first on one side, then the other	*7, 380	34, 605	35, 335	77, 320
Using 4 loadometers one under each tandem wheel	*7, 380	31, 185	31, 375	69, 940
Axle at a time on platform scales	7, 680	31, 200	31, 380	70, 260

*NOTE: Steering-axle weight obtained by using two loadometers, one under each wheel.

MR. BAUCOM: Mr. Nicholas, would you recommend that the use of loadometers in highway weight enforcement be prohibited?

MR. NICHOLAS: We have found that the latest type loadometer, when properly used, indicates weights sufficiently accurate for enforcement purposes. In many places they are not properly used. If loadometers are placed under the wheels on one side of a vehicle, that weight recorded, and added to the weight obtained by placing loadometers under the other side of the vehicle; inaccuracies will result.

MR. REESE: One of the principal requisites for accurate axle-weight determinations seems to be level scale approaches. This is an area where weights and measures officials can be of assistance, and I believe firmly that level scale approaches should be required.

I would suggest further that cooperation among the enforcement agencies of the various States should be such that a weight ticket obtained in one State would be honored in other States. This would save time both for the trucker and for the enforcing officers.

MR. RICHARD: I believe we may break down this discussion of highway vehicle weighing into two categories. Weights and measures officials are particularly interested in one aspect and that is commercial weighing. The highway weight enforcement officials have interest in the other aspect, axle weights and overloading of highways. Surely no one considers a loadometer or a similar device as a commercial weighing device. They have an accuracy characteristic generally of 1 percent as compared with $\frac{2}{10}$ percent for commercial scales. I would recommend that highway-weight enforcement officials take into consideration this possible error.

MR. LEITHAUSER: The 37th National Conference on Weights and Measures adopted a resolution recommending that a study be made by the National Bureau of Standards in cooperation with the U. S. Bureau of Public Roads, the trucking industry, and others into the various causes and amounts of discrepancy in axle-load weighing. We know these discrepancies occur, even on accurate scales. As weights and measures officials we should be interested in determining why.

We have no sympathy for truckers who deliberately overload and damage our highways, but, at the same time, we would not want to see truckers prosecuted under conditions which they cannot control.

MR. NICHOLAS: I want to assure you that the trucking industry favors further research on this subject.

Mr. Christie: In New Jersey, since 1942, we have been working toward having all commercial vehicle scales meet minimum requirements as to approaches. A number of these approved scales have been used in tentatively determining axle loads. Our weight enforcement officials allow a 5-percent tolerance.

We believe that one of the principal reasons for many load-limit prosecutions is the effort of the truckers to take full advantage of this 5-percent tolerance. We have experimented with 6, 4, and 2 loadometers employed to weigh the axles on a single vehicle. When two loadometers are used, one under each wheel of an axle, the errors developed are well within 2 or 3 percent and always favor the trucker. This method of axle-load determination has been demonstrated before the trucking industry.

We believe that our weight control operations have benefited many truckers. We have been able to show them how to load their vehicles more efficiently and thus increase their pay loads.

Mr. R. E. Meek: When the highway weight enforcement program was first instituted in the State of Indiana, I recommended that the weighing be done on scales sufficient in size to weigh the trucks as one unit. I was informed that all surveys made by Purdue University, by the engineers of the State Highway Commission, and by others had indicated that the predominant damage to State highways was done by overloaded axles rather than by overloaded trucks. Out of some 7,000 prosecutions in Indiana last year only about 200 of them were on a gross over-weight basis.

During the past year we tested 87 axle-load scales. The performance of these devices under test was well within tolerance. In addition to known-load tests we made many special weighings on axles. Variations on successive weighings of the same axle ranged from zero up to 350 pounds. As a result of these tests I am convinced that if the trucker would attempt to load only to the allowable axle-load limit, he would not be subject to prosecution. Most generally truckers find themselves in trouble only when they attempt to take advantage of the enforcement tolerance.

The Indiana Motor Truck Association has done an excellent job of educating its members. During the year 1949 between 25 and 30 percent of the trucks weighed in Indiana were in violation; whereas, during this past year less than 1 percent were in violation. This is a splendid improvement, and it exemplifies what can be done through a cooperative effort of a trade association and enforcement agencies.

Mr. Nicholas: Our effort among our members has been a campaign of education. We endeavor to check every arrest notice and to find the exact reason therefor. We have found that the great majority of weight violations during the past year were violations of axle-load limit on the drive axle of the tractor. In many cases we believe that this overloading on one axle is caused by a shifting of the cargo.

Mr. Powell: I want to verify the statements made previously that loadometers will give correct weight indication only if they are used properly. This Conference has recommended that when these portable devices are regularly used in pairs, each weigher of each such pair shall be appropriately marked to identify them as weighers intended to be used in combination. In pairs, loadometers must be used one under each wheel of a single axle, never under two wheels on one side of a vehicle.

Mr. Tate: In reply to Mr. Leithauser's comment I would like to say that the National Bureau of Standards has begun an investigation such as was recommended by the resolution and further that we hope to expand this investigation during the coming year, provided, of course, funds are available.

The reaction of an axle and tires against a roadway is not a simple problem of weight but involves the configuration of the roadway and the rigidity of the truck body as well. As has been brought up previously the grade of the approach to a scale is of vital importance. In order to determine correctly the weight of a motor vehicle, all wheels of the vehicle must be on the same level. If you raise the wheels of only one axle on loadometers, your measurement may differ considerably from the true weight of the axle.

Mr. Gehringer: Equipment is not the only element of correct axle-load determinations. There is also the matter of operators learning to use that equipment. We know that there are many inherent features in motor trucks which cause changes in axle weights. For example, some changes are caused by shifts in shackles and parts of the chassis assembly.

We also know that drivers of trucks are able to cause definite changes in axle weights. Experimentally we have asked drivers of large semitrailer units to make an effort to cause shifts in axle weights, and we have found instances where changes as high as 1,000 pounds can be caused by the method of applying the brakes and by slipping the clutch. Operators of scales must know just how loads are to be applied and must also see that they are applied in that manner.

The scale industry is willing to cooperate with the truckers and with the State enforcement agencies in order to correct some of the difficulties which arise in the determination of axle weights.

(General comments on the subject were made by Mr. Baucom, Mr. Boyle, and Mr. Campbell.)

(The Conference adjourned, to reconvene at 10 a. m. Wednesday, May 20, 1953.)

THIRD SESSION—MORNING OF WEDNESDAY, MAY 21, 1952

(A. V. Astin, President, and J. Fred True, Vice President, presiding)

FLOUR WEIGHTS

By Herman Fakler, *Vice President, Millers' National Federation, Washington, D. C.*

At some time or other in your normal daily routine, you have all likely found sacks of flour in stores or warehouses which did not conform to the stated weight on the package. At times they may have been overweight but in other instances they were underweight. You may have been obliged to take action in some instances. That is a part of your responsibility—to take whatever steps are required to protect the consumer, the manufacturer, or both. You may have wondered, at times, as to the integrity of flour millers if you encountered what appeared to you to be an unreasonable number of short weight packages.

In many respects wheat flour is a strange commodity. It has an irritating capacity to gain or to lose moisture. We say irritating because it is this characteristic that is responsible for most of our common problems associated with maintaining apparent full weight in flour packages. We shall elaborate on this later. Before doing so you may be interested in some background information on the actual physical process of packing flour.

The package represents the channel through which flour flows from mill to consumer. It must be sanitary, protective, economical. It must contain proper, full weight of product to assure honest value to the eventual user. Simple statements these, yet the attainment requires comprehensive effort on the part of the miller. In a broad sense there are two major considerations associated with the accomplishment. The first, the actual preparation of the flour package, is directly under the supervision of the miller and is his responsibility. The second relates to the storage conditions to which flour may be subjected after leaving the mill. This is most always beyond the control of the miller and is usually not his responsibility. Let us give a bit of thought to each phase.

Flour mills have automatic equipment and have established programs designed to assure proper weight of each package at the time flour sacks are filled. The tare weight for the specific package has been determined in a precise manner. This includes tare weights for coupons, inserts, tape seal or any other items forming a part of the final package. The packing supervisor adjusts his full package weight accordingly. It is his responsibility to make sure that each and every package is full net weight when packed within reasonable and practical limits.

Improper package weights can occur through faulty operation of mechanical equipment, errors in machine adjustment or the effect of the human element, careless or inadvertent. Flour mills attempt to eliminate all these errors through the use of automatic check weighing equipment and, in some instances, through employment of full time weight checkers. Such an individual is assigned the task of checking the weight of packages being delivered from each packing line whenever operating. He usually works independently of the packing department and is directly responsible to the plant superintendent.

We should like to elaborate on the manner in which a weight checker operates in many mills. At regular hourly intervals he selects several consecutive packages from a packing line. Each is weighed separately. The average weight of these control packages is recorded. These data enable those responsible to quickly appraise the reliability and accuracy of the packing operation. As long as the average package weights remain within specified control limits, no scale adjustment is made on the particular packaging line. Immediate correction is made when a weight falls outside the control limit. Whenever adjustments are made, immediate additional weight checks are taken in sufficient number to made sure the correction is adequate.

The range in the weight of the packages is also recorded. This is equally important. For a packaging operation to be considered as satisfactory it must meet requirements as to both average and range in weights. An examination of mill files of permanent packing records will show package weights within control limits and on the heavy side in weight.

We mention these details only to illustrate how flour millers handle this important operating problem. We feel that these programs of controlled checking provide adequate protection against those factors contributing to improper package weights.

Let us now consider the second phase of the flour packaging problem having to do with conditions of storage. After leaving the mill proper, flour may be held in warehouses or stores with a wide range of environment. Temperatures and humidity may vary greatly. Flour reacts quickly to either or both. Flour is hygroscopic. It readily takes on or loses moisture, depending on the atmospheric conditions to which it is exposed. Moisture change would reflect directly in corresponding weight changes.

Many studies have been made covering various aspects of this particular property of flour. Package size, type of container, length of storage time, are some of the factors studied in this connection. One of the most comprehensive and practical independent investigations was carried out by a group of cereal chemists at the University of Minnesota in 1942.[1]

For this experiment a common lot of flour was packed in 5-, 10-, and 24½-lb sacks, paper and cotton, and stored in air conditioned cabinets, where the temperature and humidity could be closely and accurately controlled. Levels of relative humidity were maintained at 36, 45, 59, and 72 percent, each at a temperature of 70° F.

At this point I should direct attention to the fact that this study was conducted prior to the time the flour milling industry, in cooperation with weights and measures officials throughout the country, worked out and put into effect a uniform schedule of flour package weights. This accounts for the use of the 24½-lb package. The industry is thoroughly convinced that the schedule of flour package sizes now in universal use is definitely in the public interest, and the industry wishes to acknowledge your cooperation in bringing about this result.

The original weight of the various bags of flour was carefully measured, and the moisture content of the flour accurately determined. After 3 days of storage in the several cabinets, package weight and moisture content was again determined. Thereafter at weekly intervals this process was repeated throughout the full storage period of approximately 10 weeks.

This study brought out a number of pertinent observations. They are of special importance to millers responsible for flour packing and to you enforcement officials responsible for appraising the true weight value of this particular commodity where it becomes available to the consumer. The experiments revealed that flour weights respond sharply to changes in relative humidity. In general, flour, as normally packed, will lose weight unless the relative humidity of the storage atmosphere is 60 percent or more. If over 60 percent, flour will gain weight. If under, it will lose. The rate of change is more rapid during the first few days of storage.

If the storage period is sufficiently long, the flour will approach a leveling-off point though it never becomes absolutely constant in weight. The degree of change depends on the initial moisture content of the flour to a large extent in addition to the relative humidity of the storage area.

Weight changes were more rapid for cotton than for paper bags and for the smaller size packages. As the storage period was extended, there was a tendency for weight to equalize regardless of size or type of container.

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[1] Anker-Geddes-Bailey, Cereal Chem. 19:128–150, 1942. A study of the Net Weight Changes and Moisture Content of Wheat Flour at Various Relative Humidities.

Thus, you can see that if it were possible to maintain each warehouse or each grocery store at a relative humidity of 60 percent, at least as far as the flour storage area is concerned, we would have little occurrence of apparent short weight in flour packages. We could anticipate little change in moisture content of the flour and therefore little change in flour weight.

If relative humidity were maintained at 72 percent, a gain in weight would take place. After one week under such conditions a 5-lb package of flour would gain about ¾ ounce in net weight. The same package stored at 45-percent relative humidity would lose about 1⅛ ounce after exposure of one week. At 36-percent relative humidity the net weight loss would be a little over 1¾ ounces, after a like storage period.

From all of this we can see that flour rarely, if ever, remains the same in actual weight over a period of time. Relative humidity is more often under than over 60 percent. For this reason you are more apt to encounter apparent weight shortages rather than overages in your examination of flour packages. It also explains the greater prevalence of such finding in the winter season, or on those occasions when the heating of space indoors prevails. Conversely, there is less apparent underweight during the summer months when high humidity is the rule.

This study brought out another major point. Although flour will lose moisture as well as regain it, the rate of loss is much more rapid than the rate of regain. This phenomenon has not been completely explained as yet, but this is one of the reasons why we previously referred to this peculiar property of flour to fluctuate in weight as an irritating characteristic.

We understand that experiments of a similar nature have been conducted by Federal Food and Drug Administration officials, and that their findings agree substantially with those obtained by the University of Minnesota scientists. Although the government data are not available for distribution, we understand any state or city weight enforcement official may have access to this information at field offices.

Assuming flour weight loss is accounted for by evaporation loss occasioned by factors beyond control, this does not solve your inspection problem. You may well ask these direct questions of the flour miller.

1. Since the miller assuredly knows his package will most likely lose weight before it reaches the consumer, why doesn't he overpack in anticipation of such loss? It would be impossible to predict how much to overpack, since he could only prophesy full net weight at destination by preparing for the extremes of temperature and humidity. No guarantee could be made, since flour continually changes in weight. There is also the question of the legality of deliberately packing packages that are substantially overweight. In addition if this were made mandatory the cost to the consumer would be increased. In effect, we would merely be forcing the consumer to purchase a larger unit of flour, which would still be subject to the same potential evaporation changes. It is your responsibility as well as ours to avoid any course of action which would deliberately raise prices. From another viewpoint if it were mandatory to overpack in anticipation of flour being shipped to areas where weight loss would be anticipated, it should be equally permissible to underpack for

shipping to areas, such as our seaboard, where weight gain is a reasonable probability.

2. Why not pack flour in a moisture proof container? This could be done, but it is not practical, and the cost to the consumer would be prohibitive. Again we are not adequately protecting Mrs. America if we deliberately increase the price of flour, which would be one result of such a course of action. In addition, we do not believe it is good practice to pack flour in a completely airtight container. Some aeration of flour enhances its baking properties. This desirable maturing action, as we call it, is possible in the present types of container. There is also the danger of mold developing when freshly milled flour is packed in an airtight package.

3. Why not reduce the moisture content of flour at the time of milling to minimize any further loss later? Couldn't the miller grind wheat that is lower in moisture content?

We select wheat on the basis of the quality of the finished flour it will produce. Its moisture content is incidental and entirely dependent on the whims of nature. Actually, reasonable variations in the amount of moisture in the wheat are unimportant. All mills try to maintain a certain range of moisture in the wheat as it comes to the grinding rolls preparatory to conversion into flour. There is one reason for this, and one reason only. The object is to so condition the wheat that the most complete separation of flour and branny material can be made. Usually this means the miller adds some water to "temper" the wheat, as the process is called. After so doing, the wheat is permitted to stand in tempering bins for a certain period of time, usually 8 to 10 hours. This permits the water to penetrate the branny portions of the wheat berry. This toughens these layers of the berry so that they will flake off rather than shatter. This makes possible a more complete separation of the endosperm or starchy material we know as flour. If this separation is not complete we get a flour that is specky in appearance, dark in color, possibly inferior in baking quality, and may not meet the Federal definitions and standards of identity for flour.

It is true that the more moisture that is added to the wheat, the higher the moisture content of the flour is apt to be. However, we are limited in the amount of moisture that can be added and still permit a satisfactory milling job. Too much moisture will make it difficult, if not impossible, to accomplish the necessary sifting within the mill. Clogging and gumming up of the extremely fine silk bolting sieves will take place. It is necessary therefore to stay within narrow limits of moisture content in both wheat and flour. The Federal Government recognizes this in its establishment of a limit of 15 percent moisture content for wheat flour. Freshly milled flour is usually around 13.5 to 14.5 percent moisture.

We have not as yet mentioned the one point which resolves most of the associated weight problems. If a bag of flour is full net weight when it leaves the mill and enters channels of interstate commerce, that bag will always give the consumer full food value when purchased, regardless of any apparent change in weight which may have taken place. The only qualification is that there be no loss of product due to leakage or spillage. You need only be concerned with this in your program of weight inspection. Assurance on this one point will automatically protect consumer and manufacturer alike. Let me repeat. Barring loss due to leakage or spillage, a bag of flour having full weight at the time it is packed and leaves the mill will always give the consumer full food value regardless of apparent change in weight due to moisture variation. This is a most important point in our discussion.

Why is this true? For this simple reason. When flour is prepared for baking, it is combined with water or some form of liquid. If a specific parcel of flour has lost moisture, it will be possible to add an equivalent amount of liquid when it is used. The homemaker makes this adjustment automatically without knowledge or concern of cup weight or moisture content of the flour. There is no loss whatsoever due to the flour itself having become drier. It is the solid matter or dry material in flour that determines its value as far as weight alone is concerned. That value will always remain the same relatively as the original net weight.

This factor is recognized by our Federal Government in its regulations covering weight of flour packages. Reasonable variations in weight are permitted if they fall into one of two classifications:

1. Those which occur in good manufacturing practice and which cannot reasonably be avoided.

2. Those which occur because of exposure to condition which may occur in good distribution practice.

The first of these applies specifically to the manufacturing and packaging of flour and does not involve evaporation loss. Variations at the time of packaging must be as often above as below the stated net weight of the package and the average weight of all packages must be as much as the declared weight for a single package. Unreasonable shortages, or overages, are not permitted. This arbitrarily prohibits deliberate overpacking or underpacking.

The second point applies specifically to the problem of evaporation loss. It recognizes that such losses will occur to some extent even in good distribution channels, but that normally the changes take place after the product is no longer under control of the manufacturer.

There are differences between the various State laws or regulations governing flour package weights. Most States follow the pattern of Federal interpretation. Some spell out specific tolerances on a weight or a percentage basis. All are subject to interpretations made by State or local authorities.

Since most all flour travels in interstate commerce, it follows that a majority of flour millers must produce a product which conforms to Federal regulations and those of many, if not all, States. The flour miller is, therefore, vitally interested in the State interpretations of weight regulations.

We believe it would be of fundamental advantage if enforcement officials in all States would adopt and follow a uniform set of interpretations and procedures. We further believe that this can be accomplished effectively within existing statutes. To do so would make your inspection more efficient and provide more protection to the public. With this in mind we should like to propose that this Conference consider four suggestions, constituting a uniform procedure for checking the weight of flour packages.

1. Concentrate check weighing of flour at primary points of distribution, where large quantities of flour are available. Mill, wholesale, and chain warehouses, and other jobbing outlets are examples. City and county weights and measures officials located in smaller communities would probably not have the same opportunity in this

regard as would enforcement officials at State levels. Therefore, it would appear desirable to suggest that local officials consult and cooperate with their respective State officials.

2. Follow the Federal regulations and procedures, and make allowance for reasonable weight variations.

3. Arrange to obtain accurate moisture analyses of representative samples of any questioned flour stocks.

4. Promptly notify the mill involved when the weight of its flour stocks is questioned. In order to coordinate activities within a State it would appear to be in order to suggest that, in addition to notifying the mill involved, the city and county officials might wish also to notify their State officials.

By concentrating your check weighing of flour packages to warehouse stocks, you would greatly simplify and extend the effectiveness of your control over this problem. Warehouse stocks represent the largest concentrations of flour within your jurisdiction. Package weights and storage conditions are easily checked at such points. You, as enforcement officials, could effectively control a much greater volume of material, and prevent short-weight packages from reaching either the retail store or the eventual consumer.

Details of the procedures followed by the Federal Food and Drug Administration are set forth in the official regulations for the enforcement of the Food, Drug and Cosmetic Act, as well as in administrative procedures. As indicated to you in a paper delivered before your Conference on May 25, 1949, by Mr. John L. Harvey, Associate Commissioner of the Food and Drug Administration, data are available to you as cooperating enforcement officials and may be examined by you at any of their offices.

You may rightly ask how you, as enforcement officials, can distinguish between a legitimate weight change caused by moisture variation and one which is actually short weight, deliberate or accidental. Gentlemen, there is only one final infallible method. This requires that an accurate moisture analysis be made of the flour in question. With this information available, it can be easily determined if the flour package contained full weight when it left the mill.

We realize that you cannot analyze the moisture content of flour on the spot as you make your weight checks. We do suggest, however, that you arrange to get this information whenever your inspection discloses a lot of flour that you consider as unreasonably short of weight. It may be possible for you to have a moisture analysis made by your own local or State laboratory. Flour mill laboratories would be glad to provide this service at your request. Should you desire it, mill records would readily be disclosed to you showing moisture content of a specific lot of flour at the time it left the mill, or any other pertinent information you would like that we have available.

We strongly urge and request your favorable consideration of these suggestions and the adoption of the four recommendations we have made.

To this end, may we suggest that a committee be created by the President of this Conference, this committee to consist of three weights and measures officials to be appointed by him and three representatives of the milling industry to be appointed by the Millers' National Federation. Further, we suggest that the President request that a representative of the Federal Food and Drug Administration be designated by the Commissioner of that agency to serve as a consultant to the committee, and that the Chief of the Office of Weights and Measures, National Bureau of Standards, also be requested to serve as a consultant to the committee.

Finally, we suggest that the President of this Conference designate one of the three weights and measures officials appointed to the committee to serve as its chariman and to see that the committee formulates resolutions to be presented to the 39th National Conference on Weights and Measures for action.

I want to acknowledge the collaboration in the preparation of this paper of four members of the industry, O. W. Galloway of Pillsbury Flour Mills, O. A. Oudal of General Mills, John T. Lynch of International Milling Company, and C. E. Joyce also of Pillsbury.

Mr. G. B. Smith: As a result of many complaints, we have instituted several investigations into net weights of flour packages. In 1949, at the request of representatives of the flour industry, a regulation was drafted and promulgated in the State of Michigan. The regulation is very similar to the Federal Food, Drug, and Cosmetics Act.

Early this year, and again as a result of many complaints, we check-weighed 146 packages of flour and found not one of the 146 packages contained full weight. These were 10-pound packages and only three packages grossed at the declared net weight. The gross weight of all other packages was less than the labeled net weight.

My recommendation for a solution to this problem is for the flour mills to overpack in a sufficient amount to allow for normal shrinkage.

Mr. Watson: Mr. Fakler has made it clear that the moisture content of flour is an important part of the problem of packing the commodity and of insuring correct weight. It might be worthwhile to consider an agreement whereby net weight at time of packing would be allowed. I would like further to offer for your consideration the possibility of a Federal inspection service at the mills, accompanied by a 100 percent checkweighing of the packages.

Mr. Fakler: The labeling of "weight when packed," if recognized by State enforcement officials, would solve our problems. Because of Federal regulations we are required to have full net weight in each package when it enters interstate commerce. The flour, with 14 percent moisture content, is full net weight when it leaves the mill. Our flour packages are checkweighed at the mill. You, as enforcement officials, are at liberty to check the mill records at any time. We have absolute moisture and weight records of every package of flour that leaves the mill.

Mr. Baucom: I would like to offer the suggestion that packages of flour be labeled with both the net weight and the moisture content. With this information a weights and measures enforcement official easily could determine whether or not the package contained full weight when it left the mill.

Mr. Austin: I will make a motion that the President of this Conference appoint a committee to study this problem of flour weights and report back with specific recommendations to the 39th National Conference on Weights and Measures. The committee is to consist of three weights and measures officials, one of whom is to be appointed as Chairman, and three representatives of the milling industry, to be selected by the Miller's National Federation. A representative of the Federal Food and Drug Administration and the Chief, Office of Weights and Measures, National Bureau of Standards, are to be designated as consultants to the committee.

(The motion was seconded, and, on a standing vote, was carried 67 ayes as against 39 noes.)

(Additional general comment on this subject was made by Mr. Campbell, Mr. Rhein, Mr. Fakler, Dr. Astin, Mr. Bussey, and Mr. O. W. Galloway.)

AUTOMATIC PACKAGE WEIGHING MACHINERY

By W. A. Scheurer, *President, National Scale Men's Association, Columbus, Ohio*

As the new president of the National Scale Men's Association, I deem it an honor and a privilege to represent our splendid organization at this Conference, and I take this opportunity to greet you on behalf of our membership. Our annual convention at Atlanta, Georgia, two months ago was one of the finest and most enthusiastic meetings of scale men and weights and measures officials ever held by our group.

I feel, as I am sure all members of the National Scale Men's Association feel, that we can, and should, work very closely with the National Bureau of Standards and weights and measures departments in the various States in matters relating to scales.

Scales are one of the most important necessities of a progressive civilization, yet one of the most neglected.

I shall discuss some of the new techniques rapidly gaining favor in high-speed automatic check-weighing. When we consider the value of consumer-size packages sold by weight at something like $8,000,000,000 per year, we begin to realize that this is a very important segment of our economy.

During the past several decades, many of the functions of the independent storekeeper have been replaced by prepackaging at the factory level. Years ago, the storekeeper purchased his product by weight, in bulk form. The cracker barrel and the bean bag provided an adequate means of displaying the product. He weighed the quantity desired by the retail customer over a manual scale and packaged it in paper bags. This method of merchandising in a relatively uncomplicated era had its advantages and disadvantages. But regardless of its advantages, it was destined for discard when mass production and increasing competition forced the merchant to improve his method of displaying his wares. The functions of display, weighing, and packaging already have been taken over by factory packaging and distribution through self-service supermarkets.

For the most part, the functions performed by prepackaging and self-service not only are more efficient than comparable functions carried out by the storekeeper, but also are more convenient for the customer.

The increased efficiency of machine packaging and self-service has resulted in a very significant decrease in the cost of exhibiting the product to the ultimate consumer. Tremendous strides have been made in the packaging field, and the trend continues as more and more products are prepared for distribution in package form. In addition, many new products, such as frozen foods, factory formulated cake mixes, and aerosols, have resulted from the increased acceptance of this form of distribution.

Where products are packaged at high speed, it is difficult to achieve weight accuracy comparable to that achieved by weighing over a manual scale. Automatic equipment, capable of guaranteeing accurate weights at speeds comparable with packaging machines, has been available only for a relatively short time. As a consequence, due to the lack of such necessary equipment, there has been a tendency to overlook this important aspect of the distribution function.

Everyone will agree that the filling machine which is so accurate it needs no checkweigher would be a highly desirable piece of equipment. Better filling machines will appear as techniques are developed. Every filling machine is capable of doing a filling job with a certain degree of efficiency. The need for a checkweigher can be likened to the need for a micrometer in machine tool operation. The better the lathe, the closer we attempt to hold tolerances, and we accomplish this by measuring the turned parts with the micrometer. Likewise, the better the filling machine, the closer we should hold weights and tolerances. The fact that more accurate machine tools are available does not mean that micrometers are less in demand. Actually, the reverse is true, because it is just as important to keep a good machine operating at its best as it is to keep a poor machine operating at its best.

For a number of reasons, there has been a tendency to overlook weight errors in packages produced on high speed filling lines. When discussing tolerances, some packers refer to such vague terms as "good commercial tolerance" and "average weight of 24 cartons should equal printed net weight on each carton," etc. We believe that high speed packaging, prior to the time 100-percent automatic check-weighing became a reality, was entitled to broad usage of the term "tolerance." Today, however, there are fast and efficient means of determining the weight of each carton, and means for keeping filling machines in control. I am sure that everyone in this group will agree that high speed and accuracy generally are opposed to each other; yet accurate weights are critically important, not only to the customer, but also to the producer. Practically all of the materials which the processors buy are bought by weight. Inadequate control of the weights of the outgoing product can mean the difference between operating at a profit or at a loss.

The following statement was made by one of the speakers at the 22nd National Packaging Conference and Exposition in Chicago last month, "Important packaging executives are generally agreed that the control of fill is one of the most serious questions they face. There can be no compromise on weight standards; the economic loss from overfill in industry can run into the millions, and the hazards of underfill are obvious."

Now, since there is ample evidence that packaging executives know that there is a serious problem in packaging, and that both underfill and overfill are hazards, why do they not solve the problem by giving correct weights? All too few packers have any real knowledge of the weight variation in their outgoing product. They may kid themselves into believing that they have accurate weights, or that their weight control measures are adequate. Most packers, however, feel a little uncomfortable and uncertain when the subject of weight tolerance of the outgoing product is mentioned. To date, the greatest emphasis in packaging has been placed on increasing speeds. A great deal of thought has been given to increasing the speed of packaging machines. Whenever a group of packaging men sit down to compare notes, 99 percent of the conversation is devoted to bragging about production speeds. When a man says his line is running at 120 per minute, or 300 per minute, he feels quite sure of himself. He can see the speed at which the line is running, and can measure its output. He is much less sure of himself when he discusses weight tolerance, and will give some vague figure which has no basis in fact.

The weight tolerance of the outgoing product is a ticklish subject. Unaccounted loss of product is a sore point. When face to face with the problem, and since they are unaware of an adequate solution, many processors seem to feel that, if they simply ignore the problem, it will go away.

Why has the packer had no real knowledge of the weight variation in his outgoing product? The reason is simply this. Until very recently there has been no means of readily and continually measuring weight variations; consequently, the assumption that everything was in control.

Please mark that I said, "Until very recently." With today's marvelous mechanical and electronic developments, there is no longer any necessity of this uncertainty regarding weight control. Mr. Arthur Sanders, Executive Secretary of the National Association of Scale Manufacturers, says, "Check-weighing of packages to insure weight protection in continuous flow of packaging operations is a must." This requirement has encouraged the development of specialized scales with predetermined weight characteristics for repetitive weighing. To facilitate this, numerous developments have come about in this century, developments which are designed to fit the particular need of the operation, varying between check-weighing a few heavy packages an hour to many light cartons a minute. Manual "spot checking" with special scales is the practice with many processors, but this necessarily causes a break in the continuity of high speed package movement in production plants.

At the other extreme, equipment for *100 percent automatic check-weighing* is a more recent development of the American scale industry. For accurate shell loading in the war, mechanical scales were teamed with electronic control for automatic continuous flow check-weighing. This development has provided an important recent contribution to the handling of materials, and has received world-wide recognition.

The important recent contribution to which I refer is the electronic checkweigher for packaged commodities. The Selectrol automatic, electronic checkweigher provides a means for controlling the weights of outgoing packages. It forms an integral part of the package conveyor line, and consequently does not interrupt the normal flow of production.

The Selectrol automatically weighs each package as it moves along the conveyor, and rejects those packages which are outside the desired tolerance limits. The rejected packages then can be trimmed to the correct weight and returned to the conveyor line. A single Selectrol, plus one girl, can provide absolute assurance of package-weight accuracy. In addition, it continuously polices the process for unwanted trends in variation. An increase in the percentage of rejects on either the underweight or overweight side is an immediate indication of the presence of a trend, and calls for corresponding adjustment in the filling machine. In a normal packaging operation, at least 8 manual checkweighers would be required to perform a similar function, with less accuracy and much less speed in detecting unwanted trends in variations.

I have used the term "trends," and it may not be entirely clear what are trends, and how important they are in packaging. Also, at this point you may be wondering why we cannot gather data on production line accuracy by ordinary hand-weighing or with a "spot check."

Manual, spot check-weighing, which is the means of weight control most generally used by processors, leaves much to be desired. First, it never will assure that every package produced is within the desired weight tolerance. Second, at modern packaging-line speeds, anything other than a very spotty check-weighing results in excessive labor costs. Third, manual operation is subject to the human error. Any highly routine operation, such as manual check-weighing, is extremely subject to such human errors as are caused by fatigue, inexperience, or indifference.

In addition, manual operation is unlikely to provide adequate or accurate information to supervisors so that corrective action can be taken. Most persons naturally are reluctant to report a condition that might adversely reflect on the ability of a fellow employee. Fourth, the very nature of the causes of package-weight variations are such that adequate control can be achieved only when an appreciable portion of the total production is checked. The cost of providing adequate check-weighing by manual methods generally is considered to be excessive.

Now, to explain trends, there are many factors which cause package weights to vary. Typical of these are:

1. Changes in density of the product.
2. Adjustment of the filler.
3. Uncertainty in the cut-off of the filler.
4. Variations in amount of product in the filler hopper.
5. Changes in the flow characteristics of the product.

All of the above factors fall into either one of two categories:

1. A random or pure chance pattern. These factors cause the weight to vary rapidly, and result in weight variations between consecutive packages. This pattern of random variations is characteristic of a particular product and packaging process. In general, it can be controlled only through machine design and maintenance.

2. Trends. These factors cause variation in the weight of consecutive groups of packages, rather than consecutive individual packages. Variations in density of product, between top and bottom of a hopper, is a good example of this type of cause of variations.

To control the weights of packaged products, it is important to distinguish between these two types of variations. The human operator making sporadic spot-check weighing has difficulty in distinguishing between the two types of variations, since the random variations are superimposed upon the trends. The human check-weigher is guided only by experience and intuition. As a result, they actually may control the process in the wrong direction at any particular instant, and surely will have difficulty in detecting trends until they are of appreciable magnitude. Any packaging process can be controlled to that weight tolerance dictated by the random variation. Proper control of the filling machine can eliminate the trends with a consequent appreciable reduction in both the over-all weight tolerance and the loss of product through overfill.

The Selectrol automatic, electronic checkweigher provides the outstanding features of (1) 100 percent check of outgoing package weights with assurance that 100 percent of the packages are within the correct weight tolerance, (2) speedy detection of trends in package weight variations, (3) no disruption in the continuous flow of the product on the packaging line, (4) no variation in the weight quality level because of fatigue or human error, and (5) assurance to the processor of confidence with respect to package weights.

Many remarkable developments have been made in packaging machinery, both in increasing the production speed and in increasing the filling accuracy. The perfect filling machine, however, probably never will be built. I suppose a perfect filling machine would be one which would operate indefinitely at any desired speed, and with no variation in package weights. Although filling-machine manufacturers will continue to press toward that goal, it is unlikely that such an ideal will be achieved. As a result, some means of assuring the processor of weight quality always will be needed. The Selectrol automatic, electronic checkweigher has been developed to fill this need.

We believe a short description of the mechanics of the Selectrol weighing system will be of interest to this group.

In the Selectrol system, the weighing element is reduced to the simplest possible mechanical device. It is simply an even-balance 1:1 ratio weighing lever. No mechanical means is provided for observing the magnitude of the lever motion. The usual indicating system would be unsatisfactory, since Selectrol instruments usually must be operated at high speeds. Consequently, the lever system is designed in such a manner that it becomes a mechanically-resonant structure whose natural resonant frequency, or rate of free oscillation, is slightly in excess of the maximum operating speed for which the unit is designed. A factor in the resonant frequency is the total mass applied to the weighing member, and, obviously, this includes the weight of the object being weighed. Reduced to simple terms, this means that, if a particular unit is designed for 100 weighings per minute, the total mass of the movable system of the scale is calculated for its moment of inertia. Sufficient reactance is applied as a restoring force to cause the weighing member to oscillate, when perfectly balanced, at a slightly higher rate than 100 complete cycles per minute.

Neglecting damping factors such as air resistance and friction, the structure adheres to all basic laws pertaining to resonance. Thus, the time required for any one oscillatory cycle is always identical to the other, regardless of the respective magnitudes of the two observed cycles. Proof of this may be observed by the use of a simple pendulum. If a long pendulum is moved from its dormant perpendicular position by an angle of 20 degrees and released, the time required for it to swing to the opposite extreme of its travel, reverse its direction, and return, will be found to be identical to the time required if the displacement is only 10 degrees. In the case of a pendulum, the restoring force is, of course, the pull of gravity; consequently, the actual mass employed does not affect the frequency of oscillation, since the restoring force varies directly with the weight of the mass. However, if a restoring force other than gravity is utilized, the mass becomes a variable factor as regards frequency.

Gravity never is used as the restoring force in modern weighing instruments except for applications where speed is not an important factor. Most commercial weighing of predetermined mass utilizes a structure comprising an even-balance weighing member with a limited lever travel, and, for the restoring force, a pair of high-grade calibrated spring-members. The system balances to the zero or null point if identical masses are applied to the weighing members and the springs are not a factor. If there should exist a slight inequality between the two masses, the difference is absorbed by a change in dimension of the restorative springs and is indicated by a suitable dial. This makes possible a faster-operating scale and the system has been developed to a high degree.

Incidentally, it is interesting to note that, while many users of weighing equipment are prejudiced against spring scales in general, practically all industrial equipment utilizes some form of spring for the restoring medium. The use of a resonant structure, called a tuning fork, is used as a frequency standard in tuning musical instruments. This is an example of an extremely accurate device and is, in effect, a tuned spring. The most accurate clocks and watches ever built depend upon the constant unchanging action of a spring exerting a force in opposition to a so-called balance wheel.

Selectrol instruments utilize the same principle. In order to make the weighing system respond rapidly, relatively stiff springs are used. This results in much less lever movement per unit of weight than normally occurs with conventional scales.

At this point I want to stress that less deflection per unit of weight does not mean a less accurate scale. As a matter of fact, percentage error due to friction is reduced as movement is reduced. In speaking of accuracy or sensibility reciprocal of the ordinary scale, we generally refer to movement of an indicator that can be read by an operator; thus, we are limited, insofar as maximum lever speed is concerned, by ability of an operator to detect movement visually.

As far as the Selectrol automatic checkweigher is concerned, there is no advantage in providing a dial that can be read by an operator, except for the purpose of setting up the machine initially. A high order of magnification must be provided for this purpose, and electrical means are required for operating weight-selection mechanism.

There are many methods of accomplishing magnification of the small motions involved. Mechanical means are ruled out because of the friction they would necessarily add to the system, and also for the added inertia. Optical magnification would be more advantageous, but it generally is not desirable, since photoelectric means would be required in addition to a precise optical system. Such an arrangement would be satisfactory for a very elementary sort of device, but, when several selection circuits are required, the system becomes difficult to adjust.

Electronic magnification eliminates completely all disadvantages of the aforementioned systems and, in addition, offers many other advantages. Magnification of any degree is possible from the same component parts. A voltage can be developed that is proportional to weighcircuits. This voltage can also be used to operate the visual balance indicator, and the indicator may be placed at any convenient location. Since the interpreting means is converted into electrical values whose magnitude is proportional to the weighing member's position, frictionless electrical damping of lever oscillation becomes possible.

This last feature is of great importance, since it allows the mechanical weighing member to be operated at its critically damped point. This means the scale lever is able to reach a state of equilibrium in the shortest possible time. Travel of ¼ cycle and over will be practically eliminated.

The electronic circuits of a Selectrol represent a simple, straightforward application of electronics. A vacuum tube oscillator is employed, and is so arranged that its frequency will vary in accordance with weigh-lever displacement. Weigh-lever displacement simply changes the capacity of the oscillator's tuned circuit. The varying frequency signal is fed to a conventional F. M. (frequency modulation) detector circuit, very similar to that employed in the ordinary F. M. radio receiver. The output from the F. M. detector circuit is a d-c voltage that is used for operating the electrical indicator, the electrical damping circuit, and weight classification relays. Conventional vacuum-tube amplifiers and voltage-regulating means are employed. Variations in tubes, aging of component parts, etc., have no effect upon operation of the equipment, since routine operating adjustments compensate for these effects.

(Mr. Scheurer showed and explained a short moving picture and a number of lantern slides which demonstrated the operation of automatic package weighing machinery.)

PROBLEMS IN LIVESTOCK WEIGHING SUPERVISION

By C. L. Richard, *Supervisor of Scales and Weighing, Livestock Branch, Packers and Stockyards Division, U. S. Department of Agriculture*

In the year 1921 Congress enacted a Federal stature, known as the Packers and Stockyards Act, which authorized the Secretary of Agriculture to supervise and regulate the marketing of livestock at public stockyards of major size. Enforcement of the Act was delegated to the Department's Livestock Branch which I represent. Since livestock, particularly slaughter livestock, is universally sold by weight, many marketing supervision problems relate directly to the weighing facilities and weighing practices employed at the regulated markets. In accordance with your Conference Secretary's request I shall discuss the problems inherent in the Federal program of livestock weighing supervision.

Last year the average American consumed some 145 pounds of meat in the form of beef, veal, pork, lamb, and mutton. Most of it, consumed in the home, was purchased throughout the year in small amounts at retail markets. It was purchased by weight and, allowing for the possible effects of the traditional "butcher's thumb", was weighed correctly because (1) a local inspector of weights and measures had tested the retail market scales and had certified them as accurate, (2) the meat was weighed in the presence of the purchaser and (3) if there were doubts regarding the weight the purchaser could have his purchase check-weighed or reweighed.

Last year too, so that each of us might have our 145 pounds per capita share of the national meat supply, the farmers and ranchers of the 48 states produced and sent to market for slaughter well over one hundred million cattle, calves, hogs, sheep and lambs. For that crop of meat animals they collected a cash revenue of approximately nine billion dollars, a greater amount than was received for any other product of their agriculture. The year's entire production of slaughter livestock was sold by weight—by live weight, on the hoof. It was sold in individual lots ranging from a single lamb of 50 pounds live weight to a group of fattened steers weighing over 30,000 pounds. Having mentioned reasons why the meat consumer's retail purchases were weighed correctly, it is appropriate to consider what protection and safeguards were provided for the individual farmers of the nation when they sold their livestock, by weight, at market.

There are three types of market outlet through which farmers may dispose of livestock intended for slaughter. The first consists of 66 terminal stockyards which are located at cities of major size and at which more than half of all livestock is marketed. These are public markets where livestock is consigned to commission firms who act as the farmers' selling agents. Sales to packers or other buyers are negotiated by "private treaty" which means that each prospective buyer, in turn, inspects the animals and makes his offer of price. When agreement is reached on price, the animals are weighed and their weight is recorded on a scale ticket to form the basis of financial settlement. Weighing and weight recording are performed by employees of the terminal stockyard companies, except that, in the State of Minnesota, by special provision in the Federal statute regulating public stockyards, they are performed by State employees.

The second type of outlet for the farmer's livestock consists of some 2,100 Auction Markets which are located at rural trading centers in 47 of the states. At these, most of which operate one day each week, livestock is received and sold at public auction in a sales ring where packers and other buyers openly offer competitive price bids. Weighing of the livestock, by employees of the auction market operator, may either precede or follow the sale negotiation.

The third type of market outlet is made up of some 1,200 packing plants or packer's buying stations located in all the states. To these the farmers transport or send their livestock, in small lots, for direct sale to the packer. The sale price is negotiated on the basis of current market quotations, following which the livestock is weighed by the packer or his employee to complete the transaction.

From the information presented thus far it will be appreciated that orderly and equitable marketing of livestock, dependent upon impartial and accurate weighing of several hundred thousand drafts during the year, at over 3,000 market outlets, on hundreds of scales, requires effective and comprehensive regulation of the market scales and their operation, if each individual producer of livestock is to receive the benefits of correct weighing and weight recording. This is particularly true because the farmer, unlike the retail purchaser of meat, generally cannot be present during the weight determination and because, in case of doubt regarding weight, a draft of livestock ordinarily cannot be identified and reweighed after it has passed from the scales to the holding pens containing other livestock. Moreover, livestock is weighed under adverse conditions, because the dead load on the scale platform changes continuously and necessitates frequent correction of the zero balance, if the derived weight values of livestock loads are to be sufficiently accurate.

It may be said with confidence that at none of the markets supervised by the Department do the actual weighing facilities—the livestock scales—constitute a problem. No other class of large capacity scales has better accuracy potentials than the 800 scales which are employed at the supervised terminal and auction markets. Each of these is tested at least twice during each year and each is required to be accurate within a basic tolerance of 1.5 pounds per thousand. Moreover, each scale is tested with standard weights to its full working capacity and at each thousand pound load stage. This is a more comprehensive and thorough test than is required by other agencies or for other large capacity scales in commercial weighing service. It is satisfying to be able to inform you that some 80 percent of all the tests conducted under our supervision each year prove the scales to be within tolerance and, indeed, some 72 percent of the scales are found to be accurate on the occasion of each test made during the year. It is worthy of comment too that about 70 percent of all scales at our markets are provided with approved-type indicators as aids to correct balancing, elimination of disturbance effects and full visibility of zero or load balance. It has been our experience that extremely few instances of incorrect weighing are due to deficient livestock scales. On the contrary, as has been discovered repeatedly in our investigations, it is the weighing and weight recording practices of weighers which are responsible for incorrect weight values either through carelessness or through deliberate intent to defraud.

All of the 66 terminal stockyards in the first-mentioned category of markets and 262 of the 2,100 auction markets in the second category operate under direct supervision of the Federal Department of Agriculture. No direct supervision is exercised over weighing at packing plants or packer buying stations, although Federal regulations do provide that "packers shall maintain and operate their livestock scales so as to insure accurate weights." I shall defer my discussion of terminal market supervision problems until later and proceed now to discuss weighing conditions at auction markets and packer plants under Departmental supervision with special reference to methods for detecting and preventing common faults in weighing service at markets in those latter groups.

At most auction markets each livestock lot is weighed immediately after it leaves the sale ring and weighing must be completed rapidly to prevent congestion and delay in the ring. Although the average farmer is usually present to watch the bidding on his livestock he seldom observes the weighing, not realizing that the benefit of a favorable sale price is lost if weighing is not performed with care and impartiality. Incorrect weighing at these markets develops from the weigher's haste, carelessness or negligence and his consequent failure to regularly correct the scale zero balance, to allow the weighbeam or dial indicator to attain equilibrium before reading or recording the weight, and to make certain that animals or persons off the scale are not in contact with the platform stock rack or gates. Aside from these instances of inadvertent weighing inaccuracies, there are occasional instances when a weigher, although presumably disinterested in the sale transaction, may be influenced to favor a neighbor, friend, or relative buying livestock at the auction. It is regrettable too that throughout the livestock marketing industry there prevails an insidious doctrine that, in weighing livestock, the buyer is entitled to the "break of the beam", a principle which, if permitted to persist, would work to the injury of the farmer-producer on each draft weighed. It is also known that some auction market operators, desirous of attracting buyers to their market, intimate that weighing of livestock will be controlled to favor the buyer, and there is reason to believe that such operators have instructed their weighers accordingly.

Weighing at packer establishments, because there is less need for rapid operation of the scales, is less subject to negligence and carelessness in zero balancing and in weight determination. Moreover, the farmer or his representative may be present during the weighing. However, because the weight determination is made by the packer or by his agent and because the average farmer is not familiar with scale operation, there are ever present opportunities for taking advantage of the latter. One method observed is to balance the empty scale with the weighbeam at the bottom of the trig loop and balance the load with the beam at the top, a manipulation which can deprive the farmer of ten pounds of weight. Another method, less common but equally effective with type-registering weighbeams, is to insert the ticket in the poise slot before balancing the load, a manipulation which also causes light weight indication and record.

The core of the Department's weighing supervision functions is a rigid code of weighing instructions which each weigher of livestock is required to observe and which specifies in full detail requirements for balancing, for weighing, for weight recording and for careful and impartial performance of all duties. Special agents of the Department make occasional undisclosed observations of weighing to ascertain if weighers violate instructions. When deliberate fraud is suspected a previously weighed lot of livestock may be consigned to a market and the sale weight will be compared with the previously obtained true weight. Where conditions are favorable, a surprise visit to a market for check-weighing of livestock already weighed may be arranged. When evidence of fraud is obtained formal action is taken against market operators or packers and they are required to discharge the weighers involved. For first offenses or where violations are inadvertent, weighers and their employers are warned, instructed and placed on notice that they will be prosecuted for future lapses.

It is at the terminal markets where the bulk of the nation's livestock is marketed that problems of weighing supervision and control require special attention. This is due, in part, to the fact that as many as 30 scales may be in operation at one time and, in part, to the fact that livestock speculators who patronize these markets include some unscrupulous individuals who may seek to influence weighers to favor them either by light-weighing their livestock purchases or by over-weighing their livestock sales. Weighers at these markets, pursuant to regulations, are rotated from scale to scale at regular intervals to prevent developments of close relations with parties buying and selling livestock and various other means are taken to insure impartiality in weighing service. Despite these precautions, however, it has happened occasionally that a weigher and a speculator conspire to defraud a buyer or seller of livestock by incorrectly recording the weight of a livestock draft. Usually this is accomplished by the weigher moving the poise of a type-registering weighbeam to the position he desires before printing the scale ticket.

Because the information will illustrate the manner and degree in which livestock weighing fraud may be perpetrated unless appropriate measures of surveillance, detection and investigation are employed, I may now describe the results of a major investigation program which we were obliged to conduct during the past three years to discover and eliminate an organized conspiracy of fraudulent livestock weighing at one terminal market where fraudulent weighing constituted a million-dollar-a-year "racket".

At this market, there was reason to believe, certain weighers were habitually issuing scale tickets bearing false weight values to favor speculators selling livestock to packers. Since detection and proof of the practice could not be accomplished by ordinary measures it was necessary, with the cooperation of the stockyard officials, to install, unknown to the weigher or to others, special devices to record secretly the true weight of each livestock draft. At the end of each week the weights recorded by the device were compared with the weights registered by the weigher on scale tickets and the differences recorded and analyzed. The results of some typical data will now be shown to you, and I commend them to your study for they represent data which you have not seen before, a realistic record of what may transpire in a scale house when a weigher is alone with his conscience.

As a result of the information developed by the investigation, all weighers involved were discharged, the conspiring speculators were barred from the market and formal administrative action was taken to prevent their continued operation. I may also assure you that measures have been taken to prevent development of similar conspiracies at other markets.

The instances of incorrect weighing which have been described or illustrated represent extreme examples and are by no means generally typical. It would be incorrect and unfair to suppose that careless or prejudiced weighers compose a majority, that most market operators or packers are dishonest or that all speculators are without sound trading ethics. Nevertheless, as examples of conditions which could develop in the absence of effective supervision they illustrate why state and local weights and measures officials should not be content simply to test livestock scales but also should adopt measures for making certain that weighing is performed correctly.

(At appropriate points in his discussion Mr. Richard showed and explained several lantern slides of charts which demonstrated the actual performance of individual weighers at livestock markets.)

PROBLEMS IN LIVESTOCK WEIGHING

By R. D. Thompson, *Supervisor, Weights and Measures Section, Department of Agriculture and Immigration, State of Virginia*

I feel that the livestock weighing problem is equally as much a State and local responsibility as it is a Federal problem.

Since the beginning of the local or country livestock auction market some twenty-five years ago, there has been a rapid and widespread growth of these facilities throughout the nation. The livestock industry itself has become a major one, producing, from meat and meat animals, 29 percent of the national farm income in 1951. This amounted to 11 billion, 308 million dollars.

A large percentage of the livestock which at one time moved through terminal markets is now being bought by packers at country markets. As Mr. Richard has told you, the United States Department of Agriculture has supervision over a limited number of the auction markets.

This leaves the responsibility for correct scales and proper weighing practices at most markets with the State and local governments. Inasmuch as weights and measures enforcement at the State level, in a majority of States, is vested in departments of agriculture, it would seem only natural that the weighing at auction markets would receive the attention which it merits.

Attention has been given auction markets in Virginia for a considerable number of years, during which we have provided State weighmasters on a voluntary basis at some auction markets. This method has been satisfactory and has, we feel, rendered a valuable service.

However, it is certainly not the complete solution to the problem. During the past two years, we have done considerable check-weighing at auction markets. When this was first started, some rather amazing results were brought to light.

Livestock at auction markets in Virginia and in many southern States is sold on a basis of "in weights." A normal shrinkage is to be expected, and buyers make their purchases with this in mind. On a 200-pound veal calf, for instance, the anticipated shrink in a period of eight hours would be approximately 8 pounds. Most of this shrink takes place in the first three or four hours. We have established this figure by check-weighing a number of pens of veal calves at various markets. In some markets, we found the shrinkage as low as ¾ of a pound in 8 hours, and, in at least two instances, a gain was noted rather than the normally anticipated shrink. This resulted in the Commissioner of Agriculture revoking the license of one market, and in a lengthy court case, on which we have not yet received a verdict.

I want to mention here the splendid cooperation and assistance which we receive from the Packers and Stockyards Division of the U. S. Department of Agriculture. For a number of years, we have tested the scales under their supervision, both at auction markets and packing plants, forwarding scale test reports to them. When we needed help with this particular situation, they came through. Mr. D. L. Bowman of their staff observed the weighing in an undercover capacity, and both he and Mr. Richard were key witnesses in our court case. Cooperation among Federal, State, and local officials will help solve many similar problems.

Regardless of how the court case turns out, weighing practices at the majority of Virginia markets certainly have improved, and recent checks show little cause for criticism.

Our men, in some instances, only recheck individual animals which have just been weighed, or check on scale balance, the use of loose balance materials, and other common infractions which may be found.

You may inquire as to the incentive to short-weigh of an auction market, which operates on a commission basis. The answer is that pressure from buyers to hold shrink down and thus increase the dressing yield is more or less common and constant. If one market yields to this pressure and short-weighs calves, for instance, 5 to 10 pounds, it will be able to get a better price per pound, which will attract producer trade. Competing markets who may want to operate honestly are more or less forced to follow the same line in order to meet competition.

Declining prices on cattle provide a further incentive to the buyer who may seek short-weight as a means of insuring his profit against another drop in the market. The producer is caught in the squeeze between falling prices and short-weight practices.

Mr. Richard has termed their findings in one large terminal market as a million-dollar racket. Similar rackets over the entire country would run into many millions.

We, as weights and measures officials, often come here and quibble over problems of popcorn and popsicle proportions and insist on ¼-ounce graduations on prepackaging food scales, yet we permit livestock, such as individual veal calves, lambs, and hogs, to be weighed over scales with a 5-pound minimum graduation. Admittedly, the 5-pound graduation on livestock scales is well established and may be satisfactory for weighing large drafts of animals However, on individual animals in the lighter weights, such as lambs, veal, and hogs, a 1-pound graduation would certainly seem essential. I feel that those of us who are agriculturally minded should give this serious consideration, and make an effort to bring such a change into practice.

While it is my understanding that, in a large part of the United States, livestock is sold at auction on "out weights" rather than "in weights," the opportunity and incentive for fraud still exists, and the problem of correct weighing remains of importance.

The testing of scales of all kinds is an important and worthwhile part of our service. Yet, if we permit these correct scales to be used fraudulently, we are not accomplishing the results for which our respective agencies are created and supported. We must not forget that the producer and intermediate handlers, as well as the ultimate consumer, pay their share of the tax load.

It would appear highly desirable to try to bring the weighing at these markets out into the light, where it could be observed by all interested parties. The scale houses should be so constructed that the weighmaster could be observed by both producers and buyers. It should also be constructed so that the weighmaster can see both ends of the stock rack on the scale.

The use of type-registering weighbeams and balance indicators or automatic-weight recorders should be encouraged. Signs might well be posted encouraging the interested parties to observe the weighing.

Just how much of this should be done by regulation and how much by persuasion or salesmanship, I am not prepared to say. However, it presents a challenge which should be met on the State level in the manner which seems most appropriate.

In my opinion, the problem of livestock weighing is one that merits the careful attention of every State department of weights and measures in the nation.

Mr. Baucom: You spoke of the voluntary weighmaster program; I would like to hear more of that activity.

Mr. Thompson: Our plan has been to furnish weighmasters who are on the State payroll to such markets as request them and reimburse the State for their salaries. The State charges the market a certain amount per day for the services of each man. We feel that we have better control over the men who actually are on the State payroll than we have over those who are merely licensed by the State.

As I mentioned in my paper, we do not believe that this completely answers the problem, since it is operated on a voluntary basis. Since the program is voluntary, it might possibly be participated in only by those markets who are particularly anxious to do an honest job.

ELECTRONIC SCALES

By George F. Graham, *Assistant Director of Sales, Streeter-Amet Company, Chicago, Illinois*

The electronic or load-cell scale is relatively a newcomer in the field of weight determination. However, the wide variety of applications that have been made using these interesting instruments attests its versatility, accuracy, and dependability.

A survey of actual applications demonstrates that, when properly applied and correctly maintained, load-cell determination has an accuracy well within the order of magnitude of the tolerances recommended by the National Conference on Weights and Measures. The high degree of adaptability inherent in electromechanical load-cell systems enhances their merit for many difficult installations. Like all other careful processes, certain safeguards and preferential practices should be adhered to if good performance is to result.

It is not within the province of this paper to discuss basic concepts of electronic systems nor to dwell on many of the more technical aspects of these devices. However, before entering into discussion of individual applications, certain comments appear to be in order.

Electronic or load-cell systems for weight determination are suitable for either commercial or industrial applications.

There have been a wide variety of load-cell weighing installations. Some of them are of commercial nature; a much larger number have been sold for other industrial applications where the tolerances and specifications set forth in Handbook 44 do not apply. Examples of these would be certain crane scales, hopper scales, or other installations where the scale was not being used in trade, but only for intraplant operations. The accuracies and characteristics of these scales should not be confused with a load-cell scale that has been sold and installed for commercial applications.

Load-cell systems have been applied to nearly every type of weighing problem that is suitable for conventional scale systems. A sizeable number of applications have been made that would be very difficult to accomplish with lever-type units. Many times, the small space required of load cells, as compared with the large space requirements of levers, is very advantageous.

Railway track scales lend themselves to the new type of installations, since, wherever very heavy capacity scales are involved, the load cell offers definite economic advantages.

High speed weighing of motor trucks is becoming prominent as an adjunct in highway weight control. In this field, the load-cell instrument presently appears to be predominant.

Because of their relatively small size, and remote recording features, load-cell crane scales are becoming very popular, and seem to fill a void that formerly existed in weight determination.

Tank and hopper scales are a natural application for the load cell. The cell works equally well in tension or compression, and the installation of cells usually presents fewer problems than any other type of load- or weight-determining system.

Testing methods are similar to those normally used for conventional units. The best way to test any scale is to load the weighbridge or other load-receiving element with successively increasing small increments of weight, and determine if the response of the weight-determining instrument is correct.

As is the case with lever mechanisms, corner tests of load platforms, center and section tests should be made, and tests of the sensitivity and repeatability should not be neglected. In passing, it should be noted that the sensitivity of load-cell units is usually very good.

Load-cell instruments are peculiarly adapted to control other functions, such as batching, computing operations, or any operation that is desirable to control by weight. The weight information is already in the form of electrical values, and, as such, is readily usable. Further, since most load-cell systems have, as an integral portion thereof, servo systems capable of accepting a signal from the cell and using it with the application of a desired amount of power, a freedom of operation exists that is not inherent in the lever systems where all the power used to perform work or extra functions must be subtracted from the weighbeam and, to that extent, introduce possibility of error.

Remote recording is inherent in most electronic systems. Full-figure printing is available with load-cell systems.

Temperature changes within normal operating limits do not affect the load cells adversely.

Unfortunately, there has been some confusion in connection with load-cell scales with regard to the presence of temperature sensitivity and zero drift. In many applications, these features are either of no great importance or may be eliminated; therefore, many noncommercial scales have been sold and have been in operation for years that do show a marked temperature sensitivity and zero drift. However, a load-cell scale that is installed for commercial applications should be expected to maintain good weighing characteristics over all normal operating temperatures. Also, its zero-drift characteristics should be negligible. Normally, these would not be more than those encountered by the accumulation of dirt on a conventional truck or any other platform-type scale.

A load-cell scale is a precision mechanism. Overload or abuse can hurt these scales, as well as the conventional mechanical units.

It should be remembered that the load-cell scale is affected by poor weighbridges, binds, bad installation, misalinement, poor fittings, etc., in exactly the same manner as a mechanical system. In certain load-cell applications, errors arising from causes exclusive of the load cell and connected recording systems are responsible for errors accredited to the new weighing methods.

While load-cell scales generally can be furnished to conform to performance specifications and to meet the requirements of normal commercial operation, there are design specifications or design considerations that have been incorporated into purchasing or acceptance specifications that do not cover the field of load-cell scales or are not applicable thereto. For instance, it means little to a load-cell scale that the allowable pivot or bearing load is 5,000 pounds per linear inch, or that the main levers must clear the bottom of the pit by so many inches. On the other hand, those portions of the specifications pertaining to tolerances, type of deck, type of construction, clearances, checking members, etc., are in most cases applicable in either lever systems or load-cell scales. This would indicate that careful consideration should be given to the possible revision of existing specifications with an emphasis towards broader application and interpretation, but without reducing many characteristics that are desirable for an operating or performance consideration.

Tare provision, multiple ranges or drop weights, zero adjustments, etc., can all be accomplished by load-cell systems.

Visual indicators and/or printers usually are incorporated in the new units.

Whereas, earlier load-cell units were of manual-balance type, most modern types are of the automatic servo variety. Among the earliest type of load-cell applications, are to be found manually balanced systems for determining load on aircraft axles, tank-weighing systems, material-testing units, platform scales, and crane scales.

An understanding of the application limitations and advantages of load cells presupposes a general understanding of the method of operation involved. Many varieties of load cells have been developed. These are capable of a varying degree of accuracy; therefore, applications should be made with the limitations or peculiar advantages of the particular type of cell in mind.

Generally speaking, there are available hydraulic load cells of several varieties which can operate visual indicators directly or, in connection with electrical components, control printers, or remote functions. These comments apply equally to the pneumatic type of load cell. Certain technical people have high regard for these two types of transducers. Material-testing machines have been developed around the use of hydraulic and/or pneumatic functions usually in connection with some form of electric actuating circuitry.

A wide variety of electrical or mechanical-electrical transducers are on the market. The fundamental concepts of the several types are of considerable interest, and all weights and measures men will undoubtedly familiarize themselves sooner or later with the several systems and their practical and theoretical advantages and/or limitations.

In brief, most systems consist of a load-receiving element which is so designed that an electrical signal proportional to applied weight is created. Some transducers generate sufficient signal strength to control indicating mechanism without amplification. Others generate a signal strength requiring a high degree of amplification. The signal developed by the transducer or load cell is used to operate a balancing component, so that, when a steady state is reached, the system is in balance. At this steady-state position, weight indicating or recording is effected.

A few of the more typical installations which have been made with systems not based on the use of levers include railway track scales, platform scales, high-speed truck scales, tank and hopper scales, and crane scales.

These units all comply with the fundamental requisite of any weight-determining device. In appearance, they may be vastly different, and, in fact, the flexibility of use and application may be, and usually is, dissimilar. However, tolerance specification, methods of testing stability, and readability all follow the pattern of conventional units.

It should be emphasized that the newest and the latest type of load-cell scales are completely different in design, construction, and accuracy than many of the earlier ones. Therefore, the present scales should not be judged by facts and rumors about scales that have been in service for some time or that have been sold for industrial applications.

While on the subject of testing, it might be well to state that the best way to test any scale seems to be to load it in reasonable increments to full capacity. No good short cuts seem to apply either to electronic or lever devices.

One interesting feature that should be mentioned with regard to electronic scales is that one instrument (recorder or visual indicator) can serve more than one load unit or scale. The recorder is simply switched from one scale to another, electrically. Or, it is equally possible to have several scales, not mechanically connected, working as a integrated weighing device, with a single recorder. Many electronic recorders are full-figure printers, and, of course, are entitled to the extra tolerance allowance of 1/2 minimum graduation.

Summarizing, the applications of electronic units have proven somewhat more flexible and equally as accurate and dependable as lever scales. They require, in most instances, only a reasonable degree of maintenance, and can, under certain circumstances, function well where conventional systems fail.

This new type of device is suitable for many problems of weight determination difficult to solve with levers. Testing procedures are substantially identical with present practices.

(Mr. Graham showed and explained a number of lantern slides depicting various components and installations of electronic scales.)

(The Conference was adjourned, to reconvene at 10:00 a. m., Thursday, May 21, 1953.)

(During the afternoon of Wednesday, May 20, informal tours of the laboratories of the National Bureau of Standards were participated in by the delegates.)

(On the evening of Wednesday, May 20, an informal party was held at the Wardman Park Hotel, the Conference headquarters, for those attending the Conference.)

FOURTH SESSION—MORNING OF THURSDAY, MAY 22, 1953

(J. Fred True, Vice President, Presiding)

REPORT OF THE COMMITTEE ON WEIGHTS AND MEASURES EDUCATION, PRESENTED BY CHARLES MORRIS FULLER, CHAIRMAN

Your Committee on Weights and Measures Education has enjoyed a year of contacts with a typical cross section of weights and measures officials, located in all parts of the country. These officials were selected mostly from those who were cooperative when we made our previous study on budgetary procedures.

The idea of developing a training and study course, based on handbooks issued by the National Bureau of Standards is not a new one. It has been discussed over the years. Certain things, however, had to be given due consideration. The preparation of a book or manual for the course would be a full time assignment for some highly qualified person.

The National Bureau of Standards already has issued many valuable publications for the purpose of disseminating authentic information and promoting uniformity in weights and measures enforcement. We felt, therefore, that it would be the logical agency for the job.

Mr. W. S. Bussey, Chief of the Office of Weights and Measures, stated that, if a training and study course would be of real value, his office might be willing to undertake the project. They would have to be convinced beyond any reasonable doubt that there is an actual demand and need for such a course. It would be of little value unless the department heads really used it and followed up with thorough examinations. It would have to be used extensively if the effort and expense were to be justified.

This explains why one hundred of you received personal letters requesting your frank opinions on the subject.

Your answers to the letters speak well for the caliber of men who are engaged in this essential work of protecting the American public.

They evidence careful study, thought, and interest. We were able to understand just how useful the proposed course would be in your jurisdictions, and your reasons for arriving at those conclusions.

The majority of answers agreed that the idea, itself, is good: "a manual as proposed would be of invaluable assistance";—"a very fine thing, especially for some States where the personnel are not able to attend meetings or participate in the National Conference";—"one of the best ideas that has been advanced in weights and measures in quite some time";—"would be especially valuable in States having relatively new weights and measures laws";—"could be used by new inspectors during their training period, or by old inspectors to refresh themselves on methods of technique";—"both practical and worthwhile and there should be a big demand for such a course";—"would be a forward step";—"great possibilities if presented right";—"a course covering the rudiments and functional experiences of all devices that officials come in contact with, is needed very badly."

A general feeling was expressed that the manual should be clear and concise; written in plain, simple language without too many technical terms; and "with short, meaty chapters followed by questions."

Emphasis was placed on the part that the National Bureau of Standards should take: "definitely of the opinion that the NBS in Washington is the only Bureau in a position to put such a project into effect";—"would be accepted by a large number of weights and measures officials";—"the more it approached the nature of a correspondence course with a series of examinations composed and preferably graded by one person or group to be designated by the National Bureau, the more effective and valuable it would become."

An opposite view regarding examinations was taken by one official, who said, "While I believe most of our local inspectors would study the manuals, I am afraid many of them would endeavor to side-step examinations. Speaking for myself, I have taken several State merit examinations and, as a result, have gotten to the place where they prove distasteful to me. The reason may be attributed to unnecessary worrying prior to the examination. I mention unnecessary worrying, due to the fact that I have never met with any difficulty in making satisfactory grades."

Another suggestion was made that the course should be slanted at career supervisors who would be the trainers for the inspectors working in their departments. In this case, it would be assumed that the supervisor had a basic knowledge of weights and measures when he was promoted. The course would include information from the Bureau on the technical aspects of the work; such as modern methods, short cuts, and new formulas for testing. It would develop his skill in leadership, in improving work methods, and in teaching others. Emphasis would be given to his responsibilities to his subordinates, superiors, the consumer public, and the vendor, including the sellers of weighing and measuring equipment. As a part of this course, there would be classroom instruction of two or three weeks' duration, conducted by the National Bureau of Standards in Washington, D. C., the expense of travel and per diem to be borne by the jurisdiction involved. "This would be a bold step and could be accomplished only through proper selling contact on the part of Bureau representatives, assisted by those of us in the field who subscribe to the program."

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Civil Service Commissions would welcome an authoritative manual as an aid to them in setting up examination procedure. It also would answer the question as to where men interested in taking civil service examinations could gain a comprehensive insight into the work entailed.

Up to this point, we have concentrated on the educational value of the proposed manual and course of instruction. Equal consideration must be given to the practical side. Would it be used enough to justify the effort and expense involved in preparing it? Your Committee has not forgotten that several years ago it labored to prepare a comprehensive list of questions and answers covering the field of weights and measures operations. The comparatively small number of requests for copies was very discouraging.

Undoubtedly, the use of the course would be affected by the probable tenure in office of the officials and inspectors—whether they are career men under civil service, or political appointees who hold the position for only a short time. In some places they are appointed from year to year and could not be expected to take much interest in an educational program.

Half of the officials who believe that it is a good idea expressed themselves as doubtful if it would be widely used. Here are some of their comments:

> There is already existent in Handbooks 37 and 45 about all the fundamental knowledge that can be contained in printed form. Frankly, I am doubtful as to whether or not it would be utilized to a sufficient degree.—(Head of a leading State department who has also had many years of experience on Conference committees.)
>
> It is my honest opinion that very few departments would use a publication of this type unless their program and budget included a trainee program.—(Head of a large and progressive county department.)
>
> I have reason to question the end result value of such an extensive effort. The splendid material which is now available provides adequate information.—(Head of one of our largest city departments who has also had much committee experience.)
>
> Definitely a waste of time. The majority of officials do not care to spend too much time studying.—(No beating about the bush by this State chief.)
>
> (Another head in a large State also was outspoken.)—I would not want to be committed to the use of such a training course. In fact, I wonder if any of them would even bother to go through an extension course that would require any of their own time, and I wonder if we would be criticized for taking time for such study while in the employment of a governmental agency.
>
> (This State chief sums up his opinion as follows:)—There is a definite need for the training of weights and measures enforcement officers throughout the United States, but, until such time as the persons who are engaged in this work feel the need for such education in order that they may perform a better service, the creation of a training program may be labor lost. We have too many persons who are well satisfied with their present inadequate efforts, or who have accepted the position as a weights and measures enforcement officer and are carrying out the work following what might be given as a rude description, "following the lines of least resistance."
>
> To get adults employed by cities, counties, and States interested enough in their work and future to put in the extra time necessary to accomplish such a course would be a miracle.—(The breezy comment of a State chief.)
>
> Frankly, I feel that at the present time, the response would not be any greater than it was for the list of questions and answers.—(A veteran of many years as a State leader.)

Other heads of large city departments had this to say: "Enthusiastic about the idea, but doubtful about the use. How much of a demand there would be, I cannot say."—"The work and expense would not be justified. Both handbooks issued by the National

Bureau of Standards are adequate. Good judgment and common sense, plus the instructions contained in the handbooks, should be sufficient to enable the official to perform his duties satisfactorily."—"My honest opinion is that it would not be worth the time or effort demanded for such an undertaking."—"This is to express my objective doubts about the project. The proposed manual would not be widely and properly used by most officials."

We could go on and quote many similar expressions. It should also be noted that 29 percent of the total number did not even answer the letters which were personally written them. This negative response would seem to indicate a total lack of interest in the project, so far as they are concerned.

On the other hand, we were assured by 27 percent of those contacted that they would definitely use the course in their own jurisdictions:

> I wish to assure you that such a manual would be used by this division. Any arguments which might be advanced with regard to the non-use of the manual might very well have been advanced against the other publications referred to in your letter. I think now that NBS Handbooks have been published and put to good use; we all can agree that they have proven of great benefit and that it would be extremely difficult to get along without them. Undoubtedly, the result would be the same if the proposed manual is written and published.—(The chief in a large midwestern State.)
>
> I will see to it that everyone of our inspectors takes advantage of this opportunity if favorable action is taken on the proposition. The benefits obtained by the people and the inspectors will be greater than anything attempted to improve and make weights and measures inspection uniform throughout the United States.—(An active southern State.)
>
> As far as this department is concerned, it would be accepted, and we have about 50 State sealers of weights and measures.—(Another large midwestern State.)
>
> I heartily endorse the idea and will certainly use it in this office.—(A southern city.)
>
> I asked my deputies how many would be willing to attend a course of this kind on their own time, and their answer was a unanimous "yes."—(A western county.)

We could continue with more opinions, both for and against the project. The foregoing, however, gives you a pretty complete picture. Your Committee believes that the proposed handbook or manual would be a valuable addition to our present textbooks. It would provide the means for a training and study course. It would promote uniformity in enforcement. But it probably would be used by not more than one out of four officials and inspectors.

These facts are submitted without further comment. The final decision about undertaking the job must be made by the National Bureau of Standards.

Your Committee prepared another questionnaire which had to do with assistance by the National Bureau of Standards to weights and measures officials. Copies of this were sent to all officials who answered our first letter.

Some of the desired services are as follows:

1. Provide field personnel to work, in an advisory capacity, with State and larger local jurisdictions. These men should be qualified to instruct and demonstrate proper methods of testing any weighing or measuring device.
2. Make surveys and offer suggestions for improving the service in the different States.
3. Encourage ownership and use of NBS Handbooks.
4. Increase attendance at the National Conference by aiding officials to get authorization and support of their governing bodies.

5. More promptness in calibration of standards submitted to the Bureau.

6. Develop an approval seal with good adhesive and non-fading qualities.

7. Establish a clearinghouse for interstate problems and complaints.

8. Encourage the organizing and expanding of State and regional associations and conferences.

9. A continuous study of current conditions, with the ratio of personnel to population in mind. This information to be issued in bulletins to aid officials in obtaining adequate personnel and equipment.

10. Put on a two- or three-day meeting in each State that would tell the complete story of weights and measures work. Demonstrate methods of testing with actual equipment. A federal exhibit to be used at State fairs would be valuable.

11. Stimulate the various departments by a survey and evaluation of their work. Issue certificates of approval where deserved.

12. Set up an experimental school at State and local conferences where the inspectors would make actual tests of both old and new equipment. They would then make out inspection sheets showing why the equipment was either sealed or condemned. These sheets would be collected and graded by the National Bureau of Standards.

13. A training course for sealers of weights and measures.

14. Expand program of railroad track scale testing. Notify the sealers far enough in advance so that they could plan to be present at tests.

15. Encourage the Federal Education System to prepare and distribute (especially to schools) movies showing the value and necessity of this work. Also a film for weights and measures personnel.

16. A consumers' educational program aimed at the housewife.

17. Impress on State officials the importance of revising and bring up to date, annually, their specifications and tolerances.

18. Increased effort in promoting, through letters and personal visits to key members of State legislatures, the creation of weights and measures laws, and the setting up of weights and measures departments in those States that do not have such laws or departments.

19. Encourage the enforcement of current weights and measures laws in the respective States, as well as suggesting additional laws of a uniform nature concerning subject matters that are common to interstate exchange.

Everybody was unanimous in desiring the Bureau to continue all of its present services without any curtailment.

Among the subjects which officials would like to have presented at State conferences by staff members, are many relating to the Bureau, itself, such as: organization and functions, services offered, current programs, accomplishments and objectives of the National Conference, illustrated talks on material in the NBS Handbooks. Staff members could preside over panels or discussion groups on problems of field inspectors; the proper relationship of the inspector to repairmen; unusual problems encountered and methods devised to correct conditions or violations; and current problems as they come up from time to time, such as liquefied petroleum gas and farm milk tanks. If possible, talks should be applicable to weights and measures problems or interests of the locality represented by the conference.

Staff members would be in a position to tell about the progress achieved in various jurisdictions and what the other States are doing, so that the delegates could benefit by experiences and methods that had proved successful elsewhere. Talks should be practical, not technical, and presented with visual aids whenever possible.

The development of electronic scales is a timely suggestion. The sale of ice cream by net weight is still a live issue, as is the consideration of other commodities sold in an improper manner, such as pickles and pickle products by liquid measure. More about the metric system and its adoption is desired.

Detailed methods for the handling and inspection of prepackaged commodities would be a welcome subject that would arouse much discussion. Many officials stressed the importance of talks that would promote uniformity, both in testing and inspection methods, and in specifications and tolerances.

Judging by the requests received, the Bureau will need an added budget appropriation for publications and printed matter. The officials would like to see the Monthly News Letter revived. They would like bulletins covering the latest types of testing equipment, with plans and specifications; bulletins on new kinds of weighing and measuring devices, with approved methods of testing same; an annual list of all sealers in the United States; an up-to-date glossary of scale, pump, and meter terms; and a digest of complicated court cases.

Handbooks could be revised and enlarged to include specifications and tolerances, as well as questions and answers, chapter by chapter for H37 and H45, and code by code for H44. Booklets should be provided to replace some of those that are out of print; for example, Circular 3, "Design and Test of Standards of Mass." A manual for new or untrained inspectors is needed. This could be similar to those used in Canada to prepare an applicant for taking an examination for inspector. It should not be as technical as the handbooks, but would explain proper methods of doing a correct job. A series of press releases, perhaps one every week, would stimulate the interest of the public.

The last suggestion hits at a vital problem—how to awaken the interest of the people to the importance of getting full weight and full measure for their money. It is a paradox that at this time, when prices are at an all-time high, the buying habits of so many are at an all-time low.

Most of you read the article, "Ask the Price! Watch that Scale!" which appeared in Good Housekeeping magazine a couple of years ago. The editors of this national publication felt that this was a subject of more than passing concern. After consulting the Office of Weights and Measures at the National Bureau of Standards, they sent a staff writer, Elsie McCormick, from one end of the country to the other, meeting officials and gathering facts from her own observation.

When the article finally was written, it had a subheading which asked the pertinent question, "Would you like to reduce your present food bills by 6 percent without cutting down either the quality or quantity of your provisions?" She estimated that American women lost over a billion dollars a year in not being efficient food shoppers—in failing, mostly through carelessness and indifference, to get full weight for their money.

It was written in an entertaining manner and related many interesting episodes to illustrate the conclusions reached. But how many of the three million subscribers to Good Housekeeping (and several times that number of readers) remember those facts today? What is more important, how many put into practice the suggestions offered that would result in saving real money for the family budget?

Nothing can take the place of personal contacts through the medium of speaking engagements. From personal experience, gained during the past few years by delivering an address, "How to be a Smart Buyer," before nearly three hundred women's clubs, men's service clubs, and other organizations, the Chairman of this Committee has had the opportunity of learning their value. The results obtained have been more than worth the time, effort, and night work required.

There must be an actual demand from the people, themselves, if we are to have improved weights and measures conditions. Many years ago, the National Bureau of Standards made a survey in California. It revealed that short weight, false scales, and tricky practices were costing the consumers huge sums of money. Those facts were given wide publicity and aroused the people to action. Any time it can be shown that they are being robbed of part of their living by underhanded methods of short weight and short measure, people are going to demand that something be done about it. A constitutional amendment, establishing laws and State-wide enforcement was submitted to the voters in California, and passed by an overwhelming majority.

The Office of Weights and Measures well might consider ways and means of effectively arousing the public, especially in backward States and communities, to a realization of how much this lack of weights and measures protection is costing them in dollars and cents. The establishment of a Speaker's Bureau for this purpose would be a worthy project.

REMARKS OF A. T. McPHERSON, ASSOCIATE DIRECTOR, NATIONAL BUREAU OF STANDARDS

We at the National Bureau of Standards are very glad to have the nineteen suggestions developed by Mr. Fuller and his committee, and we will give each and every one of them serious consideration. Two major problems confronting the Bureau necessarily will limit the amount of service that can be rendered under present circumstances. One problem is the increasing demand from many quarters for a variety of new standards and additional services, and the other is an anticipated reduction in appropriations, which is part of the Government-wide action to alleviate the tax burden and balance the National Budget.

It is gratifying to note, however, that some of the items mentioned have already been receiving consideration. For example, the calibration of weights is practically current and the backlog of other standards awaiting calibration has been reduced considerably. Currently the greatest delay is about six months and is on the calibration of volumetric standards. In the over-all calibration and testing program, involving about 320,000 items a year the average time at the Bureau is between one and two months, including the time required to do the work.

The Bureau welcomes the opportunity to participate in local and regional weights and measures conferences, but participation is limited by the fact that only Mr. Bussey and Mr. Jensen are available for this activity. In order better to serve the local and regional officials, these men must spend considerable time at the Bureau keeping in touch with the widely varied work done by 4,800 other members of the staff so as to bring pertinent new ideas and new developments to bear on practical problems encountered in the field. One such new development is exemplified by the application of statistical engineering to the calibration of gasoline pumps. This is described in a paper by Youden and Jensen, which Dr. Youden will present later in this Conference.

The small but important problem of a durable seal, mentioned by Mr. Fuller, probably can be solved through the use of information developed at the Bureau for another purpose.

As to the Educational Program, the Bureau has made very effective use of motion pictures for presenting the results of its dental research. Through a series of color film—now five in number—dentists all over the world have been able to see and learn new techniques involved in mechanical restoration. A film showing the flow of water in transparent plastic pipes has greatly aided the acceptance of a plumbing code. Films for training inspectors or for other educational purposes can readily be developed if financial support can be provided.

The Bureau, of course, is not responsible for the enforcement of current weights and measures laws in the respective States, but it has lent its encouragement to such enforcement in a very tangible way through a number of publications, the latest of which is the Weights and Measures Case Reference Book to which your attention already has been called.

We will be guided by your suggestions and we solicit your further recommendations. Perhaps we shall be able to report to you at the 39th National Conference and describe the progress we have made on your requests.

TECHNICALITIES IN WEIGHTS AND MEASURES COURT CASES

By J. A. Murphy, *Assistant Deputy Attorney General, State of New Jersey*

A technicality has been well defined as a microbe which has gotten into the law and given justice the blind staggers. A technical error or a technical objection is one which does not go to the substance of the issues or the substantial rights of the parties involved. It is addressed to form rather than substance, but may well constitute the difference between successful prosecution and failure. Many of these errors or the grounds for objection arise from carelessness or lack of care in testing or inspection, in preparing complaints for violations, in preparing for trial and in testifying at trial.

How many enforcement officers make a detailed, comprehensive, and complete report of their investigation or inspection immediately after it is made and while the details are still fresh in mind? Too much reliance is placed on memory. In view of the number of inspections made, there is bound to be some confusion in the facts of some of them. This is a constant place of attack by the trial lawyer. He will ask for a description of the place. It is a minor matter and may not be important. Generally it is not, but, if he can lead a witness into contradiction, it is one nail he has driven and will be used to reflect discredit on other testimony.

Does the report disclose the name of the defendant? Suppose it is a partnership? What if it is a trade name? Is it a corporation? If it is not the individual who is responsible, then the wrong person may be named as the defendant and the complaint will be dismissed by the court.

Where was the inspection made and where did the violation occur? If an inspection is made in Municipality A and it discloses a violation in Municipality B, the action should be brought in Municipality B where the cause of action accrues. This has also been a cause for objection and dismissal of complaints for violations. Jurisdiction over the subject matter of a cause of action is very important. It cannot be conferred by the consent of the parties, and, unless the action is brought in a court which has jurisdiction, the case must be dismissed. An individual may consent to the jurisdiction of the court over his person, but he may not consent to having a case tried in a court which has no authority to hear or determine that case.

Another source of attack is the sufficiency of the complaint. Most statutes, in defining an offense, make any one of a number of things a violation of that statute and use the disjunctive term "or" in stating them. For example, a statute may require the net quantity of the contents of an article of food in package form to be plainly and conspicuously marked on the outside of the package. It usually provides that no person shall distribute or sell or expose for sale, or have in possession with intent to distribute or sell, any article of food in package form, unless the net quantity of the contents be plainly and conspicuously marked on the outside of the package in terms of weight, measure, or numerical count. This statute may be violated in any one of five ways, distribution, sale, exposure for sale, possession with intent to distribute, possession with intent to sell. As a general rule, the offender is in violation of more than one provision. The purpose of the complaint is to acquaint the offender with the violation for which he is responsible. Many times the complaint alleges the violation in the disjunctive. It follows the words of the statute. It is generally true that, in charging a statutory offense, it is sufficient to lay the charge in the words of the act, without a particular statement of facts such as will bring the accused within its operation, but it is not sufficient if the disjunctive term "or" is used. A defendant would never know whether he was accused of distribution, or of sale, or of exposure for sale, or of possession. He would not be able to properly prepare his defense. Such a complaint is too vague and indefinite, and has, on occasions, been dismissed for this reason. You need not, however, just pick out one of the provisions and only allege that as a violation. You may allege them all, but you need only prove one. You must, however, change the disjunctive "or" to the conjunctive "and" in so doing. The general rule is that, where an offense may be committed by doing one of several things, they may be grouped together by using the conjunctive "and" where "or" occurs in the statute and so charge the defendant with having committed them all, and a conviction may be had on proof of any of these things without proof of the commission of the others.

Another target of attack in the complaint is the sufficiency of the allegation in a complaint where the doing of an act without a license constitutes a violation of a statute. It is not the act itself which constitutes the violation, but it is the performance of that act without a license. The complaint must allege not only the act, but also the fact that the defendant is without a license. Failure to allege the defendant has no license makes a complaint defective and subject to dismissal. This would appear to be an omission that would seldom occur, but nevertheless it has happened too frequently.

On many occasions the defendant has been previously convicted of other violations. Most statutes impose a greater penalty for repeated offenders, but, in order to obtain a judgment for the higher penalty, the fact of prior conviction should be alleged in the complaint. Failure to allege such prior conviction has prevented the court from imposing the greater penalty and has permitted such offenders to get off with a light one. Where the complaint fails to allege the prior conviction, objection has been successfully made by counsel to any judgment other than for a first offense.

Many statutes provide for a minimum and maximum monetary penalty which may be imposed by the court for violation of a statute. The discretion, within those limits, is placed in the court. The complaint, however, should request judgment for the maximum amount; otherwise, the court will have no opportunity to exercise its discretion. If the prayer of the complaint is for the minimum, the court will impose only the minimum. The facts of the case may justify a greater penalty, but the court will be bound by the relief asked.

Another main point of attack is the method of inspection or testing. This is particularly important, because the judge is not an expert, nor may he even be conversant with weights and measures work. Especially is this true where anything mechanical is involved and where technical words are used in explanation. It is also true where new devices are used. One example is the loadometer which is, as you know, a wheel-load weigher and is specially adapted to determining the wheel loads of vehicles on highways. One of the first questions raised is their accuracy. How were they tested to determine their accuracy? Where was the vehicle weighed? Was it on a highway? What was the grade of the road? Would the grade or angle of the road cause or increase errors in the device? How many loadometers were used? Are four more accurate than two? Were they used on both sides of the vehicle or only on one side? Was the vehicle kept level by chocks or blocks placed under the wheels? If not, did this increase the angle so as to cause error? Which loadometers were used? How were they identified? What care was given the devices? If any reflection can be made on the method of testing, then the accuracy can seriously be questioned, too.

The identification and preservation of evidence is another bone of contention which is often worried by a lawyer. It is particularly vulnerable where the evidence has been in the possession of more than one person. An attempt is always made to show it is not the same. Very pointed and pertinent questions are asked regarding its identity, its storage, who handled it, and who had access to it, in order to show that it is not. Identification is very important. It may be made by the serial number being noted in writing by all parties. A more accurate method is by using a sticker and having each person who has had custody initial the sticker. Confusion in identity of the evidence where it has been in the possession of more than one person, all of whom must testify regarding it, is many times a source of embarrassment, and too often a cause of failure in prosecution.

There is another source of attack which is directed to a basic and vital part of weights and measures. That is the questionability of the accuracy of your standards and of the standards used in making tests in the field. In order to prove a case involving weight, you must show that the weighing was done on scales which were accurate. You must, therefore, show these scales were tested by standards that are correct. These working standards, of course, are compared with the State standards in order to determine their accuracy, and are corrected, if necessary, so that they are accurate. The question, however, is not directed to the accuracy of the standards used for the test, but is directed to the accuracy of the State standards which were used for comparison and correction. It is, therefore, necessary for you to show the State standards have been certified as required by the State statute. All the laws of the States require State standards to be submitted once every certain number of years, generally ten, to the National Bureau of Standards for certification. Have you had occasion to examine this certification closely? Is it a certification? Is it not many times only a report? Is this report many times a refusal to certify rather than a certification? Does it not state many times that the set of weights submitted does not conform to National Bureau of Standards specifications for weights of a certain named class in that a certain weight or weights in that set are in error by more than the tolerance for the weight or weights of those denominations? What is the result? There has been a refusal of certification. Refusal not only of the erroneous weights, but also of the correct ones, for the report is a rejection of the entire set of weights. It is true that the result of the test with the margin of error is incorporated in the report. It is true that you may compensate for this error in correcting your working standards, but the objection is directed to the failure of certification of the State standards, that they do not comply with the law in that they have not been certified as required by the law and, therefore, may not be used as a standard of comparison for the testing and correction of the working standards. It is almost impossible to explain to, much less convince, a court that this report of the National Bureau of Standards should be considered as a certification. You may argue that it is only a question of words, but words are the principal tools of lawyers and judges. They are to lawyers what a scalpel is to a surgeon, or a slide rule to an engineer. There is a magic in words. A difference in the mere form of words may make a difference in law. If A lends money to B upon an agreement to pay interest of 5 percent, but, if it is not paid promptly, then he has to pay 6 percent, the 6 percent is invalid as constituting a penalty. However, if A and B had agreed the interest would be 6 percent, but, if paid promptly, it would be 5 percent, then it would have been valid.

The State law requires certification and uses that specific term. A set of weights is submitted to the National Bureau of Standards for certification in conformity with the law, and you receive back a report. Have you complied with your law? Are your weights certified? Once the questionability of the standards is raised, the procedure is then to attack the care with which they are kept. Where they are stored; who has access to them; are they under lock and key; who has the key; where is it kept; are they transported about; were they dropped or damaged in any way? These and numerous other questions of similar character are interposed if one wedge can be driven regarding their accuracy.

All of these objections are purely of a technical nature. They do not go to the merits of the question or the substance of the issues.

Yet any one or a number are often sufficient either to dismiss a case or discredit the evidence and raise the question of its sufficiency with the end result that the court feels there is not enough certainty in the proof. Carefulness in inspection and testing, proper identification and preservation of evidence, painstaking preparation and careful analysis all along the way are of greater importance than brilliant presentation because the former insures the latter.

Dr. McPherson: When the legal distinction between reports and certificates was pointed out during a court case and thus was brought to the attention of the Bureau, prompt action was taken. Records of past calibrations of State standards were studied, and, where they seemed appropriate, supplementary certificates were issued to give the standards legal validity. In the meantime we reviewed the statutes of the several States and, guided by the requirements stipulated therein, we now endeavor to prepare documents which are legally valid.

I would suggest that upon your return to your respective jurisdictions you examine the documents which have been issued by the Bureau with regard to your standards. If you or your legal advisors have any suggestions as to revisions, please let us know.

REPORT OF THE COMMITTEE ON LEGISLATION, PRESENTED BY MILES A. NELSON, CHAIRMAN

(Secretary's Note.—The text of the Model Regulation for Package Marking Requirements, which was adopted by the Conference, is not included in this publication. Upon request, the full text of the Regulation is available from the Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C.)

The Committee on Legislation submits this report covering matters referred to it by the 37th National Conference on Weights and Measures and other matters from other sources.

TOBACCO LABELS

Referred to the Committee by the 37th National Conference was the question as to whether or not the content indications on Federal Internal Revenue tax stamps serve adequately to fulfill the Model Law requirement for net content declarations on packages and cans of tobacco. The Committee is of the opinion that all packages and cans of tobacco should bear a plain and conspicuous net weight declaration. Under no circumstances should there be any special privilege granted to the tobacco industry or to any other industry on the net contents requirement. The Committee not only makes this recommendation with regard to packages of tobacco, but it goes further by recommending that packages of all commodities be required to bear a proper net contents declaration.

Your Committee feels that the objective of obtaining a plain and conspicuous net weight declaration on packages and cans of tobacco could be attained by a revision of the internal-revenue stamp. Therefore, your Committee recommends that the Secretary of this Conference confer with officials of the Bureau of Internal Revenue and see what can be done to revise the internal-revenue stamp so that it clearly, plainly, distinctly, and conspicuously indicates the true net weight of containers of tobacco, and report the conclusions to this Committee.

STANDARDIZATION OF PACKAGES

The second matter that was considered by the Committee was the standardization of packages. This subject was referred to the Committee by the President of the Conference last year for further study and report. It has been a subject that has been under consideration for several years.

Your Committee feels that the standardization of packages is a very desirable objective, but it is felt that such an objective cannot be obtained at too rapid a rate, especially when so many phases of industry itself cannot seem to agree as to the course that should be followed. It is thought by the Committee that the proper approach would be first to attempt to work toward standardization with some individual phases of industry and that it is still a subject that deserves further study without any specific recommendation from the Committee at this time. Your Committee recommends that it be allowed to retain this matter for further study and consideration.

SALE OF PICKLES

The Committee on Legislation was requested to consider the recommendation that was adopted by the 32nd National Conference in 1946 to the effect that pickles should be sold on a drained net weight basis, or by numerical count. Your Committee feels that this is a matter for further consideration by the Conference Committee on Methods of Sale of Commodities. We have been informed that the item is on the current agenda of that Committee. We feel that any action by the Legislation Committee must await further recommendations by the Commodity Committee and subsequent actions by the Conference.

MODEL REGULATION FOR PACKAGE MARKING REQUIREMENTS

The 37th National Conference tentatively adopted the Model Regulation for Package Marking Requirements which was offered by your Committee last year. During the ensuing year, this matter has been studied by the Committee and no further recommendations on the subject have been received. We believe that this is a regulation which will serve admirably as a model for State promulgations. It follows closely the wording of that part of the Federal Food, Drug, and Cosmetic Act which regulates package marking. Your Committee recommends final adoption of the Model Regulation for Package Marking Requirements.

LABELING OF CERTAIN PREPACKAGED FOOD COMMODITIES

One other matter in connection with the labeling of certain prepackaged foods was given considerable thought and study by the Committee. There seems to be a need for some further information to be required on such prepackaged food products as cheese, meat, fish, poultry, meat products, produce, and the like that are packaged in advance of sale in random, non-standard sizes, either by processor, distributor, or retailer, and which are offered for sale with the total price indicated on the package.

Several city ordinances and proposed city ordinances on this matter have been referred to the Committee for study. The matter also has been a subject of discussion at some weights and measures conferences and meetings. Some legislation appears desirable to prevent possible misrepresentation or misinterpretation of the unit price, or in computing the total price, when packages bear only the net weight and the total price. The Committee feels that all ordinances and regulations, which thus far have been adopted or proposed, fall short of accomplishing the desired goal.

Your Committee recommends that it be allowed to retain this matter for extensive study and consideration to the result that possible amendments to the Model Law may be necessary. The Committee is desirous of receiving copies of existing and proposed laws, ordinances, and regulations on this matter, and, in addition, suggestions from all persons who have possible solutions.

(After general discussion by Mr. Rogers, Mr. Baucom, Mr. Nelson, Mr. Bussey, Mr. Meek, and Mr. Blickley, the Report of the Conference Committee on Legislation was adopted by the Conference. This action included final adoption of the Model Regulation for Package Marking Requirements.)

(Mimeographed copies of the Model State Law on Weights and Measures can be obtained, upon request, from Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C.)

REMOTE GASOLINE PUMPS

By William B. Johnson, Jr., *Manager of Sales, Erie Meter Systems, Inc., Erie, Pennsylvania*

Last year at the 37th National Conference, the remote control gasoline dispensing system was an important subject, as a number of such installations had been made in many parts of the country, and there was a question in the minds of some weights and measures officials as to whether such systems would dispense gasoline and meet the accuracy requirements.

Actually, remote control systems are not new. They have been used for many years in limited quantity. Those systems used a gear or vane type pumping unit with air-eliminator chamber installed near the underground tank. In some cases, the air eliminator was installed in the dispenser cabinet on the island. This required a return line from the air eliminator back to the underground storage tank.

Due to the change in characteristics of gasoline made to accomodate the present day automobile, it is necessary to install the gasoline pump near, or the remote control pumping unit in or near, the underground storage tank, in order to dispense gasoline satisfactorily. The recent trend toward larger service-station serving areas is a strong influence in the use of remote control pumps, as it is easier to push gasoline long distances than it is to pull it. It is also difficult to pull gasoline at high altitudes and in extremely hot locations; therefore, the push system or remote control system is the most satisfactory in such places.

A year ago, only one gasoline pump manufacturer had advertised to any extent a remote control system. That company was the Erie Meter Systems, with which I am affiliated. Our system featured a submerged turbine pump with built-in air eliminator, in order to dispense gasoline within the tolerances. During the past year, several pump manufacturers have announced similar systems, some using submerged pumps, others using positive or gear type pumping units.

The increase in use of remote control systems is, I am sure, responsible for my being on your program today, as your association officials feel that you should be familiarized with this new system in order to better perform your jobs.

1. The proper elimination of air from the system is very important to maintain accurate measure. Air eliminators installed in or near the tank, or in the dispenser on the island, will perform this function satisfactorily. The air eliminator must have sufficient capacity to take care of empty tank conditions.

2. The system must be kept full of gasoline at all times through the use of check valves or foot valves.

3. Provision for relief of pressure built up due to the expansion of gasoline when temperature increases is very necessary.

So that you can visualize just how a remote control gasoline dispensing system operates in comparison with the conventional gasoline pump, I have prepared two charts which contain the principal features of the systems.

The conventional gasoline pump contains a motor-operated pumping unit with air eliminator which pulls the gasoline from the storage tank through a pipe which extends from the inlet side of the pumping unit to the bottom of the storage tank. In order for this system to work well, it is necessary to have a valve in the pipe line which keeps the entire system full of gasoline at all times. The valve can be either a foot valve located on the end of the pipe in the bottom of the tank, or it can be a check valve in the line directly above the tank, or it can be a vertical check valve located in the pump cabinet directly below the pumping unit. After the pumping unit pulls the gasoline from the underground storage tank, it pushes the gasoline through the meter, recording the quantity dispensed in both quantity and value.

The pumping unit in the remote control system is located in the tank, or near the tank, and pushes the liquid through a pipe line to the dispensing cabinets on the island. These dispensing cabinets contain a check valve and strainer, a manually operated shut-off valve, a meter, and the Veeder-Root clock which records the quantity and value of each sale. The dispensing cabinet in all cases has the same outward appearance as a conventional gasoline pump and is operated in exactly the same manner. When the hose nozzle is removed from the hanger and the starting lever is operated, it turns on a switch in the dispensing cabinet which starts the motor on the remote control pump. The pump then pushes the liquid through the pipe line, through the meter and visigage, and out through the nozzle into the customer's tank. Several dispensers may be connected to a remote control pump. Each dispenser is equipped to either start or stop the motor on a remote control pump.

The most important part of a remote control system to a weights and measures official is the operating accuracy. The most important factor influencing the accuracy is the elimination of air from the system, particularly in such cases where the tank runs dry and permits air to get into the suction line below the check valve. By putting a check valve directly on the discharge side of the remote control pump, a solid column of liquid is retained in the discharge line from that point all the way through the system to the nozzle. As a safety factor, some manufacturers provide an additional check valve directly below the meter in the dispensing cabinet. When the tank is run dry and air is admitted into the suction pipe below the check valve, it is necessary that this air be eliminated after a supply has been put into the storage tank and the system put back into operation.

The submerged turbine pump and the submersible motor and pumping unit combination, both of which are installed in the bottom of the storage tank, are equipped with a small copper-tube return line which dispels any accumulation of air in the system, and the remote control pump located directly above or near the storage tank is equipped with an air eliminator comparable to the air eliminator in a conventional gasoline pump. When using such a pump, it usually is customary to equip the dispensing units with an air eliminator and install a return line from the air eliminator back to the tank, in order to eliminate any air in the system and maintain the accuracy required by the weights and measures codes.

Mr. Baucom: I believe the term "remote gasoline pump" is incorrect and incomplete, since that term does not accurately and adequately describe these devices. I think these submerged pump systems are very good. Through proper placement of a number of pressure valves we are able to prevent the possibility of any air getting into the fuel line. In addition, this system enables a station operator to place his storage tank at some distance from his retail dispensing devices. This, I believe, will prevent many mistakes, such as dropping the wrong fuel into a storage tank.

Mr. Boucher: Did I understand you, Mr. Baucom, that a submerged pump made an air eliminator unnecessary?

Mr. Baucom: With this type system there is air elimination, but the conventional type of air eliminator is not necessary.

Mr. W. B. Johnson: I would like to add to Mr. Baucom's comments by saying that the submerged-type turbine pump will not pump air. The impellers do not come in contact with the side walls of the pump housing; therefore, they cannot pump air. Admittedly, it is possible to get air into the system, and means have been provided to eliminate such air before it reaches the meter.

If the tank runs empty, the liquid in the column from the submerged pump to the tank outlet will drain back into the tank and air then will enter this portion of the system—up to the check valve. We have installed a quarter-inch copper tube that runs from the highest point in the turbine-pump system, just below the check valve, back into the tank. This tube runs on the outside of the pump-column housing. When the column is full of air and the tank is loaded full with gasoline, the air is trapped between the top of the gasoline level and the check valve at the top of the column. When the pumping unit is activated the liquid pushes the air up to the check valve, and since it cannot be build up enough pressure to open the valve, the air is pushed out through the copper tube and back into the tank. The column of liquid will not compress the air to a sufficient pressure to open the check valve, therefore, air cannot get into the system beyond this check valve.

Mr. Heaslip: Is it not true that the specifications of Handbook 44 call for an air eliminator "or other effective means?"

Mr. Johnson: That is correct. Many tests have been conducted on these devices by company technicians and by weights and measures officials. All persons who have participated in these tests have been completely satisfied that the system described will eliminate air.

Mr. Turnbull: Does this system provide a proper interlock for each individual meter?

Mr. Johnson: The interlock operates in exactly the same manner as on a conventional pump. The numerals on the register must be returned to zero before the mechanism will allow another transaction to start.

(Additional general comment on the subject was made by Mr. Baucom, Mr. Boucher, Mr. Johnson, Mr. Schellenberger, Mr. R. E. Meek, Mr. Reese, Mr. Kirk, and Mr. Fraser.)

(The Conference was recessed until 2:00 p. m.)

FIFTH SESSION—AFTERNOON OF THURSDAY, MAY 21, 1953

(R. D. Thompson, Vice President, presiding)

REPORT ON THE PROPOSED INTERNATIONAL CONFERENCE ON LEGAL METROLOGY

By E. C. Crittenden, *Consultant, National Bureau of Standards*

Last year at the Thirty-Seventh National Conference, Mr. Bussey arranged for a brief account of pending proposals to establish an international conference which would be in many respects similar to your National Conference. (See Report of the Thirty-Seventh National Conference on Weights and Measures, 1952, pages 19–20.) During the year, definite progress has been made on this subject, and I am pleased to have this opportunity to tell you about it.

While the project is primarily European, we in this country have some interest in it, particularly at this time when our Government is trying to promote economic development in the countries of Western Europe. Freedom of trade among those countries would help to attain more effective use of their resources, and a reasonable degree of uniformity in the regulation of weights and measures is one condition favoring free exchange of goods.

As was reported last year, this project was launched by a formal diplomatic conference called by the French Government in 1937. It was then agreed that a permanent international organization would be worth its cost, and that it should be distinct from the existing International Bureau of Weights and Measures, which deals with basic standards rather than commercial practices. To mark this distinction the new organization was at first called International Conference on Practical Metrology; later this was changed to Legal Metrology.

A Provisional Committee was appointed in 1937 to prepare detailed plans for the organization, but the war and other calamities prevented the completion of this task for 15 years. Finally a meeting of the reorganized Provisional Committee was held in Brussels, Belgium, October 2 to 4, 1952. It included members from 15 countries: Austria, Belgium, Czechoslovakia, Denmark, France, Germany, Great Britian, Mexico, Netherlands, Poland, Sweden, Switzerland, the U. S. S. R., the United States, and Yugoslavia, and from the International Bureau of Weights and Measures. Representatives from Argentina, India, and Italy were also appointed, but for various reasons were unable to get to the meeting.

In preparation for the meeting, the officers of the Provisional Committee had prepared a draft of a treaty to set up the proposed permanent Conference. As a result of full discussion of this draft at the 3-day meeting, various amendments were adopted, and a revised draft is now out for final comment by members of the Committee. The revised statement of reasons for the creation of the new organization (translated) is as follows:

The International Conference on Legal Metrology has as its principal objects:

(1) to form a center of documentation and information; in the first place, on the different national services concerned with the control of measuring instruments which are, or may be, subject to legal regulations; in the second place, on the instruments themselves from the point of view of conception, construction, and use;

(2) to publish the texts of the legal requirements for measuring instruments and their use in force in the different countries, with such comments regarding laws and administration as are necessary for full understanding of the requirements;

(3) to study, with a view to unification of methods and regulations, those problems of metrology, either legislative or administrative, which are of interest internationally;

(4) to develop a model law and set of regulations on measuring instruments and their use;

(5) to develop a typical plan for the organization of a service to control the use of measuring instruments;

(6) to determine the qualities which are necessary and sufficient as a basis for international approval of a type of measuring instrument; and

(7) to promote relations between the metrological services and laboratories of the countries joining in the Convention.

Questions regarding legislation or administration applying to a particular country are excluded from the scope of the Conference unless that country expressly requests that they be considered.

The member countries agree to furnish the Conference with such documentation in their possession as they believe will be useful for the attainment of the purposes set forth above.

The organization proposed to carry on the work thus outlined would include three levels, being very similar to the General Conference on Weights and Measures which has under it the International Committee and International Bureau of Weights and Measures. The top authority would be an International Conference to which any country desiring to join the organization could send delegates. The Conference would meet at 6-year intervals. Its real working agency would be an International Committee consisting of 20 members elected by the Conference. These members would be men actually serving in the weights and measures services of their respective countries or having active official relations with such services. They would serve for a 6-year term, provided that they remained in weights and measures work. The Committee would meet at least once each two years, and could appoint subcommittees to carry on specific projects between sessions.

The third level in the organization would be a permanent International Bureau or Central Office to provide secretarial service, to collect and distribute documents and other information and to perform other necessary services under the direction of the International Committees.

All of this activity would of course cost some money. Up to the present time funds for general operating costs have been provided by the French government. When the organization gets into regular operation annual costs are estimated at about 100,000 gold francs, which is equivalent to \$32,670. It is proposed that costs be shared

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among member countries on the basis of population. There would be four groups of member countries to pay shares as follows:

Group	Range of population	Shares
1	Up to 10 millions	1
2	10 to 40 millions	2
3	40 to 100 millions	4
4	Above 100 millions	8

If the United States joined, it would of course fall into group four. A hypothetical budget has been set up, based on membership by 18 of the countries which have been represented in the preliminary discussions. This budget would call for the payment of about $5,000 per year by the United States.

As the next step in this project it is expected that the French government will submit the proposed treaty to all other national governments. If then no radical changes in the draft are proposed, the French government will presumably issue formal invitations to a full-scale diplomatic conference to act on the treaty. The most likely date for such a conference is now September or October of 1954.

The questions with which the proposed organization is intended to deal are of considerable potential importance because they would affect the manufacture and sale of instruments used for weighing and measuring commodities and also the practices followed in packing commercial commodities and in specifying quantities. A reasonable degree of uniformity in the requirements established by various countries would obviously be advantageous for international trade, and if the work of the Conference is carried on successfully, it would eventually have much influence in furthering such uniformity. In the beginning, however, the plan would be to collect and publish information about the requirements and practices of the different countries, rather than to attempt to change those in force in any country.

For the United States it would certainly be difficult to take an effective part in the detailed technical work of the Conference. The most obvious source of difficulty is the fact that we have no national administration of weights and measures. Even in the states, the weights and measures services often do not cover some measuring devices which the European services usually do control, such as gas, electricity, and taxi meters. Another basic difficulty is that nearly all the prospective member countries use the metric system of units, and of course any agreement to pack commodities or specify quantities in simple multiples of those units would be entirely unacceptable in this country.

On the other hand, it might be worth the cost in time and money to keep in touch with the new organization in order to safeguard American interests. For example, our participation might prevent the adoption of regulations too favorable to the use of metric units or imposing undue costs upon our exporters of agricultural or of manufactured products. When the proposal is formally presented to our Government, it will be the duty of the Department of State to weigh these considerations and make a decision, subject to Congressional approval, as to whether the United States will join in the new undertaking.

REMARKS OF WALLACE R. BRODE, ASSOCIATE DIRECTOR, NATIONAL BUREAU OF STANDARDS

(Dr. Brode outlined the editorial policy of the Bureau as it affects weights and measures publications. He stated that the printed reports of the National Conference were edited carefully in order that only useful reference material be included. The National Bureau of Standards Editorial Committee, of which Dr. Brode is Chairman, screens proposed publications and endeavors to assist in making available those documents that will be truly beneficial. Examples of recent weights and measures publications of the Bureau are Circular 501, Federal and State Weights and Measures Laws, and Circular 540, Weights and Measures Case Reference Book.)

REMARKS OF MRS. KATHRYN M. SCHWARZ, NATIONAL BUREAU OF STANDARDS

(Mrs. Schwarz recounted the preparation and contents and described methods of use of National Bureau of Standards Circular 540, Weights and Measures Case Reference Book. Mrs. Schwarz stated that a suggested method of using the new publication, as well as general information on its composition are to be found in the preface and introduction of the book.)

REPORT OF THE COMMITTEE ON METHODS OF SALE OF COMMODITIES, PRESENTED BY J. G. ROGERS, CHAIRMAN

Your Committee on Methods of Sale of Commodities submits its report to this Conference.

The field of items in our commercial and industrial systems remaining for consideration has narrowed considerably since the inception of this Committee back in 1940. In the intervening years there has been such exhaustive treatment given to many essential subjects in our commercial structure, by way of recommendations for proper methods of sale, that we have come to a point where there is very little that is new. This report, therefore, mainly contains items that were considered but not given final action at past Conferences, and others that, by requests made to the Committee, have been reopened for review. Some in this latter class that were recommended for further consideration had been so definitely concluded at past Conferences that there seemed to be little point in reviving them. They are not included in what we now offer.

There is only one item that is new in the list of those we are presenting at this time. It is, however, a highly important one, because of its nature, developments in distribution and sale, and the place it is taking commercially by reason of its expanding use in agricultural pursuits.

Outside of this, your Committee received nothing in the way of proposals or recommendations on any new subject, either from those within our Conference group or from those in commercial or industrial enterprises. We do not, however, attribute this to indifference or lack of interest in the work of this Committee as related to Conference affairs, but rather to the fact, as indicated in the foregoing, that there has been a very wide coverage of essential commodities in what already has been done, through actions of the Conference, to regulate methods of sale in pursuance of the recommendations we offered as a result of our studies and observations on each specific issue that received our attention. Of most concern now is whether the various State jurisdictions activate by law or regulation the recommendations when adopted by the Conference. The promotion of uniformity is highly desirable in weights and measures affairs, and this is only made possible through coordinated effort to establish uniform requirements in all States. Changes in laws or regulations frequently are necessary in order to carry out what the Conference determines to be the proper methods or procedures to be used in the barter and sale of commodities. Quick action is not always possible in making such changes nor in placing something new on the statute books, but no concerted action by our group should be forgotten. Where legislation to conform is needed, there should be persistent effort to obtain it, in the interest of improving the general weights and measures structure of operations. The following items are presented now for the consideration and appropriate action of this Conference.

1. *Anhydrous Ammonia and Other Liquid Chemical Fertilizers with Pressure Characteristics*—Shall be sold by avoirdupois net weight, provided, however, that, when maintained in liquid form with temperature corrected to 60° F, it may be also sold by liquid volume, based on the United States standard gallon of 231 cubic inches, its multiples and binary submultiples.

Delivery tickets shall be provided, in duplicate, containing the date of sale or delivery, the name and address of the seller and the buyer, the trade name and description of the product, and the net weight expressed in terms of avoirdupois pounds and/or fractions thereof, or the liquid volume expressed in terms of the United States gallon and/or fractions thereof, as determined.

When the product is sold and delivered in containers or in package form, it shall be sold by net weight only, and said container shall be plainly marked in a permanent manner with tare weight, and, attached to each container, shall be a tag on which the net weight of the contents is declared.

(As recommended in the Committee Report, this item listed 68° as the reference temperature. This temperature figure was amended from the floor to 60° F and accepted by Committee Chairman Rogers.)

NOTE: In this, we are dealing with a subject that is comparatively new to the weights and measures field of endeavor. The expanding use, in agricultural channels, of liquid chemical fertilizers of the classifications comprehended in this item dictates the need for setting up proper quantity control at the official regulatory level with all possible dispatch. In this event the situation will not get out of hand, as it did with liquefied petroleum gas, with which these fertilizers have comparable relationship because of their gaseous pressure characteristics.

Our recommendation is confined to the quantitative phase with which it is the main prerogative of this Conference to deal. In the development of legislation to cover fully all essentials entailed, other phases such as quality, grade, storage, transportation, distribution, equipment, and safety factors, should, and probably will, be given full consideration by the various State jurisdictions in setting up their laws and regulations to govern these fertilizers.

Evidence of the necessity for safety provisions is found in the fact that anhydrous ammonia contains 82 percent nitrogen by weight and is a substance that vaporizes at minus 28° F and exerts a pressure of 114 pounds per square inch at 70° F and 200 pounds per square inch at 100° F. The time for regulatory action on these liquid chemical fertilizers is *now*. This we recommend.

MR. WOODWARD: Since the reference temperature of 60° F, vapor pressure corresponding to 93 pounds per square inch, is standard in the industry, and since all published tables since the beginning of the industry in 1928 are corrected to 60° F, I would suggest that the Committee recommendation be amended to read "with temperature corrected to 60° F."

Mr. Baucom: Although the reference temperature of 68° F was arrived at in North Carolina after consultation with representatives from the Grange, the Farm Bureau, the Department of Agriculture, and the Board of Agriculture, I am willing to recommend that we amend the Committee report according to Mr. Woodward's suggestion and thus be in line with current industry data.

Mr. J. T. Kennedy: Although I subscribe in general to the Committee recommendation, I feel that that part which has to do with the furnishing of delivery tickets is, in general, beyond the scope of this particular committee.

(After additional general comments by Mr. Woodward, Mr. Rogers, Mr. Baucom, Mr. Morgan, and Mr. Kennedy, the Committee recommendation, as amended, was adopted.)

2. *Inert Liquid Fertilizers*—This item was retained by the Committee for further study.

(The Committee Report made the following recommendation: "Shall be sold by volume based on the United States standard gallon of 231 cubic inches, its multiples and binary submultiples, or by avoirdupois net weight.")

(Following the introduction of this item, considerable discussion ensued. Comments by Mr. Woodward, Mr. Thomas, Mr. Brenton, and Committee Chairman Rogers brought out that the item title was not sufficiently definitive and that temperature should be stipulated when pressure is the determining factor of a recommendation.)

(Upon a motion from the floor, the Conference voted that this item be retained by the Committee for further study.)

3. *Preheated Fuel Oils.*—Shall be sold by determined net weight or by volumetric measurement based on the United States standard gallon of 231 cubic inches, its multiples and binary submultiples, the said measurement to be corrected to 60° F.

When sold on the basis of volumetric measurement, determined by the certified capacity of a vehicle tank compartment, the vehicle tank compartment and the piping shall be so designed and constructed and shall be so mounted upon the vehicle that complete delivery shall be made from any compartment through the delivery faucets.

(As recommended in the Committee Report, the second paragraph of this item read as follows: "When sold on the basis of volumetric measurement, determined by the certified capacity of a vehicle tank compartment, the fuel tank and the piping shall be so designed and constructed and shall be so mounted upon the vehicle that complete delivery may be made from any compartment through the delivery faucets." This wording was amended upon motion from the floor to read as above.)

Note: In 1946 the 32d National Conference on Weights and Measures adopted a recommendation of this Committee which read as follows:

> *Preheated Petroleum Products.* Should be sold by determined net weight, and serialized delivery tickets containing proper information as to quantity, and identification of the seller and buyer should be issued to the purchaser and a copy retained by the dealer.
>
> The Committee further recommends in this connection that in jurisdictions having weighmasters, official certification be required on the prescribed tickets.

The subject of preheated oils thereby was treated in a general way, such treatment including oils of all classifications whether intended for use as fuels or for other purposes, as, for instance, preheated asphalt oils so extensively employed in road maintenance operations.

Notwithstanding the action already taken, the subject was reopened at the 36th National Conference in 1951 with specific reference to fuel oils, and, by vote of that body, was referred back to the Committee on Methods of Sale of Commodities for further study and report.

Our further explorations over the past two years have produced little to change our views as first presented. The sole purpose in this, as with other issues, is to find the safest, simplest, and most determinative way in which a commodity should be sold. The nature of the oils under consideration is such that, when they are sold by volumetric measurement, inconsistencies in quantity values are quite pronounced because of the variable factors of temperature changes, viscosities, and specific gravities. All of these variables have their effect and must be taken into consideration in arriving at quantitative determinations based on the 60° F. reference temperature employed by the petroleum industry. The process lacks the simplicity that is to be found in the weight method of determination, which, in our considered opinion, best can serve the interests of all concerned.

The industry probably will demur at the proposed change in methods, but is it any more unreasonable to require a dealer in liquid fuel to provide himself with a scale than it is for a dealer in solid fuel? However, the proposal entailed in our recommendation would not impel this. It would require representation by weight, and the scale would be the safety factor for the purveyor. The dealer would be charged with the responsibility of assuring weight accuracy, whether his determinations were made by conversion from volumetric measurement or by actual weighings. The change in methods probably would affect the wholesale level more than it would the retail level as presently constituted. Many retailers now combine the sales of liquid fuels and solid fuels in their enterprises. The prevailing competitive fuel situation has compelled this in numerous instances; consequently, such dealers are equipped with scales and would be little affected by the change.

There recently have been some experimentations at the wholesale level of the industry in the metering of preheated oils. This, of course, necessitates the heat-jacketing of meters for workability. A member of this Committee participated on one of these initial operations where comparisons of volume with weight were made. The results of quantity determinations by measurement and by weight in this project, while not in agreement, were not too far apart, and metering would, therefore, appear to have favorable possibilities. This was a bulk station operation where metering was feasible by reason of the facilities and type of installation provided. The method, if it finds general adoption within the industry, probably will be confined at present to such locations and installations. Metering of preheated oils from tank trucks at the retail level is quite another thing, and would appear to present greater problems and difficulties. Safety factors in relation to auxiliaries for the heating of meters must be considered among other things which may militate against the use of meters for these oils at this level of the trade.

In consequence of the further consideration that has been given this subject and that nothing has been offered this Committee to discredit the soundness of our recommendation as adopted by a former Conference, we maintain it in substance and principle and advocate that it stand as a completed action of this body. At the same time, we realize, of course, that there may be meritorious future developments to justify an altered opinion, but, until these transpire, we believe that the weight method of sale for preheated fuel oil and other oils in this category should be invoked.

(The Committee recommendation, as amended, was adopted.)

4. *Peat Moss*—Shall be sold on the basis of cubic contents, and packages shall be marked in terms of cubic feet and/or cubic inches.

There shall be an allowable tolerance in cubic content not to exceed 3 percent of the stated package volume. Packages shall be marked with the name and address of the producer or packer.

NOTE: This controversial subject is another holdover from the last Conference, when an initial attempt was made to formulate recommendations that would establish proper regulations as to methods of sale for this commodity.

The original thought of this Committee was that we could treat the subject of peat moss in a general way and with a single recommendation. In further exploring the subject, it became apparent that this is not feasible, due to the various classifications of the substances that are marketed under the general term "Peat Moss." In our considered opinion, this is, in many instances, a misnomer by reason of the fact that many of the products represented and sold as such are really not a moss at all, but other types of decomposed or semicarbonized vegetation, such as sphagnum peat, sedge peat, hypnum peat, leaf mold, and humus top soil. What we have really dealt with in our proposed method of sale is the peat which is a true moss derivative and which, under its proper definition, is the only one to which the designation "peat moss" properly applies.

Mr. Swecker: I am appearing here by the direction of the executive secretary of the American Rose Society, an organization having its headquarters in Harrisburg, Pa., with 13,000 members throughout the United States. Members of the American Rose Society are very much interested in this subject because they use a very large quantity of peat moss in the growing of roses. Nearly all of these members are amateur rose growers but they use peat moss in large quantities.

In the interest of rendering its members a service, the American Rose Society would like to urge the National Conference to make a thorough study of the methods in question in order to arrive at a standard method of sale which will assure fairness in measure to the consumer and not unfairly burden the seller. We are not at this time in a position to recommend a method of sale but we do wish to invite the attention of the Conference to the great variation in the character of the several methods. This variation is, in itself, sufficient reason to preclude the application of any known single method of selling all of these products in like manner to the so-called Michigan peat moss, which is vastly different in character and chemical reaction from each of several other products known as soil sponge, etc. It is our opinion that these products are humidified peats, capable of typical reactions within the soil which are associated commonly with humus particles when intimately co-mixed with the soils.

The origins of these products differ, as do the degrees of decay. Thus are created properties which will not enable all of the products to be sold in one single method. The American Rose Society, therefore, does recommend that the National Conference on Weights and Measures first establish definitions and standards of identity for the various peat products known to commerce and then provide for their sale by methods appropriate to the specified product. We do suggest that perhaps the products commonly sold as peat moss, peat humus, sphagnum peat, German peat, etc., could be identified by the nature of their origin. For instance, certain of the foregoing are known to be peat derivative products. Others are known to be of sphagnum origin, and still others are a type of processed peat.

It appears at this time feasible to identify the various peat products. When such identification is established, it further appears practical to stipulate methods of sale for the several products. I regret that I was not informed of the hearing by this committee earlier this week and did not have an opportunity to appear there and present the views of the American Rose Society. We feel that the general treatment in this way of the general subject of peat moss is not adequate to deal with the various types of peat moss that are customarily sold.

Mr. M. T. Graham: As a matter of record, the Federal Trade Commission has specified the rules for marking all peat products, and they must be marked "Peat Moss" or "Peat Moss Sphagnum." Peat moss is a peat formed in the decay of sphagnum moss, etc. The market product is peat moss and must be so marked. That is part of the Federal Trade Commission's directive.

As a matter of practice, we are suggesting that these products be sold on a cubic measure basis.

Mr. J. T. Bell: We produce and sell about a million bales of peat moss a year. Peat moss can be compressed anywhere from 2, to 3½, to 1, and, when you release the pressure or when it comes out of the bale, it resumes approximately 70 percent of its original volume. However, due to the different methods of processing, the amount of resiliency varies. We have decided to sell it by measure. However if anyone else wants to sell by weight, there is nothing to stop them. To give fair measure to the customer, they should also indicate the volume. It is the volume that counts, and not the weight. A bale of dry peat moss weighing 100 pounds could be increased by wetting up to 800 or 900 or 1,000 pounds. I suggest very strongly that the motion be adopted as recommended by the Chairman.

Mr. Swecker: One gentleman spoke of the Federal Trade Commission's requirements that each package of peat moss be labeled as to origin. Average rose growers who order a bale of peat moss or a bag of peat moss simply specify a bale or bag of peat moss and pay no attention to the origin of the product. Nevertheless, the origin does have a great deal to do with whether you are getting your money's worth. I notice one thing more about this provision. It states that peat moss shall be sold on the basis of cubic content; packages shall be marked in terms of cubic feet and/or cubic inches. I don't know what that means. Does that mean compressed content or loose content? How are you going to determine how much loose content you are going to have? It would not seem to me to mean a great deal because you could make your bag or bale of peat moss any size you want according to how much the product is compressed, how loose it is, or how much moisture it has, and it would seem to me this method would not give the customer much protection.

Mr. Rogers: Don't you believe that competition will pretty well take care of that? The buyer will decide that the next time he buys he is going to shop around and find a place that will give him a more compact article. It is difficult to establish this ratio pressure.

Mr. Swecker: I am in favor of some kind of control, but I don't believe this is going to solve the problem at all.

Mr. Bell: I would like to say that we have studied this problem at great length and perhaps if anyone should know whether the problem can be solved completely we should. We could not find a complete solution to the problem. The only thing we can do is this, if we have a bale of peat moss which measures 7 cubic feet in the bale the customer gets 7 cubic feet at least. In our case we feel we give them more because it usually expands to about 40 cubic feet, but in any case we give the customer what he has bought, namely 7 cubic feet of peat moss.

(The Committee recommendation was adopted.)

5. *Rope* (*all types and classifications*)—Shall be sold by standard net weight or linear measure. When packaged in any manner, the package must be marked with the weight or linear measure of the rope, the weight to be either the net weight or the gross and tare weights.

Note: A slight furor was caused recently by a proposed Federal specification to accept gross weight as the basis of sale for sisal rope. The negative reaction of the weights and measures authorities of the various States seems to have been quite positive in relation to this.

The 31st National Conference in 1941 adopted a recommendation of the Committee on Methods of Sale of Commodities that twine and cordage should be sold by standard net weight or linear measure. Rope would seem to fall quite definitely within that category, but, in order to clarify this and to remove all question or doubt, this Committee now recommends the foregoing.

(The Committee recommendation was adopted.)

6. *Seeds* (*agricultural, horticultural, and floricultural*)—Shall be sold by avoirdupois net weight, and, when in package form with contents exceeding ¼ avoirdupois ounce, the net quantity shall be declared on the container.

Note: This recommendation generalizes on the seed subject to include all classifications. The 33rd National Conference of 1947 took action on garden seeds and grass seeds under these specific designations as presented in Items 8 and 9 of this Committee's report of that year. Your Committee now deems it advisable to expand the recommendations as to proper methods of sale in order to remove all doubt of our intentions and to be consistent in relation to quantity regulation for seeds of all kinds. Representations that reached the Committee from various sources within the seed trade since our original action was taken on this issue influenced our reconsideration and the consequent proposal we now offer.

This recommendation is designed principally to eliminate the so-called "gross for net" method of sale for seed which has been a long prevailing custom, mainly employed at the wholesale level. Under this method, the retail dealer pays for the bag or other container at the price of the seed. When there was a parity in values between the container and its weight in seed, "gross for net" was accepted by the retailer with little if any objection. Conditions have changed. Seed prices have gone soaring. The value of the seed as compared with the container is now far out of balance, and the retailer strongly demurs because of the appreciable losses he sustains through the method of sale imposed upon him. With exceptions that are repressed by weights and measures supervision as they arise, there is little difficulty experienced at the retail level, where sale by net weight is now the prevailing custom. It should prevail in all segments of the industry. Wholesalers cannot justifiably be excepted, regardless of their handling problems of preparation, storage, and packaging. Their problems are common to all engaged in enterprises dealing in products of the soil. Equity in seed transactions straight through from the wholesaler to the consumer can only be established and maintained by a uniform method of sale based on a sound and ethical principle of trading, which in this instance is the net-weight method that we recommend.

There is another phase of the seed situation that may require specific treatment. This relates to the trade in small packages, which this Committee will further explore with the purpose of reaching conclusions as to whether the minimum of ½ ounce, as prescribed under general net-weight requirements to define what constitutes a package entitled to exemption from marking, should be reduced, and also whether another method of marking should be invoked for certain seeds that have values greater than gold.

(The Committee recommendation was adopted.)

7. *Pickles and Pickle Products in Package Form*—Shall be sold by drained net weight.

(The Committee Report contained the recommendation "PICKLES (cut, chopped, or viscous) should be marked by volume or drained net weight." This recommendation was amended on motion from the floor.)

(Following the presentation of this item, considerable discussion was entered into by the delegates. Comments and explanations developed the amendment which was offered by Mr. Blickley. Mr. Rowe stated that the regulations of the Federal Food and Drug Administration provided for sale of pickles by drained weight as well as by volume, and further that, under the Food, Drug, and Cosmetic Act, all such declarations of content must be accurate and in terms which are understandable to consumers.)

(The Committee recommendation, as amended, was adopted.)

8. *Ice Cream*

NOTE: It was recommended to this Committee that this subject be revived. Our original recommendations for methods of sale of ice cream and related frozen products are of record as having been adopted by the 32nd National Conference in 1946. References to this subject are to be found in Item 2, page 28 of the printed report of the Conference for that year.

This Committee has nothing further to add in this connection at this time other than the observation that progress has been slow in establishing sale-by-weight for such commodities. Notwithstanding this, there has been a decided trend in various areas, on the part of dealers at the retail level, to adopt this method of sale for bulk ice cream. They seem to have taken the matter into their own hands, even without laws or regulations to compel them. This, however, apparently has had no effect upon the major ice cream interests, who continue to oppose weight legislation for their products.

Our purpose of including this topic again is, therefore, in deference to the opinion of Conference members that this subject should be kept alive because of its importance as a commercial issue.

(The Report of the Committee on Methods of Sale of Commodities, as amended, was adopted by the Conference.)

(The Conference was adjourned, to reconvene on Friday, May 22, 1953, at 9:30 a. m.)

SIXTH SESSION—MORNING OF FRIDAY, MAY 22, 1953

(F. M. GREENE, Vice President, presiding)

REMARKS OF ROBERT WILLIAMS, SEALER OF WEIGHTS AND MEASURES, NASSAU COUNTY, NEW YORK

(Mr. Williams explained the operation and described the advertising of certain "frozen food plans." He stated that price-per-pound advertising of large portions of beef is sometimes misleading because of losses in trimming and preparing the meat. Mr. Williams explained that a customer might purchase a quarter of beef weighing a certain number of pounds at a price which seemed to be well below the retail price. Upon receipt of the meat, the customer learned by weighing the packages that the quantity delivered was substantially less than was represented. This loss was explained by the vendor as being due to trimming—an explanation difficult to refute or to check.

Three successful prosecutions of operators of the plans were related by Mr. Williams, who stated further that a plan of buyer education through public speaking is effective against dealers who would make false advertising claims.)

PERFORMANCE OF INSPECTORS AND GASOLINE PUMPS

By W. J. YOUDEN and M. W. JENSEN, *National Bureau of Standards*

The immediate result of any tests or scientific research is a group of numbers. The value of the data thus obtained depends upon the proper interpretation of these numbers. The Statistical Engineering Section of the National Bureau of Standards is frequently asked to give statistical consideration to data obtained in a very wide variety of tests and experiments.

At the direction of the 37th National Conference on Weights and Measures the Specifications and Tolerances Committee designed and planned a series of tests on retail gasoline dispensing devices. The survey included full-flow tests on drafts of 1, 5, 10, and 15 gallons, and 5-gallon per minute tests on 1-, 5-, and 10-gallon drafts. Members of the Office of Weights and Measures of the Bureau have interpreted for the Committee the data obtained in the survey. Important portions you will find in the Tentative and Final Reports of the Committee. This paper discusses some of the difficulties that arise in the interpretation of these data and suggests a method of reaching a conclusion.

The analysis of any group of measurements consists of searching for facts in the data. A statistician will make statements which, though puzzling to the layman, have definite meanings in statistical computations. For example when a man tells you that he has delivered 5 gallons of gasoline into the tank of your automobile, he means that the quantity is, for all practical purposes, 5 gallons. If he said that he had delivered 1,155 cubic inches, there is the implication that the volume is, to the nearest cubic inch, 1,155 cubic inches.

A statistician has at his disposal various formulas and techniques. He uses these to make certain predictions as to the behavior of numbers.

Since the 5-gallon draft is the normal test on gasoline pumps, we have analyzed the results of the 5-gallon full-flow portions of the special tests. Such an analysis is of importance, even though the tests have taught us that a pump can be within tolerance on the 5-gallon test and still fall outside the limits on a different size delivery.

Our formulas tell us that a normal distribution of measurements should furnish us with results which are predictable. In the case of a group of 923 measurements with a scattering or spread such as was obtained on the 5-gallon tests, we can predict and the data confirm, that, 2 out of 3 of the tests will be within 4 cubic inches, 19 out of 20 of the tests will be within 8 cubic inches, and 99 out of 100 of the tests will be within 10 cubic inches.

These predictions are based upon a computed "standard deviation"—a term familiar to some of you and a term that others of you might want to learn about.

These statements give a picture of the kind of scatter commonly exhibited by physical measurements. The term "scatter" will be used a number of times in this discussion, and in order that we may have a common understanding of it, suppose you consider what happens when a large number of pennies are tossed at a line. Of course, most of the coins will come to rest near the line, but some will bounce or roll and stop some distance on either side of the line. Obviously, the greater the distance from the target line, the fewer pennies we would find. This is an example of "scatter" as we use the term.

Table 1 shows a tabulation of the results of the 923 5-gallon tests obtained during the special survey. By simple computation we learn that the average error for all of the 923 pumps, on a 5-gallon test at full flow, is −1.4 cubic inches. This average error is computed by adding up all of the gage readings, taking due notice of the signs, and dividing that total by the number of pumps.

When we apply the standard statistical formula to this data we learn that these measurements do behave as we have predicted, so we are justified in considering them in search of further information.

The principal purpose of the special tests was to learn the performance characteristics of these devices, with regard to legal tolerances. Another look at our table 1 and we find that all but 62 pumps performed within the current tolerance of ±7 cubic inches on 5 gallons. It appears obvious that, if a smaller tolerance on a 5-gallon test is to be imposed, more of these pumps would be rejected. Only a reduction in the scatter of the measurements can prevent an increase in device rejection.

We have determined that the grand average of our 5-gallon tests was −1.4 cubic inches. This indicates that the pumps must have been adjusted to a slight minus delivery, and it could be advanced that a change in tolerance would lead to the disappearance of this minus tendency.

For the purpose of our study we can remove the minus tendency merely by adding 2 to each of the cubic-inch figures. This has the effect of shifting the data along the scale without disturbing the scatter. After adding the 2 cubic inches to each figure, −7 becomes −5, and so on until +3 becomes +5. Considering a limit of ±5 cubic inches, we add the pumps beyond our adjusted ±5 and find that we have 103 devices with errors greater than ±5 cubic inches—rather more than 1 pump in 7, or more precisely 15.4 percent.

This would be a high rate of rejection, and the problem that confronts us is the possibility of reducing this percentage. Various opinions may exist as to the solution of the problem. The data in table 1 will not, by themselves, supply the answer.

Suppose we consider for a moment a large number of pumps, all adjusted as carefully as possible to zero error. Once these pumps are sealed certainly no one will maintain that all the pumps are exactly right. Indeed, if the manufacturers, or service personnel, possessed any special device for measuring a 5-gallon delivery without error, this device would be adopted by weights and measures personnel. As a matter of fact, the service men copy the equipment and methods of the inspectors. If the pumps could be set precisely at zero and if the inspection tests were without error, then we might expect that the vast majority of the pumps, now spread over 14 cubic inches in table 1, would be bunched in around zero and ±1 cubic inch. How does the observed scatter come about? How much of it is attributable to the setting, and how much to the testing of the pump?

Table 1. *Tabulated results of 5-gallon, full-flow portion of special tests on retail gasoline pumps*

Cubic inches	Number of devices	Cubic inches	Number of devices
0	110	+1	49
−1	78	+2	74
−2	133	+3	13
−3	76	+4	36
−4	116	+5	20
−5	49	+6	20
−6	69	+7	4
−7	14	+8	6
−8	18	+9	4
−9	7	+10	6
−10	8	+11	0
−11	3	+12	2
−12	1	+13	0
−13	0	+14	1
−14	0	+15	1
−15	1	+16	1
−16	1	+17	2

It would seem plausible enough to expect that the larger share of the responsibility rests upon the servicemen in their adjustments than on the natural wear of the device. If the adjustment error can be reduced, the scatter of the data should be likewise reduced; but it must be admitted that pumps cannot be set more accurately than they are tested. If this were possible, surely the inspectors would adopt the methods of the servicemen.

We are led to a simple method of attacking the problem. If we can determine the scatter that arises in testing, we know that at least an equal amount must be present in the setting, or adjusting, of the pumps. What is observed in table 1 is the combined scatter from both adjusting and testing. If we can separate the scatter arising in testing the pumps, we may attribute an equivalent additional scatter to the servicing.

Most people probably have some opinion of the accuracy of the inspection tests. The measurements can be recorded to the nearest cubic inch, and inspectors have no trouble in repeating a 5-gallon test and getting results that differ by no more than 1 cubic inch. However, this by no means reveals the real errors due to inspection. It is easy to get two readings from the same pump to agree closely when they are taken in immediate succession. Here we have the same operator, the same temperature, and the same test measure. What we need is the error between tests when a pump is visited and tested independently by different inspectors, at different times, with each inspector using his own field measure. That is exactly what happens when an inspector checks a pump, set earlier by another man with different equipment. It is unreasonable on the face of it to expect the service adjustment to agree more closely with the inspector's test than inspectors can agree among themselves.

To obtain an idea of how much of the errors are chargeable to inspection, a small project was undertaken by the National Bureau of Standards, in cooperation with the Department of Weights, Measures, and Markets, of the District of Columbia. Four teams of two men each were formed, each team having a Bureau man and a District of Columbia man. These four teams tested six different gasoline pumps, using standard procedure for 5-gallon tests at full flow. Each of the two men on a team conducted a 5-gallon, full-flow test independently and each read his gage independently; however, the two men on a team used the same field standard. The 48 tests were repeated by the same teams, on the same six pumps, 3 days later. The entries in table 2 show, for each of the 96 readings, the number of cubic inches over or under zero error on the individual 5-gallon tests.

There are 16 readings for each of the 6 pumps. The bottom row of the table shows that the readings for four of the pumps were spread, from lowest to highest, over 4 cubic inches; the readings for the other two pumps differed as much as 3 cubic inches. The setting of the adjustments of the pumps cannot be held in any way responsible for this scatter in the readings, because all 16 readings were taken on the same pump and over so short a time that no sizable mechanical change in the device should be expected.

What should not be forgotten is that there must inevitably exist a variation in the actual setting of a pump of at least the magnitude shown by this scatter among the readings for any one pump. Put another way, an attempt is made to set pumps to deliver the correct values. There will be some differences in the values actually set.

TABLE 2. *Gage readings, in cubic inches, on 5-gallon, full-flow drafts—special NBS-D.C. gas-pump project*

[6 devices, 8 inspectors, 2 days]

	Gasoline pumps					
Tuesday p. m.	1	2	3	4	5	6
Inspector A	−1	+2	0	0	0	0
B	−3	0	−1	0	+1	0
C	0	+2	0	+2	+2	+2
D	−1	+2	0	+2	−1	+2
E	+1	+2	+1	+2	+3	+1
F	−1	+1	−1	+2	+2	0
G	−1	0	−2	−1	+1	+1
H	−3	+1	−2	+1	0	−1
Friday a. m.						
Inspector A	−2	+1	0	−1	+1	−1
B	−3	0	0	0	0	0
C	−1	+4	0	0	+1	+2
D	+1	+3	0	+1	+2	+1
E	0	+3	−1	+2	0	+2
F	0	+3	0	+2	+2	0
G	−1	+1	0	−1	+1	+1
H	−1	+2	0	+1	+1	−2
Spread of readings	4	4	3	3	4	4

An inspector tests a pump which is, in fact, off by some amount; and therefore the result of a test on the device includes not only the error in setting or adjusting but an additional error of the inspector who conducted the test.

It is easy to identify in these data some of the principal sources of error: Each man drew a total of 60 gallons from the same 6 pumps. The averages for the men per 5-gallon delivery are as follows:

Team	Field standard	Error for test—	
		1	2
1	A	−0. 08	−0. 50
2	B	+1. 17	+1. 00
3	C	+1. 33	+0. 83
4	D	−0. 08	−0. 25

It is clearly the case that men on the same team agreed very well and that there are larger differences between men on different teams. The two men on a team used the same field measure and ran their tests at nearly the same time; thus the difference between teams is explained as the slight differences among the gage settings on the standards, combined with the slight changes in the pumps, hose expansion and the like. There is very little difference between the days. The 48 readings made on Tuesday afternoon showed an average per five gallons of +⅓ cubic inch, as against the Friday morning readings, which indicated an average of +½ cubic inch. Time did not permit a schedule that would include a pronounced shift in temperature.

From one point of view the table appears to indicate that these devices can be operated and tested within very small limits. Here are 96 readings, and only one as large as +4 cubic inches. All readings are within ±5 cubic inches. It happens, however, that all 6 pumps were very close to being correct. How do we know this? There are 16 readings on each pump, and the pump *average* taken for the 8 men, 4 standards, and 2 days, in large part, has lost much of the scatter due to testing, because these 16 measurements tend to compensate one another. The averages per five gallons for the 6 pumps, for 80 gallons drawn, are −1.0, +1.7, −0.4, +0.8, +1.0, and +0.5.

Notice that the first pump, with its adjustment off, in fact, by only one cubic inch was charged as being off by 3 cubic inches in 3 of the 16 tests on it.

No one would be satisfied to assess the contribution of test measures, temperature, operators or devices, on the basis of just four test measures, two different times and eight men used in this study. A few repetitions of this or a similar program in different parts of the country would supplement the extensive data on pumps obtained in the special survey and in this small project, and thus permit us to estimate just how accurately we can expect gasoline pumps to be adjusted and tested.

In the absence of adequate information many will rely on personal experience and observation. Disagreements will arise because men have different experiences and place their own interpretations upon their experiences.

One way to handle any question without involving personalities is to put the question to someone not connected with the issue. This sounds fine until it is pointed out that a person with no acquaintance with the problem probably is unqualified to answer the question. If he is qualified, he probably has some personal interest in the question. There is a way out of this dilemma. The question may be framed in abstract terms and then put to the disinterested party.

Suppose we could obtain a firm estimate of the accuracy of testing. It would suffice to know, for example, the average difference between the readings on the same pump when visited at different times by two inspectors each using his own test measure. This information could be obtained by arranging for each of 100 pumps to be visited separately by 100 pairs of inspectors.

We don't know what this average would be, so let's call it X cubic inches. We know that the average error in setting a pump must be at least as large as the average error in testing.

Now for the question; and you can put it to any qualified statistician in the country and get the same answer every time. The question is: Suppose this average difference between readings is 1, 2, or 3 cubic inches, for each of these values, what percent of the devices would yield readings (obtained by the inspectors) that fall outside the tolerances of five cubic inches, seven cubic inches, or any other value? The answers to this question are tabulated below in table 3. Once you know the testing error you will be able to select the proper line in the table and come to a decision regarding the choice of tolerance limits.

The table shows that when the average difference is small nearly all the readings stay within the listed tolerances. As the testing error increases, more and more of the devices will appear to be outside the tolerance. Remember that these percentages outside the

TABLE 3. *Entries show the percentage of devices that will fall outside various tolerances, depending upon the accuracy of testing*

Average difference in cubic inches between readings of two inspectors	Percentage of devices that will fall outside the limits of			
	±2½	±3½	±5	±7
1 cubic inch	4.6	0.5	0.0	0.0
2 cubic inch	31.6	16.3	4.6	.5
3 cubic inch	50.6	35.2	18.4	6.2

limits do not include devices that fall outside because of wear, gross blunders in setting or testing, or through tampering by the owner. It is up to you to decide how often it is reasonable and proper to require the reservicing and retesting of pumps in which none of the last-mentioned causes are operative.

MR. AINSWORTH: Dr. Youden, on the basis of table 2 data, could you estimate an average between inspectors?

DR. YOUDEN: This is the sort of question that is proper to address to a statistician. Before I answer, may I state that the average difference between two inspectors will be one thing, whereas the average difference between the lowest and highest of a number of inspectors will be greater. Any estimate that I make at this time would be approximate. There might be two cubic inches, more or less, between two inspectors. More evidence would be necessary before I could make a definite prediction. I am quite confident that the result would fall within the limits of table 2.

MR. AINSWORTH: Would you be willing to limit the number to 1 to 3 cubic inches?

DR. YOUDEN: That would be my estimate.

MR. AINSWORTH: On the basis of the data that you examined, how much variation between readings on a single meter could you expect from one inspector?

DR. YOUDEN: I believe that successive readings made by one individual using one test measure on one meter would repeat within one cubic inch. Available data has supported that.

MR. AINSWORTH: Have we any data which would inform us as to the variation in successive tests on a single meter—variations chargeable to the meter itself?

DR. YOUDEN: This is something which probably could be answered out of the experience of people who work with these devices. I would expect some variance in the device itself. Among other things which might affect the accuracy of the device are temperature effects on the liquids and hose expansion as related to pressure and rates of flow. There is a position in this particular device where current inherent limitations will impose a barrier to legal performance requirements. There is not much point in requiring a device to test more accurately than it can maintain itself over a period of time.

MR. BAUCOM: Am I right in assuming that this study is based on human error?

DR. YOUDEN: Human error from two sources are an element to be studied in the establishment of legal tolerances. One person must set the device; he will not set it exactly correct. An inspector then tests the device; he also will err to a certain extent. The combination of these two errors will push a certain percent of the devices beyond the tolerance limits if those limits are too tight.

REPORT OF THE COMMITTEE ON SPECIFICATIONS AND TOLERANCES, PRESENTED BY J. P. McBRIDE, CHAIRMAN

Your Committee has held no general meetings during the year. There have been several occasions upon which two or more members of the Committee found it possible to get together for the purpose of discussing Committee problems. A meeting, held in Boston on October 23, 1952, was attended by Messrs. John P. McBride, Rollin E. Meek, and W. S. Bussey, and by representatives of the American Petroleum Institute and the Gasoline Pump and Meter Manufacturers Associations. The principal purpose of this meeting was to discuss problems relative to liquefied petroleum gas. Some of the details concerning the special gasoline pump survey also were discussed. Your Committee has continued to function through correspondence, not only among its members, but with representatives of affected industries, and with Conference members. This correspondence has covered various matters pertaining to specifications, tolerances, and regulations for commercial weighing and measuring devices. This Report, therefore, represents Committee conclusions in relation to matters referred to it by the 37th National Conference on Weights and Measures, and to those being brought to the attention of the Committee from other sources.

LIQUEFIED PETROLEUM GAS

Among the several items which have been referred to the Committee is the matter of appropriate specifications and tolerances for liquid-measuring devices used in the commercial quantity determination of liquefied petroleum gas. This has been a most difficult problem, and it is with exceeding regret that your Committee reports no substantial progress. It had been hoped that, as a result of the special meeting held in Boston, definite progress would be made.

The need for additional research and development in this field was pointed out by members of your Committee to industry representatives during the Boston meeting. The Committee feels that the need is to develop not only more accurate, but more simple and practical means for testing LPG measuring devices. To date, it has not been possible to get any such program of research and development under way.

Your Committee feels that it is the joint responsibility of industry and weights and measures administrators to develop the proper equipment and methods for testing commercial weighing and measuring devices. With this principle in mind, your Committee recommends that the 38th National Conference on Weights and Measures go on record as requesting that the meter manufacturing and petroleum industries, the National Bureau of Standards, and the various State and local departments of weights and measures cooperate in providing the necessary research and development in this field, in order that practical and accurate equipment and methods for testing these important devices might be developed. Until this is done, it is most difficult, if not impossible, for your Committee to prepare the necessary and proper amendments to the H44 code for liquid-measuring devices.

WHEEL-LOAD SCALES AND AXLE-LOAD SCALES

Your Committee has received several inquiries pertaining to the proper tolerances to be applied to wheel-load and axle-load scales used in connection with the enforcement of highway load-limit laws. It was pointed out that currently the H44 scale code is not thoroughly clear on this point and that there was a possibility of several different interpretations. It might be interpreted that paragraph T.2.3.1. and table 9 would be applicable, or it might be interpreted that paragraph T.2.3.2. would be applicable, and possibly some people might contend that paragraph T.2.3.3. should apply. Insofar as your Committee knows, all weights and measures officials have been applying Paragraph T.2.3.2. Your Committee is in agreement with this interpretation, and, in order to make the code unquestionably clear and to avoid any possible misinterpretation, we offer the following recommendations to this Conference:

SCALE CODE

Amend paragraph D.1.11. to read as follows:

D.1.11. Wheel-Load Weighers and Scales; Axle-Load Scales.—Devices intended solely for official use in the enforcement of traffic and highway laws.

D.1.11.1. Wheel-Load Weigher.—A compact, portable scale specially adapted to determining the wheel loads of vehicles on highways.

D.1.11.2. Wheel-Load Scale.—A scale, installed in a fixed location, having a load-receiving element specially adapted to determining the wheel loads of highway vehicles.

D.1.11.3. Axle-Load Scale.—A scale, installed in a fixed location, having a load-receiving element specially adapted to determining the combined load of all wheels on any single axle of a highway vehicle.

Amend paragraph T.2.3.1. to read as follows:

T.2.3.1. For Large-Capacity Scales Except Livestock, Coal-Mine, Vehicle, Wheel-Load, Axle-Load, and Freight Scales, Wheel-Load Weighers, and Railway Track Scales.—Basic maintenance tolerances for large-capacity scales except livestock, coal-mine, vehicle, wheel-load, axle-load, and freight scales, wheel-load weighers, and railway track scales, on under-registration or on over-registration, shall be as shown in table 9; basic acceptance tolerances shall be one-half the basic maintenance tolerances.

Amend the caption of table 9 to read as follows:

Table 9.—Maintenance Tolerances for Large-Capacity Scales, Except Livestock, Coal-Mine, Vehicle, Wheel-Load, Axle-Load, and Freight Scales, Wheel-Load Weighers, and Railway Track Scales

Amend paragraph T.2.3.2. to read as follows:

T.2.3.2. For Livestock, Coal-Mine, Vehicle, Wheel-Load, Axle-Load, and Freight Scales.—Basic maintenance tolerances for livestock, coal-mine, vehicle, wheel-load, and axle-load scales, and for scales used exclusively in determining charges for freight transportation, on under-registration or on over-registration, shall be 1½ pounds per 1,000 pounds of test load on ratio tests and 2 pounds per 1,000 pounds of test load on weighbeam, reading-face, and unit-weight indications; basic acceptance tolerances shall be one-half the basic maintenance tolerances.

(The recommendation of the Committee was adopted.)

FARM MILK TANKS

The 37th National Conference on Weights and Measures directed the Committee on Specifications and Tolerances to prepare a tentative code on farm milk tanks. In drafting this code, the Committee has kept in mind certain basic principles. First, this is a weights and measures code, not a sanitary code. Those agencies and persons who are interested in the sanitary phase of this equipment have been consulted, and effort has been made to avoid anything which would conflict with current or contemplated sanitary requirements.

It must be understood that this code will become a part of National Bureau of Standards Handbook 44. The provisions of the general code in that handbook are applicable to farm milk tanks just as they are to other specific codes in the handbook.

For the consideration and action of this Conference, we present the following tentative code for farm milk tanks:

TENTATIVE CODE FOR FARM MILK TANKS

A. APPLICATION

A. 1. This code applies to farm milk tanks, as defined, only when these are used, or are to be used, under an express contract between the producer and the purchaser and on the premises of the producer, for the commercial measurement of milk or other fluid dairy product. If such measurement is accomplished by means of a fluid meter, this code does not apply; in such case the meter shall be subject to the applicable provisions of the code for liquid-measuring devices.

D. DEFINITIONS

D. 1. Farm Milk Tank.—A unit for measuring milk or other fluid dairy product, comprising a combination of (1) a stationary tank, whether or not equipped with means for cooling its contents, (2) means for reading the level of liquid in the tank, such as a removable gage rod or a gage tube, and (3) a chart for converting level-of-liquid readings to gallons, or such a unit in which readings are made on gage rod or gage tube directly in terms of gallons. Each compartment of a subdivided tank shall, for purposes of this code, be construed to be a "farm milk tank." (These units are variously known commercially as "farm bulk milk tanks," "farm cooling tanks," "farm holding tanks," and "producers tanks.")

S. SPECIFICATIONS

S. 1. Design. (See also S. 2.4.)

S. 1.1. Level.—A farm milk tank shall be in normal operating position when it is in level. The tank shall be equipped with suitable special means by which this level can be determined and established, such as a permanently attached two-way or circular level, a plumb bob, leveling lugs, or the like; or the top edge or edges of the tank shall be so constructed throughout as to provide an accurate reference for level determinations.

S. 1.2. Discharge Valve.—A farm milk tank shall be equipped with a discharge valve through which the tank may be completely emptied when the tank is in level.

S. 1.3. Gage-Rod Bracket.—If a farm milk tank is designed for use with a gage rod, a substantial metal gage-rod bracket shall be rigidly and permanently attached to the tank. The bracket and rod shall be so designed that, whenever the rod is placed in engagement with the bracket and released, the rod will automatically seat itself at a fixed height and will hang in a vertical position with a clearance of not less than 3 inches between the graduated side of the rod and the tank wall which it faces.

S. 2. Indicating Means.

S. 2.1. Gage Rod.—A gage rod shall be of metal and shall be of suitable and rigid design. When seated on its bracket, the rod shall not touch the bottom of the milk tank. The rod shall be graduated throughout an interval corresponding to at least the upper one-half of the tank capacity.

S. 2.2. Gage Tube.—If a farm milk tank is designed for use with a transparent gage tube, such tube shall have an inside diameter of not less than ½ inch and shall be open at its top end. At the inlet end of the tube there shall be a shut-off valve. Immediately adjacent to the tube there shall be permanently mounted a graduated metal scale extending throughout an interval corresponding to at least the upper one-half of the tank capacity. The graduated scale shall be so designed and mounted as to reduce parallax to a minimum.

S. 2.3. Spacing and Width of Graduations.—On a gage rod or gage-tube scale, the spacing of the graduations, center to center, shall be not more than 0.0625 (1/16) inch and not less than 0.03125 (1/32) inch, and the graduations shall be not less than 0.005 inch in width. (See also G–S. 4.2.3. and G–S. 4.3.)

S. 2.4. Values of Graduations.—On a gage rod or gage-tube scale, the graduations may be designated in inches and fractions thereof. In this case there shall be provided for each such rod or scale and each of the farm milk tanks with which it is associated, a gallonage chart showing values in terms of gallons corresponding to each graduation on the rod or scale. If a rod or scale is associated with but one farm milk tank, in lieu of linear graduations, values in terms of gallons may be shown directly on rod or scale. Graduation designations shall increase from the bottom upward. The value of a graduated interval (exclusive of the interval from the bottom of the tank to the lowest graduation) shall not exceed 1 gallon for a tank of a capacity of 500 gallons or less, and shall not exceed 2 gallons for a tank of a capacity of more than 500 gallons.

S. 3. Gallonage Chart.—A gallonage chart shall show values at least to the nearest ½ gallon for a farm milk tank of a capacity of 500 gallons or less, and at least to the nearest 1 gallon for a tank of a capacity of more than 500 gallons. All letters and figures on a chart shall be distinct and easily readable, the chart shall be substantially constructed, and the face of the chart shall be so protected that its lettering and figures will not tend easily to become obliterated or illegible.

S. 4. Installation.—A farm milk tank shall be rigidly installed in level without the use of removable blocks or shims under the legs. If the tank is not mounted permanently in position, the correct position on the floor for each leg shall be clearly and permanently defined.

S. 5. Identification.—A farm milk tank and any gage rod and gallonage chart associated therewith shall be mutually identified, as by a common serial number, in a prominent and permanent manner.

N. NOTES

N. 1. Calibration.—Farm milk tanks shall be originally gaged and officially tested "to deliver."

N. 2. Testing Medium.—Water shall be used as the testing medium in gaging and testing farm milk tanks.

N. 3. Gage-Tube Readings.—All gage-tube readings on a farm milk tank, whether during gaging, testing, or commercial use, shall be made to the top of the meniscus of the liquid in the tube.

N. 4. Approval Seals.—When a farm milk-tank installation is officially tested and approved, the gage rod and the gallonage chart, if these elements are utilized, as well as the tank itself, shall be suitably marked to indicate such approval.

T. TOLERANCES

T. 1. Minimum Tolerance Values.—On a particular farm milk tank, the maintenance and acceptance tolerances applied shall be not smaller than one-half the value of the minimum graduated interval on the gage rod or gage-tube scale.

T. 2. Basic Tolerance Values.—Basic maintenance and acceptance tolerances on under-registration and on over-registration shall be as shown in Table 1.

Table 1. *Maintenance and Acceptance Tolerances for Farm Milk Tanks*

Indicated gallonage	Tolerance
	Gallons
500 or less	½
501 to 1,000, incl	1
1,001 to 1,500, incl	1½
1,501 to 2,000, incl	2
Over 2,000	2½

R. REGULATIONS

R. 1. Level Condition.—A farm milk tank shall be maintained in level.

(An amendment was offered from the floor to change S. 2.3. Spacing and Width of Graduations, to read "On a gage rod or gage-tube scale, the spacing of the graduations, center to center, shall be 0.03125 (1/32) inch." This amendment was defeated and the recommendation of the Committee was adopted.)

RECOMMENDATIONS OF THE SOUTHERN WEIGHTS AND MEASURES ASSOCIATION

Your Committee received from the Southern Weights and Measures Association three recommendations as follows:

1. We recommend that paragraph N. 1.2. on page 66 of Handbook 44, Testing Drafts for Wholesale Liquid-Measuring Devices, be amended by changing the word "should" to "shall" in the last sentence on page 66.
2. We recommend that paragraph S. 10.3. on Vehicle Tank Calibrations be amended to allow the use of more than one indicator.
3. We recommend that the tolerances on Wholesale Liquid-Measuring Devices be re-examined with the viewpoint of reducing the tolerance, both maintenance and acceptance, on metering systems delivering 100 gallons or more a minute.

In regard to the first recommendation, your Committee had this matter for consideration prior to the 37th National Conference. The Committee went so far as to include this same recommendation in the Tentative Report. However, after looking further into the matter and determining the availability of proper testing equipment in the various jurisdictions, this recommendation was deleted from the Committee's Final Report. Your Committee has made a nationwide survey on this point during the current year. Questionnaires were mailed to all State offices and to the larger city and county offices. Replies were received from 36 States, the District of Columbia, and Honolulu. Replies were received also from approximately 60 city and county departments. Nine States and the District of Columbia reported that they did possess adequate equipment for testing all wholesale liquid-measuring devices in their respective jurisdictions for one minute at full flow. Seven cities and counties reported that they have the necessary equipment for this purpose. This means simply that only nine States and the District of Columbia, plus seven cities and counties, in the entire United States, would be qualified to test legally all of these devices in their jurisdictions, were this recommendation adopted universally. It is the feeling of your Committee that, in those jurisdictions which do have the equipment to test all meters in accordance with this recommendation, it makes no difference whether or not the change is adopted. If a jurisdiction does have proper equipment, they will use it, whether or not this word is changed from "should" to "shall." On the other hand, those jurisdictions which do not possess this type of equipment could not conduct legal tests on devices which their respective laws direct that they shall test at least once each year. Your Committee is sympathetic to the thinking that prompted this recommendation; however, it is felt that present equipment does not justify the amendment. Therefore, the Committee recommends no action in this regard.

The second item recommended by the Southern Weights and Measures Association, pertaining to more than one indicator in a vehicle-tank compartment, has been submitted to the Conference previously and rejected. When the matter of recognizing vehicle-tank compartments as commercial measures of capacity was first suggested to the Conference, back about 1916, the Conference was hesitant. Many hazards are prevalent in connection with the use of these devices as measures. After much discussion and several years of investigation and consideration by the Committee on Specifications and Tolerances, a vehicle-tank code was adopted by the Conference. For the 29th National Conference in 1939, a proposal to allow more than one indicator was prepared by the Committee. This was promptly rejected by the Conference.

There are a number of sound and logical reasons for limiting vehicle-tank compartments to one capacity only. At best, a vehicle-tank compartment is a crude measuring device. A vehicle tank is portable, and obviously it will not remain always in the same position of level. The springs on the truck or trailer involved, and various conditions of loading, also contribute to varying the conditions of level. The sensitivity and readability of these devices are not ideal. Vehicle-tank indicators necessarily must be placed inside the fill opening, and well below the top thereof. The greater the distance from the top of the fill opening to the indicator, the more difficult it is to read the liquid level, and the less sensitive the device. When multiple indicators are used, it is difficult, if not impossible, to comply with the sensitivity requirements in Paragraph S.10.4. of the vehicle-tank code. Also, there is always an opportunity for confusion and possible fraud when multiple indicators are used in these compartments. Your Committee does not feel that it is good weights and measures practice to allow the use of more than one indicator in a vehicle-tank compartment.

It has been pointed out that the use of multiple indicators in vehicle-tank compartments makes it possible for tank operators to comply with State highway load-limit laws. Your Committee feels that there are sufficient means available to tank operators to achieve this necessary goal under present regulations. This can be done in any of several ways. The tank can be so constructed that it can be operated with a certain compartment or compartments empty when the heavier liquids are being transported. Another very good way to cope with this situation is to employ meters to determine the quantity, and, therefore, not depend upon compartment calibration.

Your Committee is cognizant of the fact that several jurisdictions allow multiple indicators in vehicle-tank compartments. It is unfortunate that this could not have been avoided. Your Committee recommends that this Conference go on record as requesting the American Petroleum Institute to discourage, through its various members, the use of more than one indicator in a vehicle-tank compartment, and to urge that the present code be adhered to. The Committee has heard of instances where as many as four indicators have been allowed. Suggestions have been made for as many as eight indicators in a single compartment. Your Committee does not feel this is proper.

The Committee recommends no action on the recommendation.

The third recommendation of the Southern Weights and Measures Association, relative to a possible reduction in tolerances for wholesale liquid-measuring devices, has been given very careful and serious consideration. The Committee feels that it is inappropriate to recommend to this Conference a further reduction in the tolerances for wholesale liquid-measuring devices. As you are aware, the tolerances for these devices were reduced approximately 50 percent by the 34th National Conference in 1949. These reduced tolerances were a part of the codes as published in NBS Handbook 44. Furthermore, the survey which the Committee made relative to the proposed amendment in Paragraph N.1.2. proves conclusively that only a small percentage of the jurisdictions are equipped properly and adequately to do a thorough and complete job of testing wholesale liquid-measuring devices. This is an additional reason why further reductions should not be recommended at this time.

Your Committee believes that there is a widespread lack of understanding of the purposes and uses of established tolerances for weighing and measuring devices. We all agree that tolerances are essential. It is impossible to attain perfection; however, the establishment of tolerances does not attest that all commercial equipment in a jurisdiction will be in error to the extent of the maximum tolerances provided. These tolerances merely establish the line of demarcation between "legal" and "illegal" equipment. If a device performs within the established tolerances, then its continued use is "legal." If it is in error in excess of these tolerances, it becomes an "illegal" device, and its continued use is prohibited by law. It should be the aim of every weights and measures official, device owner or operator, and maintenance mechanic to see that commercial weighing and measuring devices are maintained at as near zero error as is practicable, regardless of what the established tolerances may be. When repairs and adjustments are found necessary, it should be the constant aim to adjust each device to as near zero error as is practicable. Your Committee feels that, if all jurisdictions will thoroughtly test wholesale liquid-measuring devices in accordance with the test procedures outlined in National Bureau of Standards Handbook 45, and apply the tolerances which are now provided in Handbook 44, this situation will be well under control and no further tolerance reductions would be necessary at this time.

GASOLINE PUMP TOLERANCES

The Southern Weights and Measures Association made a recommendation to your Committee prior to the 37th National Conference relative to an amendment to that portion of Table 1, Tolerances for Liquid-Measuring Devices, applying to retail devices. This recommendation was carried over for further study after extensive hearings immediately prior to the 37th National Conference.

During the months immediately following our last Conference, discussions were held with representatives of both the gasoline pump and petroleum industries. Special tests were designed and special report forms drawn. The cooperation of selected weights and measures officials from geographically representative areas of the country was solicited and received. Both the tests and the areas for testing were approved by both industries. It was agreed that designated representatives of the American Petroleum Institute and the Gasoline Pump Manufacturers Association would be present to participate in and observe all tests.

The tests required drawing a minimum of 95 gallons from each device, and were so designed that each draft at each rate of flow was repeated at least once, and that the results from these repeat drafts were required to verify the original results within stipulated and strict deviations.

The tests included both full-flow and five-gallon-per-minute drafts at 1, 5, and 10 gallons, and full-flow drafts at 15 gallons. All field standards employed were carefully calibrated immediately prior to the special tests.

Just over 1,000 gasoline pumps, of all makes, and of representative ages and conditions, and dispensing various brands and grades of products, were tested in locations representative of the temperature and other climatic variations of the United States. The Committee is indebted to the many weights and measures officials, representatives of the industries, and gasoline service station operators who cooperated in this comprehensive survey.

The results of the tests were compiled, tabulated, and pictured graphically in the Office of Weights and Measures, National Bureau of Standards. Some of the most significant information is given below.

Since a very large majority of the testing of retail gasoline pumps is done at the 5-gallon draft, a detailed analysis was made of the 5-gallon tests. Considering only the 5-gallon tests both at full flow and at 5 gallons per minute, the following results were noted:

93.3 percent of the pumps tested were within the *current maintenance* tolerance at 5 gallons, full flow.
92.7 percent were within the *current maintenance* tolerance at 5 gallons, 5 gpm.
81.7 percent were within the *proposed maintenance* tolerance at 5 gallons, full flow.
80.3 percent were within the *proposed maintenance* tolerance at 5 gallons, 5 gpm.

While 7.3 percent of the devices tested were outside current maintenance tolerance on the 5-gallon test, 23.4 percent were outside the tolerance when all tests are considered. This indicates that approximately two out of every three pumps outside the tolerance at 1, 5, 10, or 15 gallons would have been sealed as correct if only a 5-gallon draft were employed.

The following information was derived from a study of all tests:

28.7 percent of the pumps tested were within the *proposed acceptance* tolerance on all drafts and at both rates of flow, although, as far as is known to the Committee, the maintenance tolerance would be applicable on all tests.
31.7 percent were within *current acceptance* tolerance on all tests.
69.2 percent were within the *proposed maintenance* tolerance on all drafts and at both rates of flow.
76.6 percent were within *current maintenance* tolerance on all drafts and at both rates of flow.

An additional analysis was made of the pumps which showed an error of 7 cubic inches on the 5-gallon test. Thirty-nine pumps were in this group, of which 29 (74.4 percent) were outside the *current maintenance* tolerance of 12 cubic inches on the 10-gallon test.

As a result of these special tests, two things became quite apparent. The gasoline pump used in retail trade has inherently two separate and distinct errors. (1) It has an initial error which occurs every time a draft is started with the register at zero. This error is not adjustable by means of the normal adjusting element. (2) It has a ratio or multiplying error which is definable as a certain error per gallon and which repeats and accumulates with the number of gallons in a draft. This error is adjustable by means of the normal adjusting element. These two unknown factors which affect the accuracy of the device can be determined by carefully conducted tests employing test drafts of at least three different quantities.

In a majority of instances, the initial error, which is not adjustable by means of the normal adjusting element, was in excess (over delivery). Since it is necessary to take up any existing play or loose-ness and backlash in the various gearings before the register starts recording gallonage, this is to be expected.

This survey also revealed that the ratio error, which is adjustable by means of the normal adjusting element and which is reasonably controllable, was predominantly in deficiency (under delivery).

The composite or average of all the devices tested deliver, at full flow, plus ½ cubic inch at one gallon, minus 1¼ cubic inches at 5 gallons, minus 4 cubic inches at 10 gallons, and minus 6 cubic inches at 15 gallons.

A hearing was held on Monday preceding the Conference. None of the 49 persons in attendance, representing the petroleum industry, the equipment manufacturers, and Conference members, spoke in favor of adopting the recommended change in tolerances.

One of the points stressed at the hearing was that, if officials adhered to the present code and also observed the expressed meaning of adjustment as set forth in G–R.4., satisfactory results could be accomplished under the present code. G–R.4. states, in part, "Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value."

The significance of the word "tolerance" also was discussed, and it was stipulated by the representatives of industry that they would direct their efforts, in their maintenance programs, to effect adjustments to as near zero as is practicable, whenever adjustments are made. It is the feeling of the Committee, from the data obtained, that this practice should be adopted in all States. If this practice were universal, satisfactory results would be attained under the current table of tolerances.

One point made at the hearing was in relation to test procedure. It was stated that, under certain conditions, tests should be made on drafts of different quantities. In addition to the normal five-gallon test, tests of one gallon, ten gallons, and possibly larger quantities, should be included. This is in line with the test procedure as outlined on pages 136 and 137 of NBS Handbook 45, as well as with the amendment adopted by the 37th National Conference to the Code for Liquid-Measuring Devices, N.1.2., Testing Drafts.

Your Committee recommends no change in Tolerance Table 1 of the Code for Liquid-Measuring Devices.

(The Report of the Committee on Specifications and Tolerances was adopted by the Conference. This action included adoption of amendments to the scale code and a tentative code for farm milk tanks. These will be printed as Correction Sheets to National Bureau of Standards Handbook 44 and may be obtained, upon request, from Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C.)

REPORT OF THE NATIONAL CONFERENCE COMMITTEE ON RESOLUTIONS, PRESENTED BY JOHN E. MAHONEY, CHAIRMAN

IN RECOGNITION OF AND APPRECIATION FOR THE LEADERSHIP OF DR. A. V. ASTIN

Whereas, the National Bureau of Standards, under the direction of Dr. Allen V. Astin, has continued to render inestimable service and assistance to weights and measures officials and to allied business and industry; and

Whereas, the unique and outstanding progress in this vital component of our American way of life could not have been realized without such service and assistance, and

Whereas, Dr. Astin, like his predecessors, since the founding of the National Bureau of Standards in 1901, has exhibited keen interest and objective consideration of problems relating to weights and measures supervision; and

Whereas, the service of the National Bureau of Standards to weights and measure administration throughout the Nation has been outstanding during Dr. Astin's administration; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures does express its confidence in and appreciation to Dr. Astin.

APPRECIATION TO OFFICE OF WEIGHTS AND MEASURES OF THE NATIONAL BUREAU OF STANDARDS

Whereas, W. S. Bussey, Chief, and Malcolm W. Jensen, Assistant Chief of the Office of Weights and Measures, and their able and efficient staff have extended valuable assistance and guidance to the 38th Conference, for which the Conference is very grateful; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, does appreciate such cooperation and assistance from the Office of Weights and Measures, National Bureau of Standards, and wishes to make this resolution a part of the records of this Conference.

APPRECIATION TO THOSE PARTICIPATING IN PROGRAM

Whereas, various committees, speakers, and individuals have given generously of their valuable time and efforts to make the 38th National Conference on Weights and Measures a success; Therefore, be it

Resolved, That the 38th National Conference on Weights and Measures does hereby record its grateful appreciation to all who have contributed to the success of the Conference.

APPRECIATION TO COOPERATING OFFICIALS

Whereas, the governing officials of the various States, counties, and municipalities, through their manifest interest in weights and measures work, have made it possible for their respective jurisdictions to be represented at this 38th National Conference on Weights and Measures; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, does appreciate such cooperation and assistance and wishes to make this resolution a part of the records of this Conference.

APPRECIATION TO MANAGEMENT OF HEADQUARTERS HOTEL

Whereas, the management of the Wardman Park Hotel has done everything within its power to make our Conference a success; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures does express its warmest appreciation and thanks to the management of said hotel for their cordial hospitality and cooperation during our meetings; be it further

Resolved, That the Secretary of this Conference transmit a copy of this resolution to the management of the Wardman Park Hotel.

APPRECIATION TO THE PRESS, RADIO, AND THE SCALE JOURNAL

Whereas, the press and radio of the City of Washington have been generous in reporting the activities of our present meeting; and

Whereas, the Scale Journal has likewise been generous in publishing news and advance notices of our present meeting; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, does hereby record its appreciation to the press and radio of the City of Washington and to the Scale Journal.

APPRECIATION TO WASHINGTON BASEBALL CLUB

Whereas, the Management of the Washington Baseball Club of the American League did furnish tickets for the baseball game to the members of this Conference; Therefore, be it

Resolved, That this 38th National Conference on Weights and Measures go on record showing our appreciation for this fine gesture, and furthermore, be it

Resolved, That our Secretary send the Washington Baseball Club a letter of appreciation from this Conference.

ON INVESTIGATION FOR ACCURATE DETERMINATION OF AXLE LOADS ON HIGHWAY VEHICLES

Whereas, the 37th National Conference on Weights and Measures recommended an extensive and scientific investigation into the entire field of testing axle loads to devise a method for accurately obtaining a determination of such loads, Whereas, a method of accurately obtaining a determination of axle loads is vitally needed, and

Whereas, for fully ample and just reasons, no more than organizational plans and procedures for the study were developed during the past year; Therefore, be it

Resolved, That this 38th National Conference on Weights and Measures recommends and urges the National Bureau of Standards, in cooperation with the States, The U. S. Bureau of Public Roads, and the trucking industry, to complete the extensive and scientific investigation into the entire field of testing axle loads in order to devise a method of accurately obtaining a determination of such loads.

APPRECIATION TO INDUSTRY

Whereas, the representatives of industry by their support of the National Conference contribute materially to the accomplishments of the Conference, and

Whereas, the support from industry also expedites understanding and clarification of mutual problems; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, expresses its recognition of and appreciation for the cooperation of industry and its manifest interest in developing adequate weights and measures administration.

APPRECIATION OF PUBLICATIONS

Whereas, the dissemination of weights and measures information and education is a field in which commercial publishing interests have not entered to any extent; and

Whereas, printed information and education is a necessary element in the efficient progress of any governmental function; and

Whereas, the personnel of the Publications Section of the National Bureau of Standards have been untiring in their efforts to make available, with both accuracy and dispatch, such printed material on this subject as is indicated essential; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, does acknowledge and appreciate such aid and assistance, and wishes to make this resolution a part of the records of this Conference.

ON CONSOLIDATIONS OF WEIGHTS AND MEASURES ACTIVITIES WITH OTHER ACTIVITIES OF GOVERNMENT

Whereas, weights and measures supervision is both a responsibility of government and a protector of the people; and

Whereas, the technical requirements of weights and measures inspection are such as to demand continued study and attention; and

Whereas, it is known to this body that occasional efforts are being made to consolidate weights and measures administration with other inspectional activities of government; and

Whereas, this activity is of a special and technical nature and does not lend itself to combination with other diversified inspection activities; and

Whereas, the benefit of weights and measures supervision, both to consumers and to businesses and industries allied with the activity, is reduced by such consolidations; Therefore, be it

Resolved, That this the 38th National Conference on Weights and Measures desires to go on record as opposing such consolidations which are designed for economy but tend to bring about inefficiency through the loss of specialization and technical advance.

ON FUNCTION OF STANDING COMMITTEES OF CONFERENCE

Whereas, the several standing committees of the National Conference on Weights and Measures do much research and develop many worthwhile recommendations which are adopted by this Conference, and

Whereas, the eventual promulgation and enforcement of these recommendations by the several States, counties, and cities is most important to uniform and efficient weights and measures administration, and

Whereas, the President of this Conference has suggested that the activities of the several standing committees be expanded to include the furnishing of necessary leadership in bringing about the official adoption and enforcement of Conference recommendations, Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, go on record as authorizing the several standing committees of the Conference to include the furnishing of leadership as one of their regular functions.

Whereas, it is acknowledged by all that audio-visual aids are of supreme benefit in all fields of education; and

Whereas, both efficiency and true value of adequate weights and measures supervision are dependent upon education both of participating personnel and of the consuming public; and

Whereas, this is a problem nation-wide in scope and best solved by nation-wide consideration; Therefore, be it

Resolved, That this, the 38th National Conference on Weights and Measures, recommends and solicits the Federal Government, through its National Bureau of Standards, consider undertaking and instituting a project of planning, preparing, and making available to the several State weights and measures officers a series of motion pictures, in color and sound, said motion pictures to cover such topics as "Precision Calibration of Standards," "Value Versus Cost of Adequate Weights and Measures Supervision," "The Consumer's Interest in Weights and Measures Administration," "The National Bureau of Standards," and the like.

(Signed) JOHN E. MAHONEY, *Chairman,*
C. D. BAUCOM,
J. C. GOLL,
M. O. NICKON,
J. M. O'NEIL,
W. H. ROBERTS,
Committee on Resolutions.

(The report of the Resolutions Committee was adopted by the Conference.)

REPORT OF THE NATIONAL CONFERENCE TREASURER

May 1, 1953

Balance on hand May 1, 1952		$1, 014. 03
RECEIPTS:		
May 23—Registration fees—1952 Conference 334 at $5.00	$1, 670. 00	
Interest accrued, May 1, 1952, to May 1, 1953	16. 71	
		1, 686. 71
Total		2, 700. 74
DISBURSEMENTS:		
May 20–23, 1952—Expenses of 37th National Conference		1, 506. 29
Balance on hand May 1, 1953		1, 194. 45

(Signed) GEORGE F. AUSTIN, *Treasurer.*

(The report of the Treasurer was adopted by the Conference.)

REPORT OF THE NATIONAL CONFERENCE COMMITTEE ON NOMINATIONS, PRESENTED BY C. A. BAKER, CHAIRMAN, AND ELECTION OF OFFICERS

The Committee submitted the following nominations for office in the National Conference to serve during the ensuing year, or until such time as their successors are elected.

OFFICERS

For President: A. V. ASTIN, Director, National Bureau of Standards.
For Vice Presidents: GEORGE F. AUSTIN, JR., of Detroit, Mich.; JAMES E. BOYLE, of Maine; FRANK M. GREENE, of Connecticut; J. ROY JONES, of South Carolina; JAMES W. REESE, of Iowa; ANTHONY C. SAMENFINK, of Rochester, N. Y.
For Secretary: W. S. BUSSEY, National Bureau of Standards.
For Treasurer: J. P. MCBRIDE, of Massachusetts.

For members of the Executive Committee: S. H. Christie, of New Jersey; J. F. Corrigan, of Rhode Island; R. L. Flanagan, of Oklahoma; Arthur Forrest, of Claremont, N. H.; J. W. D. Harvey, of Georgia; H. E. Howard, of Miami, Fla.; G. L. Johnson, of Kentucky; O. A. Kirkland, of Texas; A. J. Mayer, of Louisiana; J. I. Moore, of North Carolina; H. J. McDade, of San Diego County, Calif.; W. H. Roberts, of Vigo County, Ind.; S. H. Seighman, of Pennsylvania; W. K. Tripple, of Norfolk, Va.; C. J. Wills, of Portland, Maine.

(Signed) C. A. Baker, *Chairman,*
Nalls Berryman,
E. R. Fisher,
J. T. Kennedy,
R. S. Ackerman,
C. M. Fuller,
Tom Webb,
Committee on Nominations.

(The report of the Committee on Nominations was adopted and the officers were elected unanimously.)

(R. W. Searles, Chaplain, closed the meeting with prayer, and the Thirty-seventh National Conference on Weights and Measures adjourned at 11:30 a. m.)

MEETING OF THE EXECUTIVE COMMITTEE OF THE CONFERENCE

Immediately following adjournment of the 38th National Conference on Weights and Measures, a meeting was held of the newly elected Executive Committee and the chairmen of the standing committees. Present at this meeting were eight of the nine officers, ten of the sixteen Executive Committee members, four of the five chairmen of standing committees, and the Conference Chaplain. The meeting was presided over by the Conference President, Dr. A. V. Astin.

Among the decisions reached by the Executive Committee were the following:

The 39th National Conference will be held May 17–21, 1954. These five days will include a full day of committee hearings on Monday, two sessions on Tuesday, one session on Wednesday (this session to be held at the National Bureau of Standards and to be followed by afternoon tours of the Bureau laboratories), two sessions on Thursday, and one session on Friday.

The Sheraton-Park Hotel (formerly Wardman Park Hotel) was selected as the headquarters for the 39th National Conference.

The entertainment, both for the delegates and their ladies, will be approximately the same as during the past several years.

Detailed arrangements for the Conference were left to the Conference Secretary.

It was decided that Monday of the Conference week should be made a definite and formal part of the meeting. This day will be used by the various standing committees for hearings on subjects of interest to the group. All agreed that participation in these hearings by weights and measures officials and others is both desirable and beneficial.

An additional suggestion was made that the East Building Auditorium on the grounds of the National Bureau of Standards be retained for discussions on Wednesday afternoon. If such arrangements can be made, these discussions will be participated in by those delegates who do not wish to take part in the tour of the Bureau and by members of the Bureau staff.

The Executive Committee expressed the hope that all persons who attended the 38th National Conference will address comments concerning same to the Conference Secretary, Mr. W. S. Bussey, Office of Weights and Measures, National Bureau of Standards. Whenever possible, these comments should include suggestions for the program of the 39th National Conference. Matters for consideration by any of the several standing committees also should be submitted early.

Rollin E. Meek of Indiana, who served as Attendance Chairman of the Executive Committee for the 38th National Conference, gave a report on the activities of the Committee in this regard. Mr. Meek was commended both for his efforts and the results obtained therefrom.

J. Roy Jones of South Carolina was appointed Attendance Chairman for the 39th National Conference.

PERSONS ATTENDING THE CONFERENCE

DELEGATES—STATE, CITY, AND COUNTY OFFICIALS

ALABAMA

State	W. C. Beatty, Inspector of Weights and Measures, Clayton.

ARIZONA

State	Dick Frank, State Inspector of Weights and Measures, State Office Building, Phoenix.

CALIFORNIA

State	James E. Brenton, Chief, Bureau of Weights and Measures, Department of Agriculture, Mull Building, Sacramento.
County:	
Alameda	William A. Kerlin, Sealer of Weights and Measures, 333 Fifth Street, Oakland.
Los Angeles	Charles M. Fuller, Sealer of Weights and Measures, 3200 North Main Street, Los Angeles.
San Diego	Herbert J. McDade, Sealer of Weights and Measures, 1480 F Street, San Diego.

COLORADO

County: Denver	Harry N. Duff, City and County Sealer of Weights and Measures, 4328 York Street, Denver.

CONNECTICUT

State	Frank M. Greene, Chief, Division of Weights and Measures, Food and Drug Commission, State Office Building, Hartford.
	Frank J. Delaney, State Inspector of Weights and Measures.
County:	
Fairfield	William E. Sheehy, Sealer of Weights and Measures, County Court House, Bridgeport.
	Ernest R. Wilson, Deputy Sealer of Weights and Measures.
Hartford	Fred E. McKinney, Sealer of Weights and Measures, County Building, 95 Washington Street, Hartford.
	Joseph J. Fanelli, Deputy Sealer of Weights and Measures.
New London	Donald A. Fraser, Sealer of Weights and Measures, Salem.
Tolland	William F. Masinda, Sealer of Weights and Measures, West Willington.
City:	
Bridgeport	Louis Snow, Sealer of Weights and Measures, 925 Main Street.
Hartford	Nathan Kalechman, Sealer of Weights and Measures, Municipal Building.
Manchester	Winston S. C. Turkington, Sealer of Weights and Measures, 137 Pearl Street.

DISTRICT OF COLUMBIA

Department of Weights, Measures, and Markets
300 Indiana Avenue NW.
Washington

District	J. Thomas Kennedy, Director.
	James G. Dance, Deputy Director.
	John M. Boucher, Supervisor.

District	G. Stuart Reeder, Supervisor.
	J. T. Bennick, Inspector and Investigator.
	Walter W. Brandt, Inspector and Investigator.
	Leo F. Brooks, Inspector and Investigator.
	William T. Brunson, Inspector and Investigator.
	Walter R. Cornelius, Inspector and Investigator.
	Leo A. Gnotta, Inspector and Investigator.
	Fenton C. Harbour, Inspector and Investigator.
	William H. Jennings, Inspector and Investigator.
	Theodore B. Middleton, Inspector and Investigator.
	Ralph A. Montgomery, Inspector and Investigator.
	Bernard A. Pettit, Inspector and Investigator.
	Francis M. Warner, Inspector and Investigator.
	Woodrow W. Wells, Inspector and Investigator.

FLORIDA

State	Nalls Berryman, Supervisor, Weights and Measures Division, Department of Agriculture, Nathan Mayo Building, Tallahassee.
	William H. Frays, State Inspector of Weights and Measures, 1427 Park Circle, Tampa.
City:	
Jacksonville	Howard E. Crawford, Inspector of Weights and Measures, 431 West Eighth Street.
Miami	Harvey E. Howard, Supervisor of Weights and Measures, Department of Public Welfare, P. O. Box 1861.

GEORGIA

State	H. W. Striplin, Supervisor, Division of Weights and Measures, Department of Agriculture, State Capitol, Atlanta.
	Lawrence W. Henry, State Weights and Measures Inspector.
	John W. D. Harvey, Assistant Chemist, State Oil Laboratory, Department of Revenue, 524 State Office Building, Atlanta.

ILLINOIS

State	Lowell D. Oranger, Superintendent, Division of Foods, Dairies, and Standards, 160 North LaSalle Street, Suite 1600, Chicago.
	Merrill M. Emerick, Assistant Superintendent, Division of Foods, Dairies, and Standards, Springfield.
City: Chicago	Irvine M. Levy, Sealer of Weights and Measures, 608 City Hall.
	Frank J. Fitzgerald, Deputy Sealer of Weights and Measures.

INDIANA

State	Rollin E. Meek, Director, Division of Weights and Measures, Board of Health, 1330 West Michigan Street, Indianapolis.
	John M. Galloway, Deputy State Inspector.
County:	
Grant	Reuben C. Parks, Inspector of Weights and Measures, Court House, Marion.
St. Joseph	Bert S. Cichowicz, Inspector of Weights and Measures, 5718 Grant Road, South Bend.
Vigo	William H. Roberts, Inspector of Weights and Measures, Court House, Terre Haute.

City:	
Fort Wayne	James A. Hilgemann, Deputy State Inspector of Weights and Measures, 301 South Clinton Street.
Gary	Cleo C. Morgan, Sealer of Weights and Measures, City Hall.
Indianapolis	Harry H. Brunner, Supervising Inspector of Weights and Measures, City Hall.
Terre Haute	John T. Harper, Inspector of Weights and Measures, City Building.

IOWA

State	James W. Reese, Supervisor, Division of Weights and Measures, Department of Agriculture, Des Moines.

KANSAS

State	J. Fred True, State Sealer, Weights and Measures Division, Board of Agriculture, 915 Harrison Street, Topeka.

KENTUCKY

State	George L. Johnson, Director, Division of Weights and Measures, Department of Agriculture, New State Capitol, Frankfort.
City: Louisville	Vernon Herbert, Investigator, Division of Weights and Measures, City Hall.
	Thomas Hester, Investigator, Division of Weights and Measures.

LOUISIANA

State	A. J. Mayer, Director, Division of Weights and Measures, P. O. Box 4292, Capitol Station, Baton Rouge.

MAINE

State	James A. Boyle, Deputy State Sealer, Bureau of Weights and Measures, Department of Agriculture, State House, Augusta.
City: Portland	Charles James Wills, Sealer of Weights and Measures, 389 Congress Street.

MARYLAND

State	Dr. Paul E. Nystrom, Chief, State Department of Markets, University of Maryland, College Park.
	John E. Mahoney, Superintendent of Weights and Measures, State Department of Markets.
County:	
Baltimore	Frank J. Vittek, Chief Inspector of Weights and Measures, 25 Susquehanna Avenue, Towson.
	George A. Klein, Assistant Inspector of Weights and Measures.
Montgomery	A. Morton Thomas, Director, Department of Inspection and Licenses, Court House, Rockville.
	Wilford Ellis Dayhoff, Inspector of Weights and Measures.
City:	
Baltimore	George H. Leithauser, Senior Assistant Superintendent, Division of Weights and Measures, 1106 Municipal Building.
	Edwin E. Jaffa, City Inspector of Weights and Measures.

MASSACHUSETTS

State	John P. McBride, Director of Standards and Necessaries of Life, Department of Labor and Industries, 194 State House, Boston.
	T. J. Dacey, State Inspector of Weights and Measures, Worcester.
City:	
Arlington	James J. Dolan, Sealer, Weights and Measures Department, Arlington Town Hall.
Cambridge	Joseph M. O'Neil, Sealer of Weights and Measures, Municipal Building.
Chelsea	Frederick J. Ryan, Sealer of Weights and Measures, 88 Parkway.
Medford	John J. Carew, Sealer of Weights and Measures, City Hall.

MICHIGAN

State	Miles A. Nelson, Chief, Bureau of Marketing and Enforcement, Department of Agriculture, 725 State Office Building, Lansing.
	Clyde O. Cottom, Supervising Inspector of Weights and Measures.
County: Washtenaw	George P. Smith, Sealer of Weights and Measures, Court House, Ann Arbor.
City:	
Dearborn	Alexander Stacy, Administrative Assistant to Mayor, City Hall.
	John Jay Hubbard, Administrative Assistant, 7055 Mead Avenue.
	Mitchell O. Nickon, Superintendent Department of Licenses, Weights, and Measures, 4731 Korte Street.
Detroit	Hazen L. Funk, Commissioner and City Sealer, Department of Purchases and Supplies, Bureau of Weights and Measures, 740 Elmwood Avenue.
	George F. Austin, Jr., Deputy Sealer.
	William B. Heaslip, Supervising Inspector.
	John T. Daniell, Inspector.
	James H. Hitchings, Inspector.
	Charles D. Marsden, Inspector.
	Victor F. Steinhart, Inspector.
Grand Rapids	Otto Skodsholm, Sealer of Weights and Measures, 301 Market Avenue S. W.
Lansing	Walter M. Saxton, City Sealer and Marketmaster, 333 North Cedar Street.
Muskegon	B. T. Sullivan, City Sealer of Weights and Measures, City Hall.
Pontiac	Walter A. Baerwolf, Sealer of Weights and Measures, 8 North Perry Street.

MINNESOTA

State	Warren Czaia, State Inspector of Weights and Measures, 325 South Third Street, Minneapolis.
	Melvin C. Ilstrup, State Inspector of Weights and Measures.
	Rudolph E. Thalin, State Inspector of Weights and Measures.
City: Minneapolis	Russell S. Ackerman, Superintendent, Department of Licenses, Weights, and Measures, City Hall.

MISSISSIPPI

State	Adlia Morgan, Director of Petroleum Taxes, Office of Vehicle Comptroller, Jackson.

MISSOURI

State	L. C. Carpenter, Commissioner, Department of Agriculture, Jefferson City.
	Al E. Hard, Administrative Assistant.
City: University City	D. J. Almon, General Inspector, City Hall.

NEBRASKA

City: Omaha	Willis W. Gray, Chief Inspector of Weights and Measures, Department of Public Affairs, Room 100 City Hall.

NEVADA

State	E. L. Randall, Department of Weights and Measures, Public Service Division, P. O. Box 719, Reno.

NEW HAMPSHIRE

State	Clement A. Lyon, Director, Division of Markets and Standards, Department of Agriculture, Concord.
	Alfred H. Dittrich, Chief Inspector, Bureau of Weights and Measures, Division of Markets and Standards.
City:	
Claremont	Arthur Forrest, Sealer of Weights and Measures, 45 Hanover Street.
Manchester	Fernand A. Genest, City Sealer of Weights and Measures, 180 Franklin Street.

NEW JERSEY

State	Joseph G. Rogers, Superintendent, Division of Weights and Measures, Department of Law and Public Safety, 187 West Hanover Street, Trenton.
	Archie T. Smith, Assistant Superintendent.
	Samuel H. Christie, Senior Inspector.
	Joseph A. Murphy, Assistant Deputy Attorney General, Department of Law and Public Safety, State House.
County:	
Bergen	Michael J. Santimauro, Superintendent of Weight and Measures, 66 Zabriskie Street, Hackensack.
	Ernest E. Dawson, Assistant Superintendent of Weights and Measures.
Burlington	Paul F. Nunn, Superintendent of Weights and Measures, Centerton Road, Masonville.
Camden	Albert C. Becker, Superintendent of Weights and Measures, City Hall, Camden.
Cumberland	Alfred Lirio, Superintendent of Weights and Measures, Court House, Bridgeton.
	Winfield K. Thompson, Assistant Superintendent.
Gloucester	Martin J. Caulfield, Superintendent of Weights and Measures, Westville Road, Almonesson.
Mercer	Ralph M. Bodenweiser, Superintendent of Weights and Measures, Court House, Trenton.
Morris	Del G. Nelson, Superintendent of Weights and Measures, Court House, Morristown.
Passaic	William Miller, Superintendent of Weights and Measures, Administration Building, Paterson
Union	James M. Dietz, Superintendent of Weights and Measures, Court House, Elizabeth.

City:

Bayonne	Walter Flynn, Superintendent of Weights and Measures, 469 Boulevard.
Clifton	Felix J. Sandri, Superintendent of Weights and Measures, City Hall.
Englewood	Leonard DeRienzo, Superintendent of Weights and Measures, City Hall.
Garfield	Charles Benanti, Municipal Superintendent of Weights and Measures, Police Building, Somerset Street.
Jersey City	John S. Burke, Superintendent of Weights and Measures, City Hall.
Passaic	Paul DeVries, Superintendent of Weights and Measures, P. O. Box 663.
	Joseph Shaw, Assistant Superintendent of Weights and Measures, Municipal Building.
Paterson	Joseph P. Leonard, Superintendent of Weights and Measures, 115 Van Houten Street.
	William J. Kehoe, Assistant Superintendent of Weights and Measures.
Union City	Alfred O. Oslund, Superintendent, Department of Weights and Measures, Palisade Avenue and 38th Street.

NEW YORK

State	Clement A. Baker, Director, Bureau of Weights and Measures, Department of Agriculture and Markets, State Office Building, Albany.
County:	
Genessee	Glenn A. Pullman, Sealer of Weights and Measures, 19 Buffalo Street, Bergen.
Monroe	Earl D. Hubble, County Sealer, Department of Weights and Measures, Room B, 1400 South Avenue, Rochester.
Nassau	Robert Williams, Sealer of Weights and Measures, Old County Court House Annex, Mineola.
	William Kirk, Jr., Assistant Sealer of Weights and Measures.
Niagara	Henry C. Hulshoff, Sealer of Weights and Measures, 17 High Street, Lockport.
Oswego	Leland M. Flower, Sealer of Weights and Measures, Lycoming.
City:	
Binghamton	Harry A. Lason, Sealer of Weights and Measures, 60 Robinson Street.
Lackawanna	John J. Seres, Sealer of Weights and Measures, 84 Rosary Avenue.
Rochester	Anthony C. Samenfink, Sealer of Weights and Measures, Department of Commerce, Rochester Food Terminal.
Yonkers	S. John Dimase, Sealer of Weights and Measures, City Hall.

NORTH CAROLINA

State	C. D. Baucom, Superintendent, Weights and Measures Division, Department of Agriculture, 415 Agriculture Building, Raleigh.
	John I. Moore, Supervisor.
	Charles E. Dolan, Inspector of Weights and Measures.
	S. M. Woolfolk, Inspector of Weights and Measures.

NORTH DAKOTA

State	J. C. Goll, Chief Inspector, Weights and Measures Department, Public Service Commission, Bismarck.
	Earl W. Wilcox, Inspector of Weights and Measures, P. O. Box 1515, Jamestown.

OHIO

State	V. D. Campbell, Deputy State Sealer, Division of Foods and Dairies, Department of Agriculture, Room 710 State Office Building, Columbus.
County:	
Clinton	Harold E. Morris, Deputy Sealer of Weights and Measures, 610 N. Mulberry Street, Wilmington.
Medina	Robert W. Searles, Deputy Sealer of Weights and Measures, Court House, Medina.
City:	
Akron	Robert K. Slough, Sealer of Weights and Measures, 102 Municipal Building.
Cincinnati	William E. G. Rhein, Superintendent, Markets, Weights and Measures, Market House, Sixth and Plum Streets.
Lorain	Gabor Toth, Sealer of Weights and Measures, 3019 Caroline Avenue.

OKLAHOMA

State	T. C. Beck, Assistant Director, Marketing Division, Board of Agriculture, 122 Capitol Building, Oklahoma City.
	R. L. Flanagan, Supervisor of Weights and Measures.
City: Oklahoma City	Clarence M. Fowler, Inspector, 507 Municipal Building.

PENNSYLVANIA

State	Joseph F. Blickley, Director, Bureau of Standard Weights and Measures, Department of Internal Affairs, Capitol Building, Harrisburg.
	Spencer H. Seighman, Assistant Director.
	James R. Redclift, Senior Inspector of Weights and Measures, Box 109, Shenandoah.
City:	
Erie	Paul F. Watson, Inspector of Weights and Measures, City Hall.
Philadelphia	James J. Powers, Supervisor, Bureau of Weights and Measures, Room 306 City Hall.

RHODE ISLAND

State	Edward R. Fisher, Sealer of Weights and Measures, Department of Labor, State House, Providence.
	James F. Corrigan, Deputy State Sealer of Weights and Measures.
City: Cranston	Armand E. Renzi, Sealer of Weights and Measures, 14 Tulip Circle, Garden City, Cranston.

SOUTH CAROLINA

State	J. Roy Jones, Commissioner, Department of Agriculture, P. O. Box 1080, Columbia.
	Carl H. Stender, Assistant Commissioner.
	Alex H. Gibert, Director, Bureau of Inspection.
	Lowrie M. Beacham, Field Representative, Department of Agriculture, P. O. Box 432, Spartanburg.
	Carl S. Hogue, Field Representative, Department of Agriculture, P. O. Box 1080, Columbia.

TENNESSEE

City:	
Memphis	C. S. Meehan, Inspector of Weights and Measures, 590 Washington Street.
Nashville	Tom Webb, Sealer of Weights and Measures, 300 Demonbreun Street.

TEXAS

State	JOHN L. CLARK, State Inspector of Weights and Measures, Division of Weights and Measures, Department of Agriculture, State Office Building, Austin.
	O. A. KIRKLAND, Inspector of Weights and Measures, 3422 West Jefferson Boulevard, Dallas.
City:	
Dallas	J. D. WALTON, Supervisor, Weights, Measures, and Markets, 311 City Hall.
Houston	ROBERT OLIVER DEVILLIER, Deputy Sealer of Weights and Measures, City Hall.

UTAH

City: Salt Lake City	EDWIN C. WESTWOOD, Sealer of Weights and Measures, 118 East First Street.

VERMONT

State	GEORGE E. CARPENTER, Supervisor, Division of Weights and Measures, Department of Agriculture, Montpelier.

VIRGINIA

State	J. H. MEEK, Director, Division of Markets, Department of Agriculture and Immigration, 1200 East Main Street, Richmond.
	R. D. THOMPSON, Supervisor, Weights and Measures Section.
	J. A. ROSEN, State Inspector of Weights and Measures, 3126 Lamb Avenue, Richmond.
	C. F. WINGFIELD, State Inspector of Weights and Measures, 202 Hanover Avenue, Ashland.
	CLARENCE E. WHITMAN, Field Supervisor, Scale Maintenance, Department of Highways, Richmond.
City:	
Norfolk	W. K. TRIPPLE, Chief, Bureau of Weights and Measures, City Market Building.
Petersburg	C. R. THOMPSON, Sealer of Weights and Measures, Room 205 City Hall.
	CLAUDE R. BRANCH, Assistant Inspector of Weights and Measures.
Richmond	CONWAY C. MUNDY, Chief, Bureau of Weights and Measures, Room 121 Mosque Building, Laurel and Main Streets.
	M. L. RICE, Inspector of Weights and Measures.
	J. N. WHITLOW, Inspector of Weights and Measures.
Roanoke	JAMES M. HUDGINS, Inspector of Weights and Measures, City Market Building.

WASHINGTON

City: Seattle	WALTER L. DANIELS, Director of Licenses and Standards, Department of Finance, Office of the Comptroller, 100 County-City Building.
	D. M. TURNBULL, Supervisor, Division of Licenses and Standards.

WISCONSIN

State	C. L. JACKSON, Chief, Division of Economic Practices, Department of Agriculture, State Capitol.

City:

Janesville	E. W. Schellenberger, Sealer of Weights and Measures, City Hall.
Kenosha	Felix Mayer, Sealer of Weights and Measures, City Hall.
Madison	C. D. Kenison, Inspector of Weights and Measures, E. Mifflin & Blount Streets.
Milwaukee	Louis E. Witt, Sealer of Weights and Measures, 1331 North Fifth Street.
Racine	Robert J. Zierten, Sealer of Weights and Measures, City Hall.
West Allis	Arthur E. LaBoda, Sealer of Weights and Measures, City Hall.

HONORARY LIFE MEMBER

Ralph W. Smith, 700 Elm Street, Chevy Chase, Md.

DELEGATES—NATIONAL BUREAU OF STANDARDS

Director's Office:
- A. V. Astin, Director.
- W. R. Brode, Associate Director.
- A. T. McPherson, Associate Director.
- L. J. Briggs, Director Emeritus.
- E. C. Crittenden, Consultant.
- William S. Bussey, Chief, Office of Weights and Measures.
- Malcolm W. Jensen, Assistant Chief, Office of Weights and Measures.
- H. Haig Russell, Chief, Scale Section, Office of Weights and Measures.
- Charles H. Oakley, Coordinator, Office of Weights and Measures.
- Herbert L. Badger, Physicist, Office of Weights and Measures.
- Allen A. Williams, Mechanical Inspector, Office of Weights and Measures.
- Mrs. K. M. Schwarz, Attorney-Editor, Office of Weights and Measures.
- Mrs. F. C. Bell, Chief Clerk, Office of Weights and Measures.
- Mrs. R. E. Taylor, Clerk-Stenographer, Office of Weights and Measures.
- William R. Tilley, Chief, Technical Reports Section, Office of Scientific Publications.
- John Friedman, Office of Scientific Publications.
- Bernard H. Barbour, Office of Scientific Publications.

Applied Mathematics Division:
- Churchill Eisenhart, Chief, Statistical Engineering Section.
- W. J. Youden, Consultant, Statistical Engineering Section.

Atomic and Radiation Physics Division:
- Lela J. Hamilton, Neutron Measurements Section.

Electricity Division:
- Earl M. Otto, Chemist, Electrochemistry Section.

Mechanics Division:
- H. S. Bean, Chief, Capacity, Density, and Fluid Meters Section.
- B. C. Keysar, Capacity, Density, and Fluid Meters Section.
- B. L. Wilson, Chief, Engineering Mechanics Section.
- R. R. Bouche, Mechanical Engineer, Engineering Mechanics Section.
- Francis C. Falkinburg, Mechanical Engineer, Engineering Mechanics Section.
- Roscoe L. Bloss, Physicist, Engineering Mechanics Section.
- Alvin C. Legate, Physicist, Engineering Mechanics Section.
- Douglas R. Tate, Physicist, Engineering Mechanics Section.
- L. B. Macurdy, Chief, Mass Section.
- T. W. Lashof, Assistant Chief, Mass Section.
- Eleanor M. Clinton, Physicist, Mass Section.
- Mildred W. Jones, Scientific Aid, Mass Section.
- Nancy J. Tighe, Mass Section.

Optics & Metrology Division:
- Wilmer Souder, Consultant.
- L. V. Judson, Chief, Length Section.
- Ralph W. Crouch, Jr., Photometry and Colorimetry Section.

Organic and Fibrous Materials Division:
- William D. Appel, Chief, Textiles Section.

Planning Staff:
- James J. Cockerill, Management Analyst.
- Thomas C. Leffingwell, Management Analyst.

GUESTS REPRESENTING UNITED STATES GOVERNMENT

U. S. Department of Agriculture:
- J. ROY ALLGYER, Research Coordinator, Agricultural Research Administration, Washington 25, D. C.
- HENRY MARSTON, Research Coordinator, Agricultural Research Administration, Washington 25, D. C.
- CHARLES L. RICHARD, Supervisor of Scales and Weighing, Livestock Branch, 3530 South Building, Washington 25, D. C.

U. S. Department of Commerce:
- CRAIG R. SHEAFFER, Assistant Secretary for Internal Affairs, Washington 25, D. C.

U. S. Federal Supply Service:
- R. M. GREENE, Technologist, Alcott Hall, Washington, D. C.
- G. L. MILLER, Federal Supply Service, Alcott Hall, Washington, D. C.

U. S. Food and Drug Administration:
- SUMNER C. ROWE, Chemist, Food Division, Washington 25, D. C.

U. S. Navy Department:
- GEORGE I. DEWEY, Chairman, Technical Committee on Cordage, Bureau of Ships, Washington 25, D. C.
- R. W. WEBSTER, Materials Engineer, Bureau of Ships, Washington 25, D. C.

U. S. Tariff Commission:
- C. A. SCHOFFSTATT, Member, Technical Committee on Cordage, Washington 25, D. C.

U. S. Air Force Department:
- HASSELL C. PETTUS, General Foreman, Instrument Repair, Norton Air Force Base, San Bernardino, California.
- BREWSTER H. WOODBURN, Measuring Devices Repairman and Inspector, Norton Air Force Base, San Bernardino, California.

GUESTS REPRESENTING MANUFACTURERS OF WEIGHING AND MEASURING DEVICES

Ace Glass Incorporated: C. I. KRAMME, Vineland, N. J.

American Can Company: HAROLD L. DUENKEL, 100 Park Avenue, New York 17, N. Y.

American Meter Company: W. V. STOCKTON, JR., District Sales Manager, P. O. Box D, Wynnewood, Pa.

Balwin-Lima-Hamilton Corporation: MALCOLM L. HALL, Manager, Testing Equipment Department, Philadelphia, Pa.

Black & Decker Manufacturing Co.: E. E. POWELL, Manager, Loadometer Department, Towson 4, Md.

Bloomer Brothers Co.: RAYNOR M. HOLMES, Research Engineer, Newark, N. Y.

Bowser, Inc.:
- I. W. BALDWIN, Regional Manager, 830 Washington Building, Washington 5, D. C.
- WALTER M. HARKS, Vice President, Fort Wayne, Ind.
- JAMES B. MARSH, Assistant Regional Manager, 830 Washington Building, Washington 5, D. C.

Brodie, Ralph N., Co., Inc.:
- DON W. KINGSLEY, 550 South Columbus Avenue, Mt. Vernon, N. Y.
- C. J. MCCAFFREY, Vice President, 550 South Columbus Avenue, Mt. Vernon, N. Y.

Chatillon, John, & Sons: GEORGE C. REILEY, Vice President—Sales, 85 Cliff Street, New York 38, N. Y.

Continental Can Company, Inc.: WARREN D. AYRES, Assistant Product Sales Manager, 349 Oraton Street, Newark 4, N. J.

Control Engineering Corporation: R. BYRON WHITE, Engineering Division, 560 Providence Highway, Norwood, Mass.

Creamery Package Manufacturing Co.: L. T. GUSTAFSON, 1243 West Washington Boulevard, Chicago 7, Ill.

Dairy Equipment Co.: K. S. HART, Vice President, 1444 East Washington Avenue, Madison 3, Wis.

Damrow Brothers Company: PETER P. WEIDENBRUCH, President, 196–234 Western Avenue, Fond du Lac, Wis.

Detecto Scales, Inc.: MRS. CARRIE G. WOODLAND, Representative, Woodland's Temple Grove, Fellsmere, Fla.

Dixie Cup Co.: ARTHUR J. NOLAN, Vice President, Easton, Pa.

Erie Meter Systems, Inc.:

Paul R. Fishburn, Chief Engineer, P. O. Box 559, Erie, Pa.

William B. Johnson, Jr., Manager of Sales, P. O. Box 559, Erie, Pa.

Exact Weight Scale Co.:

E. A. LeVay, 120 West 25th Street, Baltimore 18, Md.

W. A. Scheurer, Vice President, 944 West 5th Avenue, Columbus 8, Ohio.

James F. Sullivan, Chief Engineer, 944 West 5th Avenue, Columbus 8, Ohio.

Oliver H. Watson, 608 Dearborn Street, Chicago 5, Ill.

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Fairbanks, Morse & Co.:

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C. A. Hennie, Field Engineer, 657 East 25th Street, Baltimore 18, Md.

Frederick C. Johnson, 80 Broad Street, New York 4, N. Y.

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Fisher Governor Co.: Walter H. Hoagland, Eastern Manager, 212 East State Street, Westport, Conn.

Forschner, R. H., Co.: Richard A. Forschner, General Manager, 205 Third Avenue, New York 3, N. Y.

Fuller, H. J., Co.: H. J. Fuller, President, 1371 West Third Avenue, Columbus 12, Ohio.

Gilbert & Barker Manufacturing Co.:

Clifford A. Bellows, Manager, Patents and Weights and Measures, West Springfield, Mass.

William Keay, Manager, Sales Service, West Springfield, Mass.

Joseph A. Logan, Consulting Engineer, West Springfield, Mass.

Gilmore Industries, Inc.: G. E. Di Geronimo, 5511 Euclid Avenue, Cleveland 3, Ohio.

Girton Manufacturing Co.: Paul K. Girton, President, Millville, Pa.

Gould Equipment Co.: Earlon W. Barrett, Representative, Cape Elizabeth, Maine.

Gurley, W. & L. E.: Franklin G. Williams, Washington Representative, 5514 Nevada Avenue, N. W., Washington 15, D. C.

Hobart Manufacturing Co.:

Murray W. Craig, Weights and Measures Representative, Dayton Scale Division, Troy, Ohio.

Ernest A. Reussenzehn, Chief Scale Inspector, Dayton Scale Division, 448 Huffman Avenue, Dayton 3, Ohio.

Howe Scale Co.: R. A. Parham, Branch Manager, 1300 Curtain Avenue, Baltimore 18, Md.

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Marvel Rack Manufacturing Co., Inc.: Charles M. McCarthy, President, 24 North First Street, Minneapolis 1, Minn.

McIntyre, J. J., & Sons: John Lawrence McIntyre, Philadelphia 11, Pa.

Minnesota Mining & Manufacturing Co.: Howard Ecker, 900 Fauquier Avenue, St. Paul 6, Minn.

Moody, Edward G., & Son, Inc.: Edward G. Moody, Box 130, Nashua, N. H.

Neptune Meter Co.:

H. Alfred Lentz, Jr., 14 Bell's Mill Road, Philadelphia 18, Pa.

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Owens-Illinois Glass Co.: J. D. Laird, Chief Specification & Service Engineer, Toledo 1, Ohio.

Penn Scale Manufacturing Co., Inc.: Sydney Black, President, 150 West Berks Street, Philadelphia 22, Pa.

Republic Steel Corporation: Howard L. Zupp, Corporation Weighing Inspector, 333 Delaware Avenue, N. E., Massillon, Ohio.

Richardson Scale Co.: Arthur J. Burke, Chief Engineer, 668 Van Houten Avenue, Clifton, N. J.
Rockwell Manufacturing Co.:
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- Edward R. Eyler, Sales Engineer, 12 Mayflower Court, Baltimore, Md.
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- James H. Judge, Sales Manager, Gasoline, Oil & Industrial Meters, 400 North Lexington Avenue, Pittsburgh 8, Pa.
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Sanitary Scale Co.: Harold V. Smith, District Manager, Belvidere, Ill.
Sealright Co., Inc.: Earl Foster, Chief Chemist, Fulton, N. Y.
Seraphin Test Measure Co.: T. A. Seraphin, General Manager, 1314 North Seventh Street, Philadelphia 22, Pa.
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Southwest Pump Co.: R. Eugene Risser, Jr., Vice President, Bonham, Texas.
Stimpson Computing Scale Co.: Frank M. Doyne, General Distributor, 468 Weaver Street, Larchmont, N. Y.
Streeter-Amet Co.:
- George F. Graham, Assistant Director of Sales, 4101 Ravenswood Avenue, Chicago 13, Ill.
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Tel-A-Dial Scale Co.: Roy R. Dunlap, 401 Wyandotte, Kansas City, Mo.
Thatcher Glass Manufacturing Co., Inc.: James Arrandale, Director, Quality Control & Service, 623 West Water Street, Elmira, N. Y.
Tokheim Oil Tank & Pump Co.: William E. Louthan, Service Manager, Fort Wayne 1, Ind.
Toledo Scale Co.:
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- D. J. Boudinot, Assistant General Sales Manager, Toledo 1, Ohio.
- E. C. Smith, Industrial Division, 213–215 East 27th Street, New York 16, N. Y.

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- Edward J. Furey, General Manager, 911 Arch Street, Philadelphia 7, Pa.
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Veeder-Root, Inc.:
- J. J. Brannick, Sales Manager, Computer Division, 915 Van Buren Street, N. E., Auburn, Ind.
- Austin E. McKeever, Sales Manager, Master Meter Duplicator Division, Hartford 2, Conn.
- David J. Post, Vice President, Hartford 2, Conn.

Wayne Pump Co.:
- F. H. Ainsworth, Assistant Chief Engineer, Salisbury, Md.
- C. F. Bateman, Chief Engineer, Salisbury, Md.
- W. L. Connelly, Jr., Sales Engineer, Salisbury, Md.
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Wood, John, Co.:
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Atlantic Peat Moss Co., Ltd.: Emilien Langevin, General Manager, 2005 McGill College, Montreal, Quebec, Canada.

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