NATIONAL BUREAU OF STANDARDS REPORT

5787

PROJECTS RELATED TO BUILDING RESEARCH

AT THE

NATIONAL BUREAU OF STANDARDS

FOR FISCAL YEAR 1958

Compiled by the
Building Technology Division
D. E. Parsons, Chief

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Inquiries regarding the Bureau's reports should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
1000-40-1099	February 28, 1958	5787

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0906 is now 1007.
0501 is now part of 1004

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INTRODUCTION

This report lists unclassified projects concerned with building research and related subjects in progress at the National Bureau of Standards in Fiscal Year 1958.

Most projects mentioned are directly related to engineering and research in the building field. However, other NBS projects not directly related, such as those on instrumentation and properties of gases, are included in the belief that the basic information is sometimes applicable to building research.

The projects are listed under the several main categories as given in the index immediately following. Each project is identified by ten digits. The first four, followed by a dash, indicate the division and section at NBS which is carrying out the work. The next two indicate the scientific activity class, as follows.

11 Basic Research
12 Applied Research
20 Development
30 Testing, Calibration, and Specifications
40 General Scientific Services

The last four digits identify the projects within the basic organizational unit. Thus, project 1003-20-4832 refers to a Division 10, Section 3, development project No. 4832. Under each main category the projects are arranged in the order of their scientific activity classification, denoted by the second group of digits. The first and last group simply identifies the projects within the NBS organization.

INDEX

KEY TO ABBREVIATIONS
APPEARING IN THIS REPORT

AF . . . . . Air Force
AISI . . . . . American Iron and Steel Institute
ASHAE . . . . . American Society of Heating and Air-Conditioning Engineers
ASRE . . . . . American Society of Refrigerating Engineers
ASTM . . . . . American Society for Testing Materials
ASA . . . . . American Standards Association
AEC . . . . . Atomic Energy Commission
AFSWP . . . . . Armed Forces Special Weapons Project

BYD . . . . . Bureau of Yards and Docks

CAA . . . . . Civil Aeronautics Administration
CRL . . . . . Cement Reference Laboratory

FCDA . . . . . Federal Civil Defense Administration
FHA . . . . . Federal Housing Administration

GSA . . . . . General Services Administration

HRB . . . . . Highway Research Board

IES . . . . . Illuminating Engineering Society
ISO . . . . . International Standardization Organization

NACA . . . . . National Advisory Committee for Aeronautics
NBS . . . . . National Bureau of Standards
NEMA . . . . . National Electrical Manufacturers Association
NRDL . . . . . Naval Radiological Defense Laboratory

OCE . . . . . Office of the Chief of Engineers, Department of the Army
OCT . . . . . Office of the Chief of Transportation
OQMG . . . . . Office of the Quartermaster General

PEI . . . . . Porcelain Enamel Institute

QMR&E . . . . . Quartermaster Research and Engineering Command
QRDC . . . . . Quartermaster Research and Development Command

SEAC . . . . . Standards Electronic Automatic Computer

VA . . . . . Veterans Administration

ACOUSTICS

0601-12-0632 Architectural Acoustics

Objectives: (1) To investigate the basic physical phenomena involved in the transmission and absorption of sound in acoustic materials, building materials and building structures; (2) to develop new measuring techniques in architectural acoustics, and improve existing techniques; (3) to assist in developing appropriate standards in this field.

Importance of the Project: As the noise levels produced by society increase, more attention has to be paid to reducing noise levels inside buildings. Acoustic materials are widely used for reducing noise and for improving the acoustics of buildings, and new techniques are being developed for improving the sound insulation of walls, floors, and doors. Many of the phenomena of sound propagation in materials and structures are imperfectly understood, and need theoretical and experimental elucidation before advances can be expected. Measuring techniques in this field are generally antiquated and poor, and require much improvement. For example, reverberation room measurements of the sound absorption of acoustic materials made in different laboratories often produced different results for the same material. The same is true of sound insulation measurements of wall constructions. There is urgent need for improving these measuring techniques. Another item of importance is the development of sound insulation standards for building codes. The United States is lacking such standards, although several European countries and Canada have them; this project would be the logical place to develop them.

Activity Summary: 1) A new method of averaging the sound transmission loss figures at different frequencies for a partition, which is considered more informative than the decibel average generally used, was developed. A paper on this subject was presented at the 2nd International Acoustics Congress entitled "On Standard Methods on Measurement in Architectural Acoustics."

2) Theoretical work on the diffraction effect of a square patch of material in a reverberant sound field has yielded useful results which are in satisfactory agreement with experimental results obtained some years ago. This work is being written up as a technical paper.

ACOUSTICS (con.)

0601-12-0632 (con.)

3) An exponential horn-coupler was built to enable 1-foot square acoustic tiles to be measured for sound absorption on an impedance tube. Its performance was worse than reports in the literature indicated it should be, and measurements of relative phase and pressure level over the exit plane of the horn are being made to see whether plane wave conditions exist, as they should.

4) Some countour maps of interference patterns in reverberant sound fields have been prepared with the aid of SEAC. These maps show how closely measurements can be made to the walls of a reverberation chamber without departing from the diffuse field conditions required in reverberation chamber work.

5) Further work has been done on the effect of reflected impedance on the output of acoustic sources, and a manuscript on this topic is under review. A method of computing the power radiated in the near field of a simple source has been used which enables results to be obtained in closed form for certain boundary conditions.

Plans for Fiscal Year 1958: In line with a recommendation by an advisory committee appointed by the Director in 1955, work on the development of a standard method for measurement of sound absorption coefficients of acoustic materials will be accelerated to the fullest extent available funds will permit. The work will involve a critical re-examination of the area effect, placement of material, and sound pattern in the reverberation chamber.

0601-30-0605 Acoustic Measurements

Objectives: 1) To measure the sound absorption of acoustic materials; 2) to measure the sound insulation properties of wall and floor constructions; 3) to perform standard calibrations of microphones, sound level meters, earphones, and audiometers.

ACOUSTICS (con.)

0601-30-0605 (con.)

Importance of the Project: Large quantities of acoustic materials are used annually by the Government. The performance of the material used is measured under this project, to check its compliance with Federal Specifications SSA-118-B, and SSA-111. Measurements of the sound absorption of acoustic materials, and of the sound insulation of building constructions are also made for industry and private individuals. The reason is that measuring methods in this field are not yet fully standardized, and systematic differences between results obtained in various laboratories have not yet been resolved. (Work is in progress under Project 0601-12-0632 above to standardize on good measuring techniques in this field.) The performance of standard calibrations of microphones and other electroacoustic devices has been requested by various laboratories, including industrial and university laboratories.

Activity Summary: This has been a continuing project that was started about 30 years ago. Shortly after the beginning of the fiscal year the project was superseded by 0601-30-3618, and work done on Acoustic Measurements during Fiscal Year 1957 is reported under the latter project.

0601-30-3618 Acoustic Measurements

Objectives: For government and for non-governmental organizations, 1) to measure sound absorption of acoustic materials; 2) to measure sound transmission loss of building and other structures; 3) to calibrate microphones, sound level meters, vibration pickups, audiometers and earphones used for secondary acoustic standards; 4) to test devices such as dictating machines, phonographs, and loudspeakers for acoustic performance; 5) to measure noise output of air conditioning equipment, fans, aircraft, sirens, and similar devices.

Importance of the Project: Large quantities of acoustic materials are used annually by the Government to control noise in buildings. The performance of various acoustic materials is checked under this project for compliance with Federal Specifications for such materials. The Government also relies on the Bureau's test results of sound transmission loss measurements on various building

ACOUSTICS (con.)

0601-30-3618 (con.)

constructions such as walls, floors, roof decks and doors. Sound absorption and transmission tests are made also for industry and private individuals for the reason that test methods for these properties are not standardized at present.

Acoustic equipment manufacturers, government and university laboratories, and the radio and sound recording industries depend on calibrations of secondary standard microphones for maintaining the acoustic quality of products or services provided by them. The medical equipment manufacturers and otologists require calibrations of audiometers and earphones used for diagnosis of hearing loss. Secondary vibration pickup standards are needed by engineers working in the field of noise reduction.

The Government is a large user of devices like fans, phonographs, and dictating machines. Tests are often required to determine the degree of compliance of the equipment with Federal Specifications for noise output.

Activity Summary: This is a continuing project that was started about 30 years ago. During Fiscal 1957 the following tests were reported; 18 reverberation chamber tests, 25 sound transmission loss tests, and 7 microphone calibrations.

Technical advice was furnished to a company building underwater ultrasonic velocimeters for the Navy Department.

Plans for Fiscal Year 1958: To continue the program along the same lines as above.

AIR CONDITIONING, HEATING, AND REFRIGERATION

1003-12-1014 Air Conditioning and Refrigeration Processes

Objectives: The purpose of this project is to develop new technical data for use in handbooks, codes, and standards on the principles and processes of air conditioning, heating, and refrigeration for buildings, warehouses, trailers and other enclosed spaces and to publish the results of technical investigations in these fields.

Importance of the Project: There is a need in both Government and industry for more technical information on the processes of heating, air conditioning, and refrigeration to permit codes to be prepared on a performance basis, to provide test methods that are sufficiently precise and designed to reveal important qualities and characteristics, and to provide an equitable basis for rating, specifying, and purchasing such systems. Further information is needed on the measurement and control of air infiltration in buildings, refrigerated enclosures, warehouses, etc.

Activity Summary: A metering heat sink apparatus to determine the total heat transfer of a refrigerated enclosure, under temperature conditions normal to intended use, was developed in prototype form. A particular adaptation of this metering heat sink apparatus was modified and used under another project for the Quartermaster Research and Engineering Command in evaluating the performance of refrigerated trailers. The metering heat sink method takes into account not only the sensible heat transfer of the refrigerated enclosure under observation but the effect of moisture vapor and air infiltration as well. This method has tentatively been selected as a basis of rating commercial refrigerated trailers.

A careful calibration of the portable infiltration meter designed in this section was made and referenced in a paper entitled, "Design and Performance of a Portable Infiltration Meter," which was presented at the meeting of the American Society of Heating and Air-Conditioning Engineers at Murray Bay, Canada, on June 25, 1957.

A draft of an industry standard on ratings and methods of testing for rating residential air conditioning systems was prepared by a joint committee with members from the National Warm Air Heating and Air Conditioning Association, the Air Conditioning and Refrigeration Institute and the National Bureau of Standards (Note: Mr. R. S. Dill, Chief of Section 10.3, served as Chairman of this Committee until his sudden death in January, 1957).

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-12-1014 (con.)

In cooperation with a project for the Corps of Engineers, a study was made of heat transfer measurements of a model of and an actual installation of a Nike launcher chamber to determine if actual heat transfer of such a structure could be predicted by performance of a model. No satisfactory relationship was established and the study was terminated.

A preliminary study of the resultant surface temperatures of eight insulated panels was made under conditions of varying summer insulation. This was of particular interest in regard to selection of surface treatment or skin materials for refrigerated vehicles. The study was not completed by the close of summer and was deferred until next summer. An observation of interest was that the olive drab finish on military vehicles had a lower surface temperature than some aluminum surfaces.

Plans for Fiscal Year 1958: For Fiscal Year 1958 the effort will be confined primarily to three principal tasks: a) to study moisture and heat transfer and air leakage in refrigerated trailers using the metering heat-sink method; b) to prepare papers for publication on a ceiling panel heating system, on radiant heating and cooling of a house with reflective coverings on walls and ceiling, and on studies of air infiltration in the Test Bungalow; and c) to further develop the portable infiltration meter for use in studying hospital ventilation.

1003-12-1016 Air Cleanliness in Buildings

Objectives: To study two test methods for evaluating the effectiveness of air filters for heating and air conditioning purposes using a series of test dusts with narrow size ranges, to correlate the different efficiency values obtained by the two methods. To study the principles of dust deposition on horizontal and vertical surfaces, with a view toward finding methods of inhibiting the soiling and discoloration of interior surfaces of buildings.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-12-1016 (con.)

Importance of the Project: Huge sums of money are spent each year for cleaning, reconditioning, and replacing interior surfacing materials in public buildings as a result of contaminants in the air in the buildings, part of which are brought in through the ventilation or air conditioning ducts. Several limited studies made under the sponsorship of the Public Buildings Service on acoustical tile have shown that the mechanisms of filtration, impingement, and thermal precipitation all cause the deposition of dust or dirt in varying degrees in building materials. However, little study has been given to basic mechanisms by which particles of dust become attached to surfaces, and little is known about the methods for preventing or inhibiting such deposition. Likewise, the control of dust brought in through ventilating and air conditioning ducts is variable, to say the least, because of disagreements on methods and requirements for air filters and the lack of a standard test dust for evaluating their effectiveness. Potentially great savings could be realized if better standards were available for air filters and if the principles of dust deposition in enclosed spaces were better understood.

Activity Summary: New Project.

Plans for Fiscal Year 1958: Two transferred fund projects related to air contaminants; namely, Aircraft Engine Air Filters, and Soiling of Acoustic Tile, both due to be completed during Fiscal Year 1958, will be converted into an expenses fund project during the year under the title "Air Cleanliness in Buildings." In recent years the air filter program has been a testing program on a reimbursable basis, but research work is needed on the dust-spot and other test methods because the industry has been in strong disagreement on test methods. Studies would be undertaken to compare the usefulness of the weight methods and dust-spot method for evaluating the effectiveness of air filters for heating and air conditioning purposes using a series of test dusts with narrow size ranges with a view toward correlating the different efficiency values obtained by the two methods with the test dusts now in use. Studies would also be undertaken of the principles of dust deposition on horizontal and vertical surfaces as affected by temperature difference, velocity of approach, pressure difference, difference in electrostatic potential, surface characteristics, and dust characteristics with a view toward finding methods of inhibiting the soiling and discoloration of the interior surfaces of buildings.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-12-4881 Underground Pipe Insulation

Objectives: To provide data on the insulating properties, water permeance, expansion characteristics, mechanical and chemical stability of insulating materials and methods for underground steam and hot water lines as a basis for the preparation of adequate specifications, and test methods, for such materials by Federal Agencies.

Importance of the Project: Central heating plants often require extensive underground piping systems for distribution of steam or high temperature hot water to the area of usage. Many types of insulation and embedment have been used in addition to various kinds of tunnels. Some of the characteristics desired for underground pipe insulation are low thermal conductivity, low moisture permeance, high crushing strength, suitable expansion characteristics, adequate long life and stability at temperatures ranging from below freezing to 350°F. The Department of Defense and other Federal Agencies spend millions of dollars each year for installation of this type and the Corps of Engineers of the Department of the Army requests information on the performance of such insulating materials in order to prepare adequate specifications for purchase. Their experience has indicated that not all materials offered as underground pipe insulation possess the important characteristics to the required degree.

Activity Summary: This is a continuing project which was initiated in the third quarter of Fiscal Year 1954. The testing apparatus was brought to its present state of development in 1955, and some trial tests made as a guide to further operations. During Fiscal Year 1957, the thermal conductivity, heat transmission, and moisture resistance of cellular concrete used as an insulating material was investigated. A report on the studies made during the previous fiscal year on a vermiculite aggregate concrete as pipe insulation was nearly completed during this fiscal year. Conferences were held on the performance of Hylag and Wicor pipe insulations, with representatives of the Office of the Chief of Engineers, the manufacturer, and the NBS participating. An inter-agency conference to prepare recommendations for the Secretary of Defense on the use of certain underground pipe insulations was attended. An investigation of the insulating and thermal characteristics of the dirt used as a cover for pipe insulation systems was started. Parts of the test apparatus were revised for improvements gained from experience of previous tests.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-12-4881 (con.)

Plans for Fiscal Year 1958: This study will be continued with tests of steam pipe embedded in dry earths of various kinds, and prefabricated units with pressure-tested steel sheath. A test apparatus for determination of the thermal characteristics of underground pipe insulation under simulated use conditions using electric heat in place of steam or hot water will be developed.

1003-12-4884 Standards for Mechanically-Refrigerated Enclosures

Objectives: To complete the development of a metering heat sink method for rating the heat transfer of a mechanically-refrigerated enclosure under normal conditions of heat, moisture, and air transfer and to adapt it to the particular problems of refrigerated truck-trailers as used both by Government and industry. Basic information on air leakage and moisture transfer processes in refrigerated enclosures will be developed. The metering heat sink method will be described and reported in a way that will permit adoption by the Truck-Trailer Manufacturers Association as a standard for rating commercial semitrailers.

Importance of the Project: Many types of refrigerated enclosures can be designed more effectively if accurate heat transfer can be determined. This project deals primarily with one type of refrigerated enclosure, the refrigerated semitrailer for hauling frozen food. The transportation of perishable foods in refrigerated motor trucks and trailers has increased tremendously in recent years such that the manufacture of refrigerated trailers and the refrigerating units to cool them has reached the proportions of one hundred million dollars per year. At present there exists no standard for rating truck and trailer bodies for heat gain, moisture gain, and air leakage nor any standard methods for rating the several types of refrigerating systems; yet the truck operator is expected to deliver frozen food in good condition with trailers bought from one industry and refrigerating units bought from another industry, neither of which has a good yardstick for describing the performance of his component.

Activity Summary: This is a new project to be started in Fiscal 1958.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-12-4884 (con.)

Plans for Fiscal Year 1958: Three or more commercial 35-foot refrigerated semitrailers will be rated for overall heat transfer under varying conditions of temperature, humidity, sun load and wind, using a metering heat sink apparatus to be constructed as a part of this study. These same vehicles will then be operated over the road under various operating conditions to determine the relationship between the ratings obtained in the laboratory and over the road. These comparative results will be used to modify the laboratory method to bring the results into closer agreement. The laboratory method so selected will be outlined for industry consideration as a standard and the prototype metering heat sink apparatus, including instrumentation, will be blueprinted for use by industry in setting up the necessary test facilities.

1006-12-4831 Air Conditioning of Underground Installations

Objectives: To develop information concerning the potential heat sink capacity of rock surrounding an ice-and-water-filled underground reservoir, and the time required for such a reservoir to attain, or following its emergency use to regain its potential heat sink capacity; to investigate means of filling reservoirs with ice and controls necessary to keep them full; to prepare additions and revisions to the Corps of Engineers Manual on Heating and Air Conditioning of Underground Installations.

Importance of the Project: Underground installations for special purposes must in some instances be kept in operation for adequate periods even if cut off from outside services such as electric power and water. For an internal power generating plant to operate during such periods, an adequate heat sink must be provided to absorb the waste heat produced. Large reservoirs of water within the installation have been investigated as heat sinks, but must be undesirably large for extended periods of use. An ice-filled reservoir has much greater capacity as a heat sink, both because of the latent heat of fusion of ice, and because at the onset of need, the reservoir and surrounding rock are at a reduced temperature. Heat absorption by the rock when the reservoir is used as a heat sink represents a substantial part of the heat sink capacity, depending on the initial rock temperature and the rate of heat delivery to the reservoir.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1006-12-4831 (con.)

A question important for a new installation, and doubly important for an installation recovering from an emergency period in preparation for a second emergency, is that of estimating how long a reservoir must contain ice before its full potential as a heat sink is obtained or restored. Information on this point is fundamental for design estimates of the operative life of such installations under emergency conditions.

Activity Summary: This is a continuing project. During Fiscal Year 1957, ice formation on a refrigerant-containing pipe in water was investigated mathematically and experimentally, as a function of pipe temperature, heat input to the water and time. Experimental work on the air conditioning effect of long tunnels in rock was concluded, and the results were compared with a mathematical treatment of the subject. A report to the sponsor has been drafted. Also, consultative services were furnished to the sponsor and others in connection with practical phases of underground installations.

Plans for Fiscal Year 1958: A determination will be made, by mathematical methods, of the time for an ice-filled rock-surrounded reservoir to attain or regain, its potential capacity as an emergency heat sink. An experimental investigation of the factors involved in filling a reservoir with ice, using ice in small pieces from an ice-making machine, and distributing it under a rough water-touched ceiling, will be made, including development of a method of automatic control to keep the reservoir ice-filled.

The Corps of Engineers Manual on Heating and Air Conditioning of Underground Installations (Part XXV), issued in 1956, contained much of the information developed in past years on this project. Information more recently developed, on the thermal design of refrigerated reservoirs, and on the use of long tunnels in rock as preconditioners for ventilating air, will be added to the Manual, and some revisions made to it, to increase its scope and usefulness.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-20-4832 Refrigeration and Field Equipment

Objectives: To continue development of portable and mobile refrigeration and field equipment with improved characteristics, including performance, size and weight; to develop and apply standard test methods to refrigerated field equipment, including both refrigerating machines and refrigerated structures, with a view to adapting commercial products to military use, as far as possible; to recommend modifications of prototype equipment and standardize capacities, rating conditions and physical components of such equipment; to develop and apply test methods for refrigerated structures with particular reference to the occurrence and effects of condensation of water within the component parts; develop and amend specifications for military refrigerating equipment.

Importance of the Project: The availability and proper performance of portable and mobile refrigerating equipment is of primary importance to the Military Service, and this fact is reflected by the actions of the Office of The Quartermaster General in desiring our cooperation in the development of equipment for this purpose and means for verifying its suitability. The evolution of refrigerating equipment since World War II, when available equipment changed greatly, has continued and many new applications are now being made with equipment of a greater variety of size and characteristics now in use. Standardization is essential for minimizing the stock of necessary spare parts, especially since military operations are worldwide. The revision of specifications is essential to enable the military agencies to procure commercial items, where applicable, and thus take full advantage of quantity production, in the interest of reducing costs.

Activity Summary: This is a continuing project, initiated in 1944. During Fiscal 1957, a new metering heat sink method of measuring the heat transmission of a refrigerated enclosure with the enclosure under normal temperatures was developed and a prototype apparatus constructed. Measurement of the heat transmission of a refrigerated enclosure by this method takes into account the normal effects of water vapor and air infiltration where the heat loss method normally used does not. Using this method the heat transmission of a refrigerated trailer was measured as up to 1000 lb of ice accumulated in the insulated space. Three prototype gasoline engine-driven refrigerating units for refrigerated trailers or warehouses were tested for performance. Three refrigerated trailers were studied for

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-20-4832 (con.)

solar heating effects. Recommendations on industry comments on Federal Specification AA-R-211d were submitted and several conferences were held with QMR&E representatives in connection with this specification. Work was begun on the performance tests of four domestic refrigerators. Work on the exhaust gas-to-refrigerant heat exchanger on the thermo-mechanical control system, and on the simultaneous heat and moisture vapor tests of warehouse panels was suspended during Fiscal 1957. Progress reports were submitted during the year in letter form and in NBS Report No. 5283.

Plans for Fiscal Year 1958. Heat transfer performance characteristics of a 600 cubic foot plastic-panel demountable refrigerated enclosure will be studied. Air infiltration of and air distribution in a refrigerated trailer will be investigated. Final performance tests at minus 40°F of the prototype exhaust gas-to-refrigerant heat exchanger will be completed. Reports of the long series of refrigerated trailer heat transfer measurements will be completed. Power requirement and refrigerating capacity of standard military compressors will be made to verify results to be obtained from a private testing laboratory. Observations of the performance of prototype refrigerated trailers, portable refrigerated warehouses and refrigerating units of both stationary and portable application will continue.

1003-20-4838 Air Filter Systems for Army Aircraft

(SEE MISCELLANEOUS)

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-20-4885 Life of Upper Air Tubes

Objectives: The stock Upper Air Tube of the M41 Tent Stove has been found to have a service life not commensurate with that of the stove burner. The objectives of this project are 1) to determine by laboratory tests in the stove, the service life of twelve sets of upper air tubes now available from OQMG using three firing schedules; 2) with the guidance obtained from these results and metallurgical information, to determine by tests, material or materials to recommend for the upper air tube that will yield a satisfactory service life. The following factors will be considered in the recommended materials; a) producibility by large or small foundries; b) probable availability of the materials under the restrictions of wartime; c) machinability of the parts; and d) cost.

Importance of the Project: The gasoline-burning M41 Tent Stove is used for space heating in temporary and semi-permanent housing over a wide geographical distribution. Failure of the Upper Air Tube incapacitates the stove and in failing, it may cause destruction of the pot burner, thus multiplying the problems in the field of immediate replacement. Development of an Upper Air Tube of life commensurate with that of the stove and of specifications for the material, taking into account the factors mentioned above, is important from the standpoint of military reliability, economy and of facility in procurement.

Activity Summary: This project was approved during the last quarter of 1956 but only preliminary planning was accomplished. During 1957 a temporary test structure adequate to house twelve stoves operating under test conditions was obtained. The twelve stoves with all necessary measuring equipment with automatic controls for round-the-clock operations were installed and checked under operating conditions.

Plans for Fiscal Year 1958: Chemical and metallurgical examinations will be made of tube specimens showing premature failure and of tubes lasting the life of the test. The stoves will be burned twenty-four hours a day until at least two thousand hours burning time have been logged. A regular time schedule will be followed in measuring and inspecting the upper air tubes as burning time accumulates. The project will be concluded in Fiscal Year 1958 and a final report will be prepared.

AIR CONDITIONING, HEATING, AND REFRIGERATION (con.)

1003-20-4891 Standardization of Refrigeration Unit Components

Objectives: The purpose of this program is to evaluate a tentative military standard for refrigerant-to-air heat exchangers of the type used for condensers and evaporators in portable military refrigerating units.

Importance of the Project: The military agencies are faced with a difficult procurement and stocking problem because of the lack of standardization of components used in assembling the various refrigerating machines used by them. In the past the Armed Services have bought and used refrigerating units for their portable and mobile refrigerating equipment that were developed by various manufacturers to meet their military requirements. There has been almost no interchangeability of parts in units of similar capacity and there has been limited progress in simplifying and limiting the number of different sizes of the major components required to cover all of the applications. This has resulted in large inventories of spare parts, and unnecessary obsolescence of equipment in the field and loss of refrigerated product from breakdowns that could not be speedily repaired because spare parts were not available in the right place. The present test program will evaluate the practicability of the tentative military standard as a basis for classification and the proposed A.S.R.E. testing and rating method, will serve as a basis for recommending modifications to both of these standards, and will also reveal whether interchangeable air-cooled condensers are now available for military refrigerating units.

Activity Summary: This is a new project, approved during May 1957, for work to be done in Fiscal Year 1958.

Plans for Fiscal Year 1958: The immediate objective for Fiscal Year 1958 is to determine whether air-cooled condensers made of combinations of copper, aluminum, and steel can be standardized in heat-rejection capacity when maximum overall dimensions, minimum tube and fin thickness, minimum fin spacing, and minimum air circulation rate are specified.

0603-30-0613 Testing Wind Equipment

(See TESTING MATERIALS AND PRODUCTS)

CEMENT, CONCRETE, AND MASONRY

0900-11-0914 The Chemistry of Portland Cement

Objectives: To study the fundamental physical chemistry of calcium silicate systems related to portland cement: To obtain experimental data extending our knowledge of such systems, and to find theoretical interpretations yielding general correlation of the facts observed; to develop new experimental techniques if needed for obtaining the required data; to relate the results when possible with the burning of portland cement clinker and the hardening of concrete, for improved understanding of these processes and ultimately for the advancement of their technologies.

Importance of the Project: The portland cement industry is large, and its product is vital to many parts of the nation's economy. Fundamental research on the physical chemistry of silicates at high temperatures and in hydrous systems, of the type done in this project, is of potential importance to many other fields of industry, and of science as well.

This research project has been carried on by the Portland Cement Association Fellowship since 1924. It has done pioneering work on the formulas of the major cement clinker constituents, the measurement of heats of hydration, the application of spectrography and X-ray diffraction to cement analysis, and the development of new tools and approaches to phase equilibrium research at high temperatures. Almost all cement manufacture is now receiving the benefits of some of these developments.

Activity Summary: This is a continuing project. During the year the work has been concentrated in the fields of high-temperature phase equilibria and X-ray crystallography. The study of the quaternary system CaO-$2CaO{\cdot}SiO_2$-$12CaO{\cdot}7Al_2O_3$-$2CaO{\cdot}Fe_2O_3$ was continued. The techniques of quenching, differential thermal analysis, and microscopic and X-ray examination are being used for the determination of solid-liquid equilibria involving the $2CaO{\cdot}Fe_2O_3$ solid solution phase, which had been previously determined in the ternary boundary system lacking silica.

The high-temperature centrifuge used to study the senary system K_2O-Na_2O-CaO-Al_2O_3-Fe_2O_3-SiO_2 was rebuilt and considerably improved, particularly by the provision of forced-air cooling for the metal shaft to which the ceramic rotor is attached. The determination of the course of crystallization for selected mixtures in the composition range of practical cement clinkers is continuing.

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The study of X-ray diffraction intensities for calcium hydroxide was used as a test of a newly procured microdensitometer, with special modifications for single-crystal X-ray diffraction patterns. The development of optimum techniques for applying this instrument to X-ray diffraction promises to increase greatly the precision obtainable by film methods.

The previous study of the $2CaO \cdot Fe_2O_3$ solid solution in the ternary system suggested the possibility that structural changes occur within the composition range previously thought to represent complete solid solution without change of phase. This question is being further studied by single-crystal X-ray diffraction methods. Crystals of a composition approximating $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ are being studied.

Publications incidental to the program included:

"Differential Thermal Analysis Above 1200°C," by T. F. Newkirk (submitted to J. Amer. Ceram. Soc.)

"The Pseudo-Ternary System Calcium Oxide-Monocalcium Aluminate ($CaO \cdot Al_2O_3$)-Dicalcium Ferrite ($2CaO \cdot Fe_2O_3$)," by T. F. Newkirk and R. D. Thwaite. (Manuscript being reviewed preparatory to publication in the NBS J. of Research)

"Hydration of Tricalcium Silicate," by Max Swerdlow, H. F. McMurdie, and Francis A. Heckman, (published by the Royal Microscopical Society in "Proceedings of International Conference on Electron Microscopy held at London, July, 1954").

Plans for Fiscal Year 1958: The studies of phase equilibria and crystal structure will be continued. In addition, a study of the physical chemistry of hydrous calcium silicate systems will be started, with emphasis on the determination of the activities of ionic species in calcium silicate solutions, and their effect on the equilibria and rates of formation of the hydrous silicates.

0906-11-0923 Chemical Properties of Cementing Materials

(See Properties of Materials)

CEMENT, CONCRETE, AND MASONRY (con.)

1001-11-1002 Dimensional Stability of Reinforced Concrete

Objectives: To secure basic data in the laboratory on the dimensional changes in reinforced concrete undergoing drying shrinkage.

Importance of the Project: It is known that the dimensional stability of reinforced concrete as affected by moisture is dependent upon the amount and disposition of reinforcement, the size of reinforcing bars andtheir bond strength. The dimensional changes in concrete structures must be accurately known in order to make proper allowances for them in the design of structures. The literature on reinforced concrete contains only a meager amount of useful data on this subject and information is needed to establish a precise relationship between the drying shrinkage of small unrestrained concrete specimens and the length changes which may be expected in reinforced concrete members of sections commonly encountered in design.

Plans for Fiscal Year 1958: (1) Review the applicable literature on shrinkage of reinforced concrete members to determine the dimensions of specimens and methods of measuring dimensional changes which yield the most useful information. (2) Fabricate reinforced concrete and companion plain concrete specimens of the same cross sectional area to determine the effect of the following variables: ratio of reinforcement, size of bars, disposition of reinforcement relative to the periphery of the specimen, bonding efficiency of the reinforcement and, if possible, the rate of drying as determined by the ambient relative humidity. (3) Make measurements of the over-all changes in length of concrete and steel as well as of the changes in length in short gage lengths at midlength of the specimens. (4) Reduce those data which will be available at the end of the first year. Large specimens will require longer periods to attain equilibrium.

1001-11-4812 Stresses in Masonry

Objectives: To determine by tests of small-scale models and by approximate theoretical analysis the directions and relative intensities of stresses in masonry and monolithic concrete walls which are restrained from shortening at the foundation level while undergoing drying shrinkage or thermal contraction.

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1001-11-4812 (con.)

Importance of the Project: The widespread cracking of walls of concrete masonry has necessitated large expenditures for repair. Extensive experience with structures and the results of tests conducted in laboratories both indicate that drying shrinkage is responsible for much of the cracking observed. Despite widespread interest in this problem the literature contains little or no information which engineers can use to estimate the minimum spacing of control joints or the least amount, location, and form of reinforcement that would be most effective in minimizing objectionable cracking under various conditions.

Activity Summary: This has been a continuing project which was initiated in 1953. During the past year all scheduled experimental work was brought to completion. Six aluminum wall-steel foundation models representing walls of different length to height ratios and with foundations producing different degrees of restraint were subjected to load tests simulating shrinkage in masonry walls. The data obtained in these tests have been reduced to relative stress values. A numerical solution obtained with the assistance of SEAC was added to two numerical solutions obtained previously, thus completing three of the scheduled four. Experimental and theoretical results show favorable comparison and have been prepared for presentation in the final report to which will be added the results of the fourth theoretical solution pending completion delayed by computer malfunctioning.

0906-12-0910 Physical Properties of Concreting Materials

(See Properties of Materials)

1001-12-1000 Masonry and Reinforced Concrete

Objectives: To secure basic data in the laboratory on the strength, behavior under load, elastic properties and durability of masonry and masonry components, concrete and reinforced concrete.

Importance of the Project: Data on properties of masonry and reinforced concrete are needed as a means of establishing satisfactory specification and code requirements for various service conditions and for effecting economies. There is a need for up-to-date information on properties of masonry constructed with modern portland masonry cements, and collaborative work with Masonry Research Fellowship

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is needed to secure this information. In order to predict durability of brick and stone under various conditions of weathering, there is need for correlating various physical properties determined in the laboratory with results of outdoor exposure tests. In order to improve design practices and conserve steel, it is necessary to study the behavior of reinforced concrete structural members under load with respect to their strength, stiffness, elastic properties, and modes of failure.

Activity Summary: This is a continuing project. Favorable results were obtained in the development of an accelerated test method for measuring the drying shrinkage of concrete masonry units. The shrinkage characteristics of thin laminas cut from either top or bottom of blocks at right angles to the face shell showed good concordance with control specimens, while the time required for the test was reduced by a factor of about 5. The new type of bond specimen previously described proved to be a valuable tool in estimating the widths of cracks at the periphery of reinforcing bars. This width was found to be significantly less than the width of crack measured at the exterior surface of the concrete. A report on this work was prepared for publication. Another report prepared for publication presented a new analytical treatment of the problem of cracking and data showing the effect of compressive strength of concrete on the width and spacing of cracks. The study of bond strengths of masonry assemblages with concrete masonry units and clay brick as component materials was completed by the Masonry Research Fellowship.

Plans for Fiscal Year 1958: (1) Properties of masonry: Continue studies of properties of masonry in collaboration with Masonry Research Fellowship by carrying out full scale tests of masonry walls to determine their resistance to transverse, compressive and racking loads. (2) Durability of brick and stone: Continue periodic observations of stone exposure test wall and other long-term exposure test specimens and study different laboratory procedures which may be useful for predicting durability of marbles. (3) Continue the evaluation of the accelerated shrinkage test method with respect to concrete masonry units cured with low pressure steam. (4) Evaluate the usefulness of the tensile bond test specimen with regard to measurement of the effective modulus of elasticity of bars embedded in concrete and flexural rigidity of reinforced concrete.

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1001-12-4811 Precast Concrete Structures

Objectives: To evaluate and develop prototype design of thin-shell precast and prestressed concrete elements and structures.

Importance of the Project: Precast thin-shell ribbed panels and hollow-section framing members are a relatively new type of construction, particularly those containing prestressed reinforcement. Buildings making use of structural members of this type are being planned at present by the Bureau of Yards and Docks and technical data are urgently needed on such design aspects as the cross-section of the members, orientation and amount of reinforcement, elastic stability, adequacy of water-tightness and resistance to fire.

Activity Summary: This is a continuing project which was initiated in Fiscal Year 1953. During the past fiscal year extensive work was done in the study of properties of slabs formed by arranging cellular units in a checkerboard fashion and prestressing them in two directions. Slabs consisting of concrete cells and of cement-asbestos were included in the study. A 16- by 30-ft building of precast thin-shell concrete panels was used to study the adequacy of watertightness of various calking materials that were installed in the joints between roof and wall panels. An investigation was made to determine the effect of transverse reinforcement on lap-welded splices in precast thin-shell box girders as it pertains to the rotation of the joint due to eccentricities and the cracking of the concrete due to this rotation. Pilot tests of pretensioned prestressed beams representative of the longitudinal ribs used in thin-shell construction were planned and designed to determine the effect of plain and deformed prestressing tendons on the load-deflection relationship and the formation of cracks under load. Observations of several thin-shell precast roof panels were continued to determine their behavior under sustained load.

Plans for Fiscal Year 1958: (1) Further evaluation of prestressed cellular assemblies: Prestressed slabs consisting of mesh reinforced cellular units will be studied with regard to their stiffness, flexural strength and resistance to shear. (2) Water-tightness of joints between precast elements: This investigation will be expanded by completely enclosing the 16- by 30-ft panel frame test structure and testing additional calking

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materials along with evaluation tests of protective coatings for concrete roofs and walls. (3) Further evaluation of the effect of transverse reinforcement lap-welded splices: Additional tests of precast thin-shell box girders and other assemblies containing lap-welded splices will be made to determine the type, placement, and optimum amount of transverse reinforcement necessary to minimize the rotation of the splices and the cracking caused by it. (4) Behavior of thin-shell elements under sustained loads: Observation will be continued on several thin-shell precast roof panels to determine their behavior under sustained load.

1001-12-4814 Design Stresses in Reinforcement

Objectives: To provide basic data needed for determining proper design tensile stresses in concrete reinforcement of different physical properties.

Importance of the Project: For the national welfare, it is obviously desirable that allowable design stresses be as liberal as is compatible with reasonable safety and satisfactory performance of reinforced concrete structures. Test data indicate that the resisting bending moments of beams failing by yielding of reinforcement are a linear function of the yield strength of the reinforcement. If failures by yielding of the reinforcement were the only manner of failure possible, immediate increases in allowable design tensile stresses would be warranted for some types of reinforcement. Unfortunately, there are other possible causes of failure and of unsatisfactory performance and their probability often is not predictable. Test data are needed to enable designing engineers to predict loads causing diagonal tension failures, deflections, widths of cracks, and bond strengths when the reinforcement is subjected to unusually high tensile stresses.

Activity Summary: The experimental work dealing with the effect of stresses in longitudinal reinforcing steel on the resistance of beams to shear was completed. By means of suitable instrumentation, it became possible to estimate the amount of shear transferred by the longitudinal reinforcement across diagonal tension cracks and to determine the radically different elastic curves generated by the compression and tension faces of the beam within the shear span. It is hoped that these data will be helpful in determining the mechanism of failure of beams in diagonal tension.

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A report on the previously completed series of flexural tests is being prepared for publication.

Plans for Fiscal Year 1958: The new experimental work in this project will deal with bond characteristics of modern deformed bars having a yield strength of 100,000 psi. The purpose of this study is to develop data which would establish the relationship between bond values and ratios of length of embedment to bar diameter, for two different sizes of bars. Before proceeding with beam tests, preliminary tests of pull-outs will be made to determine the range of lengths of embedment.

A report on the results of diagonal tension tests will be prepared for publication.

1001-12-4815 Insulating Concretes

Objectives: To secure basic data on properties of insulating concretes needed to evaluate the usefulness of different varieties of insulation concrete and for preparation of an improved general specification.

Importance of the Project: In recent years lightweight aggregate and cellular concretes have been used in thermal insulation "fill" for roofs, cavity walls and underground steam lines. Current specifications for the quality of these materials are not satisfactory since they do not always insure that the finished product has the desired properties. There is an immediate need for an improved specification based on a study of properties of insulating concretes which would incorporate means for controlling the product on the construction site and secure a material of desired properties.

Activity Summary: Compressive strengths of several perlite and vermiculite concretes were determined as functions of mix proportions, wet and dry densities, size and shape of specimens, and type of curing. Several test procedures were evaluated in an attempt to formulate a method of determining the bulk specific gravity of perlite and vermiculite.

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Plans for Fiscal Year 1958: Continue the experimental work with perlite, vermiculite and cellular concretes to determine such properties as indentation and compressive strengths, drying shrinkage and rate of drying as functions of composition, proportions and density of the mixes. Evaluate the properties of small reinforced slabs made with insulating concretes to determine the feasibility of combining insulation with structural function.

0903-20-4428 Properties of Concrete at Elevated Temperatures

Objectives: Study the mechanism responsible for spalling and failure of concrete when exposed to intense thermal shock.

Importance of the Project: Concrete aprons used by jet aircraft were often observed to deteriorate rapidly, even explosively, as a result of the extreme thermal shock occurring both during the warm-up and take-off periods. While it was generally assumed that the water content of the concrete was an important factor in deterioration of concretes subjected to severe thermal shock, it was not known whether both bound and unbound water were involved or what effect such factors as mode of preparation, type of aggregate, porosity, etc., would have on the amount of water retained. Such information needs to be obtained in order to design new concrete formulae with improved thermal stability.

Activity Summary: Data were obtained which indicate that the primary cause of spalling of concretes when subjected to rapid thermal shock is related to the total amount of unbound water present in the concrete. Additional data were obtained on the rate and amount of water that is absorbed by concretes as a function of the mode of preparation, type of aggregate employed and porosity of the hardened mass. Wide variations in both the rate and amount of water absorbed and returned were observed depending on the type of aggregate used. The available pore space or degree of consolidation in the aggregate is the dominant factor in the selection of a proper aggregate. Measurements completed on the water vapor pressure developed in neat cement when heated rapidly, giving results approximating those of the Steam Tables.

Plans for Fiscal Year 1958: The immediate goal is to fix the dried conditions or water content limit for failure under test. The role of the aggregate as to water holding

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capacity, etc., will continue to be studied. A study of the mechanism by which water vapor travels through the concrete will continue.

0906-20-4473 Chemical and Physical Properties of Dolomitic Limes

(See Properties of Materials)

0906-30-4415 Cement Reference Laboratory

(See Testing Materials and Products)

0906-30-4433 Acceptance Testing, Cement

(See Testing Materials and Products)

0906-30-4444 Miscellaneous Testing

(See Testing Materials and Products)

CODES AND SAFETY STANDARDS

0501-30-0501 Preparation of Specifications and Standards for Paints, Varnishes, Lacquers, and Component Materials

Objectives: To provide Federal Specifications for organic coating materials and for the products used in their formulation. Also, to participate in the development of standards for similar materials by ASTM and ISO.

Importance of the Project: The competitive bidding system under which most Government paint purchases are made depends for its success on the availability of documents that provide accurate and adequate descriptions of the products purchased. Specifications furnish such a basis for mutual understanding between the industrial supplier and the Government buyer. Government procurement agencies, notably the General Services Administration, have long depended on the Bureau to assist them in the technical aspects of specification writing. Participation in the standardizing activities of technical societies provides an opportunity to keep abreast of developments in this area and to utilize them to best advantage in the Federal program.

Activity Summary: The Bureau has been responsible for the development of paint procurement specifications for many years. During Fiscal 1957 the principal activity with respect to Federal Specifications was in reviewing and submitting comments on new, revised, and amended specifications for coating materials. Assistance was given in drafting a revised edition of the Commercial Standard for prefinished wall panels and cooperation was continued in the international standardization program for lac resins through ASTM and ISO.

Plans for Fiscal Year 1958: 1) Complete revision of standard for prefinished wall panels and review of Federal Specifications for organic coatings and ingredient materials as required. 2) Cooperate with ASTM and ISO in preparation of standards for organic coating raw materials.

CODES AND SAFETY STANDARDS (con.)

0700-30-0719 Preparation of Specifications for Organic and Fibrous Materials

Objectives: To provide specifications for organic and fibrous materials.

Importance of the Project: It is an established practice in Federal and State Governments and in industry to purchase supplies that conform to minimum standards as set forth in purchase specifications. One of the functions of the National Bureau of Standards is to cooperate with Government and nongovernmental agencies and technical organizations in the preparation of specifications, test methods, and standards for organic and fibrous materials for use in purchasing these materials. The activity is conducted through leadership and membership on committees and acceptance of responsibility for the preparation of detail specifications and test method standards. The NBS has accepted responsibility for Federal Test Method Standards for rubber, textiles, paper, leather, plastics, insulated wire and cable, adhesives, and floor coverings.

0201-30-0208 Specifications for Lamps and Color

(See MISCELLANEOUS)

0400-40-0497 Recommendations for Radiation Protection

(See MISCELLANEOUS)

1005-40-1022 Construction Codes and Safety Standards

Objectives: To assist in the preparation of safety and construction standards either by serving as a sponsor or by furnishing technical service to committees under the sponsorship of other technical or scientific organizations.

Importance of the Project: Uniformity of safety and construction standards is of the utmost importance to industry and to the public. If every city and state were to prepare different requirements, mass production of such items as elevators, crane hoists and derricks, would not be possible.

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Each piece of equipment would have to be designed and built to meet local laws and ordinances. The common use of standards and data by all organizations in the field has the effect of gradually reducing unnecessary differences in technical safety requirements and of producing uniformity where that is practicable and desirable. NBS cooperates in efforts to bring about greater uniformity on a voluntary basis, recognizing that there are some local conditions that justify differences in safety requirements. It is realized that in many cases it is of equal importance to strike a balance between safety and health and the cost of construction. New materials, constructions, and methods should be considered and permitted by codes as soon as their worth has been demonstrated by test and trial use.

Activity Summary: During the current year, active work has been carried on in connection with:

1. Cooperation in development of model building codes.

2. A survey was made of existing municipal building codes.

3. Assisted in the reorganization of ASTM E-6 (Methods of Testing Building Constructions).

4. Preparation of a draft of ASA Standard A41 (Reinforced Masonry) for letter ballot.

5. A rough draft is being prepared for a new publication "Capacities of Stacks in Sanitary Drainage Systems for Buildings."

6. Previously unpublished data on surging flow in horizontal drains is being assembled and made ready for publication.

7. Revision of Part II of the National Electrical Safety Code has been carried on actively by several subcommittees.

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8. In the Code for Protection against Lightning, the revision of the section on the Protection of Oil Storage Tanks was completed, the letter ballot taken, and results reported to the annual meeting of the National Fire Protection Association (a co-sponsor). This will be printed as an NBS Handbook as soon as the present stock of H46 is exhausted.

9. The Executive Committee prepared a list of editorial changes and a few code amendments which have been approved by the Sectional Committee. Prior to reprinting the Elevator Code, these are soon to be submitted to ASA for approval. Tentative drafts of the Inspectors' Manual have been prepared and much of the new material reviewed by the Manual Subcommittee.

10. An editorial revision of the Head and Eye Code was made.

11. A tentative draft of a revised Safety Code for Electric Fences was prepared for circulation and comment.

12. The Section has actively participated in the work of other ASA Sectional Committees. These include B11 Safety Code for Punch Presses, Recommended Practices for Electrical Installations of Textile Machinery, Safety Code for Parking Garages A113, and Specifications for Steel Conduit and Electrical Metallic Tubing.

Plans for Fiscal Year 1958: Carrying on the revision of the National Electrical Safety Code and possible preparation of a revised discussion of Part II (overhead and underground transmission lines). Completion of the Elevator Inspectors' Manual, including necessary line drawings and photographs. Further work on the Code for Electric Fences, with emphasis on acceptable shock ratings. Review proposed changes in National Electrical Code. Submission of Head and Eye Code to ASA for approval and preparation of copy for printing. Development of further formulas for wind pressure on structures. Consider proposals for change in Code for Portable Metal Ladders based on field use. Endeavor to eliminate existing differences in requirements between Code for Protection against Lightning and the Standard of Underwriters' Laboratories, Inc. Complete paper on Capacity of Soil Stack; publish data on surging flow in horizontal drains; work with the Building Research Advisory Board Review Committee on

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program for plumbing research and a plumbing manual for Federal Agencies; study earthquake loading used in building design; and make a detailed study in cooperation with 10.02 of fire protection requirements of model building codes.

FIRE PROTECTION AND EXTINGUISHMENT

0706-11-3872 Thermal Decomposition of Cellulose

Objectives: To gain an understanding of the mechanism of thermal decomposition and flame retardation of cellulose so that improved flame-resistant cellulose textiles can be produced.

Importance of the Project: The QRDC requested the NBS to conduct research on the flame proofing of fibers and fabrics. In practice, various inorganic additives are used as flame retardants. However, the mechanism of their action has not been fully established. It is assumed that they catalyze the thermal decomposition reaction producing water and carbon dioxide at the expense of the reaction producing flammable tars. It appears evident, therefore, that the study of the mechanism and kinetics of the thermal decomposition of cellulose, treated and untreated, is necessary for a thorough understanding of flame retardant action.

Activity Summary: This project was started in December, 1954. Samples of cellulose triacetate, Fortisan, NO_2-oxidized cellulose, and cellubiose, with or without flame retardants, were pyrolyzed in a high vacuum, and also in nitrogen at atmospheric pressure. Rates of degradation in a vacuum and activation energies were determined for cellulose triacetate and Fortisan. As in the case of cotton cellulose, addition of sodium carbonate to cellulose triacetate resulted in a decrease of yield of tar. Pyrolysis in nitrogen yielded less tar and more H_2O and CO_2. Cellulose triacetate and Fortisan have about the same initial rates of degradation and activation energies as cotton cellulose. Cellobiose degrades similarly to viscose rayon. NO_2-oxidized cellulose yields very little tar and degrades initially very rapidly.

1002-11-4873 Mechanism of Fire Extinguishment

Objectives: To provide basic information on the mechanism of fire extinguishment and the effectiveness of various types of extinguishing agents as applied to fires in different fuels and to study specific ignition, combustion, and explosion, characteristics of propellants and/or mixtures of them with common materials.

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Importance of Project: The current trend in the Defense Department toward greater emphasis on development of large missiles of the self-propelled rocket type has resulted in the introduction of a whole series of new types of fuels together with their associated fire hazard problems. Because of the urgent demand for solutions to these problems, it appears desirable to investigate the nature of initiation and extinguishment of fires involving such fuels with more than trial and error techniques. The investigation proposed here is designed to provide more basic information than is currently available on the mechanisms of extinguishment of fires, special emphasis being given to those involving propellant materials.

Activity Summary: A considerable amount of the work proposed for fiscal year 1957 was accomplished with primary emphasis on dry chemical extinguishment.

1. A review was completed of recent work relating to mechanism of fire extinguishment. This made it obvious that new techniques were required for measuring the effectiveness of various agents.
2. Two laboratory methods were devised to measure the effects of rate of application and powder particle size on extinguishing efficiency. These methods permitted a certain degree of separation of some of the factors considered likely to be important in controlling the effectiveness of agents when applied to fires. Means were also devised to measure the dispersibility characteristics of powders. These measurement methods are all new and provide substantial means for studying extinguishing agents.
3. The proposed work on water sprays was deferred at the request of the sponsor to permit measurements of the ignition behavior of two solid propellants.

Plans for Fiscal Year 1958: General emphasis will be placed on the development and use of methods for application of agents to larger fires in which a closer approach to full scale will be made. Specific tasks may be outlined as follows: (1) Continue development of new uniform rate powder applicator and use this to study effect of powder particle size, rate of application, etc., on extinguishment of flammable liquid fires on about 5 in. diameter pans, (2) Continue work with explosion tube apparatus for study of chemical decomposition products of powders, (3) Additional studies will be made as requested by the sponsor on the initiation of combustion in propellants and other materials.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-12-1029 Fire Hazard Studies

Objectives: To investigate methods of preventing and reducing losses resulting from accidental fires.

Importance of Project: There is a constant need for up-to-date information on the fire resistive properties of new building materials and of fabricated assemblies, particularly those designed to reduce weight and cost as far as possible. A better knowledge of the basic mechanism of ignition of materials as a result of self-heating phenomena, and the study of combustible characteristics of materials is essential for effective detection and control of fires. There is little incentive for industry to carry on these researches. Most of the results of the work bear particularly on the development of safe practices and both industry and other Government agencies look to the NBS for leadership in this field.

Activity Summary: This is a continuing project. Many of the proposed tasks for last fiscal year have been completed. The proposed paper on fire resistance study of cellular concretes though not finished, is in process. The fire resistance studies on plaster incorporating perlite aggregates has been completed and is being prepared as a publication. The new method of measuring ignition behavior of materials has been used successfully to study a large variety of materials and a paper is in preparation on this work. The proposed work on development of a new combustibility test method was postponed to permit the development of a high speed direct dynamic electric analogy method of solving transient heat flow problems. This device was designed, constructed, and tested within a nine month period and promises much for the estimating of relative fire endurance behavior of specimens. It is in continual use. The radiant panel method for evaluating the flame spread behavior of materials has been used to study a group of plastic types, in connection with ASTM work, and a group of wall finish materials furnished by the Australians as representing materials on which full scale tests have been performed. Work continues on studies of fire retardant treated fabrics.

Plans for Fiscal Year 1958: 1) Fire resistance: The small scale heat flow studies of plaster will be enlarged to include some vermiculite and sanded type aggregates. The recently developed electronic analog will be used in an effort to achieve a better understanding of the important variables in constructing fire resistance test specimens and procedures used in performing tests. 2) Combustibility test method: It is expected that the development of the proposed new test method may be initiated

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during the coming year. The method involved is the use of an adiabatic furnace calorimeter with provision for burning the combustible content of the material under test at variable temperature. 3) Fabric flammability: It is expected that the study of fire retardant treated fabrics will be completed during the fiscal year.

1002-12-4872 Fire Resistance of Reinforced Concrete

Objectives: To provide basic information on the factors affecting the fire endurance of reinforced concrete constructions.

Importance of Project: Although reinforced concrete has long been used as a building construction material, its behavior when exposed to fire is only very imperfectly understood. This fact is emphasized by the results of recent tests performed for the Department of Defense in which early failure was observed. Because of the very large amount of reinforced concrete work erected each year by the Government, it seemed likely that a better understanding of the necessary fire resistance construction requirements might result in some savings in construction cost or at least improve the overall functional quality of the construction.

Activity Summary: The objectives outlined for completion during the fiscal year have only partially been achieved because of the rather modest financial support afforded the project during the fiscal year. Fire resistance tests were completed on four large T beams. Additional small slab specimens were fabricated and are now in condition for test. An analysis has been initiated for the purpose of comparing computed fire endurance with that observed during experimental studies.

Plans for Fiscal Year 1958: Fire resistance tests will be performed on the small concrete slabs now available. Additional large beam specimens will be prepared to investigate new methods which have been suggested for securing the concrete cover over the reinforcing steel. Analysis will be continued of fire resistance data now available for the purpose of determining the possibility of correlation with recent data and that predicted by theory.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1005-12-1005 Lightning Hazards of Ungrounded Metallic Roofing, Siding, and Thermal Insulation

Objective: To determine the possibility of ignition of combustible structural members, thermal insulation, or building contents by lightning striking ungrounded metal-roofed or metal-sided buildings, and to investigate the lightning hazard of metallic foil or foil-covered organic insulation.

Importance of the Project: During the past decade, there has been a relatively large increase in the number of metal-roofed and metal-sided buildings constructed. This has been partly due to an increased consciousness of fire hazards on the part of the public (such roofing and siding protect against fire spread due to flying embers). Another factor has been the more favorable relative price of metal as compared with wood products. Inquiries received at NBS indicate that metal roofing is being sold with the statement that it will protect against lightning and that such roofing does not need to be grounded.

There has also been an increase in the use of thermal insulation. Much of this material is combustible.

Where panels of metal foil or metalized insulation are used beneath an ungrounded metallic roof, there is always a fair probability that such material may form a part of the path to ground. There is, consequently, a possibility of ignition by an electric discharge or by drops of molten metal from the fused foil; or dust on a highly heated foil surface may become ignited.

The following data are needed: 1) The temperature at which molten metal will ignite specific organic insulating materials; 2) The spread of fire in a vertical unit of typical construction; 3) Ignitability of various insulating materials by an electrical discharge; 4) The metallic cross section necessary to carry a current capable of starting fire; and 5) The effect of current discharge through the frame structure or ungrounded metallic roof and sidings.

Activity Summary: A frame structure with a cross sectional width of 12 feet and a stud height of 8 feet, provided with a sloping roof having a rise of one foot in three, has been built. Corregated galvanized iron roofing was first tried. Discharges of 12,500 amp at 2 million volts "went to earth" through the wood framework. Corner posts and certain studs

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in the path were split. Tests were made by building a grounded steel-armored electrical cable to the center of the overhead space, thus bringing grounded metal within 2 feet of the roof. On test, this gave a heavy current flow along the sway bracing.

With one-mil (0.001 in.) aluminum foil placed between the studs, the top in contact with the metal roof and the bottom about 1/2 inch from a grounded metallic cable (BX), combustible material such as cotton, excelsior, etc. could be itnited repeatedly. Fires could also be started with Kraft paper covered with 1/2 mil (0.0005 in.) aluminum foil. Apparently, a cross sectional area of 16 in. by 1/2 mil will carry sufficient current to start fires.

A small graphite crucible with a long steel handle has been made with which it is hoped to test the effect of small amounts of molten iron, and perhaps aluminum, on various thermal insulating materials. An organic insulating material labelled as "fire retardant" sustained a flame for at least one minute before being extinguished with a dry CO_2 extinguisher.

Attempts to produce molten metal by a discharge of 25,000 amp at one million volts failed because with the equipment being used for the test the necessary "follow-up" current is not available.

Plans for Fiscal Year 1958:

Task 1. Investigate the conditions under which commonly used thermal insulations of organic materials (cotton, wood fiber, etc.) and light wooden members may be ignited by an electrical discharge.

Task 2. Test the ignitability of combustible thermal insulation with a foil covering and located in a wall space between an ungrounded metal roof and the ground or the possibility of ignition of building refuse (shavings, sawdust, etc.) in such a location by an electric discharge between the roof and ground.

Task 3. Investigate the effect of an incipient blaze in a wall of conventional construction.

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Task 4. Determine experimentally the temperatures at which molten metals will ignite flammable insulating materials. Various small amounts of molten iron and possibly aluminum will be used. This will be the amount that would be melted by the energy in lightning strokes of various current ratings.

Task 5. Investigate the possibility of grounding metallic foil or metallic-coated insulations by means of metallic foils or strips which are, in turn, grounded.

Task 6. Prepare for publication the results obtained under Tasks 1 to 5, inclusive. The published material should be in such form that it will be of maximum usefulness in preparation of building codes and of codes for protection against lightning.

1002-20-4875 Fireproofing Structural Steel

Objectives: To investigate practical methods of protecting structural steel members against early failure when exposed to fire.

Importance of Project: In certain types of buildings such as aircraft hangers, it is common practice to leave the structural steel work unprotected. In cases where sprinkler protection is not furnished and fire hazard is high, this practice can lead to great losses. There is on the market today a variety of materials which can be applied by spray techniques and are claimed to be useful for protection against fire. Little performance data are available to indicate their effectiveness.

Activity Summary: This project has been active only about five months. As a result it was not possible to fully complete the objectives proposed for '57. Some preliminary small fire resistance studies have however been performed on one type of coating material. This has permitted selection of a desirable support system for application of the coatings. Nine manufacturers, of the eleven contacted, have been requested to furnish specimens of their coating materials.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-20-4875 (con.)

Plans for Fiscal Year 1958: The nine different coatings now being procured will on receipt be evaluated on the basis of the following studies:

(1) Fire resistance behavior of material as applied in three thicknesses to both painted and unpainted metal.

(2) Mechanical bond to metal.

(3) Limited studies of moisture equilibrium content.

(4) Chemical studies for corrosive acids.

(5) Thermal conductivity measurements.

(6) Short term corrosive behavior of metal backing.

1002-30-4829 Marine Material 1956

Objectives: To obtain data on the constructional features and evaluate operating behavior of equipment and materials requiring Coast Guard approval for marine use (confined to work authorized in Fiscal Year 1956).

Importance of the Project: The Sponsor is charged with the maintenance of safety aboard United States vessels. Because of this responsibility it is necessary to perform examinations and tests on new devices and materials as well as studies on parts which have shown poor behavior in service. Because of the diversity of types of examination and testing procedures required, it has been considered necessary to have the work performed at the NBS.

Activity Summary: The work authorized under this project has with one exception been completed. Uncertainty of early completion of the remaining work together with the costs of maintaining the project active with the very small amount of unexpended funds have made it desirable to close this project out.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-30-4874 Marine Material 1957

Objectives: To obtain data on the constructional features and evaluate operating behavior of equipment and materials requiring Coast Guard approval for marine use (confined to work authorized in Fiscal Year 1957).

Importance of Project: The sponsor is charged with the maintenance of safety aboard United States vessels. Because of this responsibility it is necessary to perform examinations and tests on new devices and materials as well as studies on parts which have shown poor behavior in service. Due to the diversity of types of examination and testing procedures required, it has been considered necessary to have the work performed at the NBS.

Activity Summary:

A total of 32 technical investigations were completed. These involved metallurgical, chemical, and thermal properties of marine materials. Twelve other investigations were authorized but were not completed.

Plans for Fiscal Year 1958: The 12 unfinished investigations will be completed. These include studies on fire resistance of bulkhead panels and deck coverings, performance of dry cells and first aid fire extinguishing devices. A new project will cover work authorized by the sponsor in 1958.

1002-30-4876 Marine Material 1958

Objectives: To obtain data on the constructional features and evaluate operating behavior of equipment and materials requiring Coast Guard approval for marine use (confined to work authorized in Fiscal Year 1958).

Importance of Project: The sponsor is charged with the maintenance of safety aboard United States vessels. Because of this responsibility it is necessary to perform examinations and tests on new devices and materials as well as studies on parts which have shown poor behavior in service. Because of the diversity of types of examination and testing procedures required, it has been considered necessary to have the work performed at the NBS.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-30-4876 (con.)

Activity Summary: Not applicable.

Plans for Fiscal Year 1958: Examinations, performance tests, and development of new test procedures will be performed as requested by the sponsor.

HEAT TRANSFER

1006-11-1015 Heat Transfer Measurements

Objectives: To obtain basic information on the thermal conductivity and heat transfer properties of materials and building constructions and to make calibration measurements on specimens for reference use by other laboratories; to develop and improve apparatus for accurate and expeditious measurements of these properties, and new methods for specialized purposes; to conduct fundamental mathematical and experimental studies of the thermal characteristics of materials and their applications in building constructions.

Importance of the Project: The thermal conductivity and heat transfer measurements made in this laboratory on insulating and building materials are relied on for purposes of design, specifications, and procurement by governmental agencies. They are considered by governmental agencies, private industry, and technical societies as a paramount source of dependable data for guidance in this field. Other laboratories utilize NBS calibrated reference specimens for standardizing their equipment. The services on measurements and calibrations of the thermal conductivity of metals at high temperatures appear not to be furnished by any other laboratory in the country; they have been in continuous use for the past two years by defense agencies and a few industrial laboratories.

Activity Summary: This is a continuing project. In Fiscal Year 1957, measurements were made of the thermal conductivity of a number of rock specimens from core drill samples, and of some special-purpose plastics, using the new stainless steel bar comparison apparatus. Development of a ceramic-core radial flow apparatus was continued, and measurements were made with it of the thermal conductivity at elevated temperatures of a variety of granular insulations. Due to voluntary separation of the operator of the high temperature metals apparatus, a backlog of metal specimens accumulated. During the training period of a new operator, improvements were made to the apparatus, and a new procedure of calculating results was developed, which have considerably improved the accuracy of results and increased the productiveness of the individual tests. Measurements on metal specimens are currently being made at a very satisfactory rate.

1006-11-1015 (con.)

Plans for Fiscal Year 1958. Emphasis will be placed on completion of laboratory work, and preparation of papers for publication, on the apparatuses for measuring the thermal conductivity of (a) metals at temperatures up to 700°C, (b) granular materials and preformed pipe insulations at temperatures up to 1500°F, and (c) rocks and solids at room temperatures.

A mathematical analysis of the effect of the distribution of thermal mass and insulating material in wall constructions on the indoor temperature stability of buildings exposed to the sun has been initiated. Quite complex mathematics are involved, but solutions capable of numerical evaluation are obtainable for relatively simple boundary conditions, from which the potential value of an experimental investigation of the effect with more varied but practical internal conditions can be judged. The study will be carried forward mathematically and by use of an available electronic analog equipment, possibly including some simple experimental trials of prototype walls.

1006-11-4886 Effect of Nickel on the Thermal Conductivity of Steels

Objectives: To obtain quantitative data on the effects of nickel addition to nickel alloy steels on the thermal conductivity of the alloy at temperatures ranging from -300°F to temperatures approaching 1000°F.

Importance of the Project: The effects of nickel addition on the physical constants of nickel alloy steels are not at present precisely known quantitatively. The sponsor of the project has made arrangements to obtain much of the needed information by investigations at other laboratories but has been unable to find an outside laboratory equipped for thermal conductivity determinations. The accumulated data of the effect of nickel on alloy steels is intended for publication in the proposed revised Data Book "Nickel Alloy Steels" which will make the information available generally to metallurgists and other technically interested people.

1006-11-4886 (con.)

Activity Summary: Because of pressure of other work and lack of personnel, activity during Fiscal Year 1957 was limited to development of a suitable test method. A trial specimen of AISI 1030 steel was prepared, and successful runs were made with it at the temperatures of boiling water, and melting ice.

Plans for Fiscal Year 1958: Conduct and complete measurements of the thermal conductivity of the six specimens of nickel alloy steel furnished by the sponsor. Prepare a paper on the results for publication.

1006-12-4887 Moisture in Roof Insulation

Objectives: To provide data for estimating or calculating the thermal insulating effect of various types of insulated roof deck constructions under similar service conditions; to investigate and determine the effectiveness of various methods of expelling, under service circumstances, moisture that may be present in insulations as a result of initial moisture, or later accumulation.

Importance of the Project: Concrete roof decks are commonly insulated by thermal insulations of various kinds laid on the deck and covered by built-up roofing. The latter is practically impermeable to water or water vapor, and moisture retained in the insulation causes serious loss of insulating value of the roof. Discrepancies between actual heat loads and those calculated using thermal conductivities based on laboratory measurements are of practical importance in regard to the performance of both heating and air conditioning systems. To evaluate these discrepancies, quantitative information is needed concerning the effect of initially-present or accumulated moisture on the insulating performance of various types of roof-deck insulations.

Some roof deck insulations contain substantial amounts of moisture when they are placed, and often cannot be thoroughly dried before roofing is applied. Various means of allowing such insulations to dry in service, such as vents to outdoor air, moderately vapor-permeable bases, or combinations, appear possible, and warrant investigation as a guide to construction requirements and applications.

1006-12-4887 (con.)

Activity Summary: During Fiscal Year 1957, observations of the effect of moisture on the insulating value of several different roof deck insulations were concluded. Data were obtained for the specimens when initially dry, and for three successive increments in moisture content, measurements being made at each moisture content under simulated summer and winter conditions. After preparation of new specimens, work was initiated on the preliminary phases of an investigation of the moisture-expelling effect of vents through the roofing, and of a moderately vapor-permeable substructure. A draft of a report on work concluded is in progress.

Plans for Fiscal Year 1958: Continuation and completion of the third experimental phase of the project, studying the moisture-expelling effects of air vents through the roofing, and of moderately vapor-permeable under-decks, as determined by exposure of a variety of different insulated roof deck specimens to simulated seasonal and diurnal temperature changes. Preparation of a report to the sponsor on the results of the first two phases of the project, covering the experimental findings as to the effect on the insulating value of various roof deck constructions of (a) exposure temperature variations with and without moisture present and (b) different degrees of moisture content in various insulations under similar exposure temperature conditions. A final summary report will be drafted after completion of the third phase of the project.

PLUMBING AND FLUID MECHANICS

0603-11-0618 Fluid Mechanics Research

Objectives: To provide basic information on the mechanics of flow of water and air.

Importance of Project: In nearly every phase of technology problems arise in connection with the flow of fluids or movement of bodies through them. Solutions to these problems mean better performance of equipment, new means of accomplishing some objective, or more reliable means of calculating performance. The problems arise mainly through ignorance of the basic mechanisms involving the effect of fluid friction on the flow near solid surfaces or surfaces separating one fluid from another. These problems touch on many diversified fields, and their solution may have immediate or long-range benefits. A general project which provides means for basic research with continuity of effort, and means for conducting investigations on methods of measurement, development of techniques, and permitting exploratory work on new problems and methods, is important for providing the flexibility necessary for original research. Also provided is the important activity of making available information resulting from literature surveys, or resulting from investigations conducted in the laboratory. The latter may include reporting discontinued working-fund projects.

Activity Summary: A number of tasks were performed under this project during the year. One investigation which continued throughout the year was the investigation of interfacial phenomena associated with a denser layer of salt water flowing under a pool of fresh water. Mixing, frictional effects, and formation of waves at the interface were studied. Other tasks carried on for parts of the year were: 1) Study of fluid friction on surfaces composed of hydrophobic material. Methods of embossing teflon surfaces with air-retaining pits, closely spaced, were studied on small samples. Experiments on smooth plates oscillating vertically through a water surface were performed. 2) Preparatory work on apparatus for using bi-refringent fluids and polarized light for studying intermittent turbulent flow in long, transparent tube. 3) Investigation of resistance to flow in grooved pipe. The grooving was designed to lower resistance. The opposite effect was obtained. The reason for the failure was not determined, but roughness of grooves was suspected, and tests were suspended. 4) Preparation of final report on terminated project 3562 entitled, "Mechanism of Turbulence." 5) Writing a Section B of Vol. 5 of Princeton Series, "High Speed Aerodynamics and Jet Propulsion." Section B entitled, "Turbulent Flow," by G. B. Schubauer and C. M. Tchen.

0603-11-0618 (con.)

Plans for Fiscal Year 1958: The investigation of interfacial phenomena between a flowing layer of salt water and a pool of fresh water will be continued.

A small amount of work on items 4 and 5 will carry over into 1958. It is expected that more work will be done on Item 1, but the amount is indefinite. Item 2 will be carried on most vigorously during the summer, but it is expected to remain active throughout the year.

0603-12-3586 Hydraulics of Short Pipes

Objectives: To develop culvert inlet designs of greater hydraulic efficiency than those currently used and to determine the hydraulic characteristics of the more common types of non-rectangular culverts now being used.

Importance of the Project: The sponsor of the project estimates that approximately 12% of the costs of multi-lane highway construction, amounting to several hundred million dollars per year, is required for culvert installations. These high costs of modern culverts exert substantial economic pressure upon the sponsoring agency to develop culvert design methods of increased hydraulic precision, both with regard to the design runoff and to the ability of the culvert to economically discharge the design runoff. The research program of the sponsoring agency in regard to the hydraulics of culverts is therefore aimed at the dual problem of 1) developing means, by consideration of hydrological and meteorological data, to increase the precision of estimating the peak runoff of drainage areas and 2) developing methods of increasing the ability of economically sized culverts to discharge these peak runoffs, particularly on supercritical slopes. The present project constitutes the sponsoring agency's research activities relating to the hydraulic characteristics of culverts of non-rectangular cross section.

Activity Summary: During the past fiscal year the second and third progress reports of the investigation were issued to the sponsoring agency. The second progress report summarized an experimental study of pressure conditions near the outlet of a model culvert together with an analysis of the variation of the resistance coefficient in the entrance length and barrel of the culvert. In the third progress

0603-12-3586 (con.)

report the effect of approach channel conditions on the capacity of various types of pipe culverts was reported.

The development of improved types of culvert inlets was initiated during the past fiscal year. Experimental results from this phase of the investigation have shown that approach channel conditions substantially affect culvert performance. Hence design standards developed experimentally for a particular type of inlet cannot be expected to apply with equal accuracy to all the possible approach channel conditions that may be encountered in the field. For this reason the experimentation has been directed towards the establishment, for certain improved types of inlets, of design standards based upon experimental data secured under a variety of unfavorable approach flow conditions. Experimental results presently available indicate that design standards of this type may be developed experimentally which will apply to wide variations of inlet geometry within certain broad classes of inlets.

Plans for Fiscal Year 1958: The principal activity of the project will be to develop inlet structures of increased capacity under unfavorable approach flow conditions.

1005-12-1004 Capacities of Horizontal Drains in Plumbing Systems

Objectives: To determine the flow capacities of nominally horizontal drains under conditions of surging flow, such as actually occur in plumbing drains in service, and to prepare a report on the results that will be useful to design engineers and code writers.

Importance of the Project: Data on which current loading tables for building drains, building sewers, and horizontal branches are based are too limited in scope to warrant the use that has been made of them. Additional laboratory data should be obtained to supplement those obtained in 1939 by the NBS. A detailed knowledge of the manner in which various factors affect the flow capacities of drainage system components is essential to a reasonable balance between economics and ability to perform safely, as would be reflected by the drain-loading tables in an ideal plumbing code. Such detailed knowledge is lacking today and, because of the absence of any published material on the subject, few persons

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now engaged in design or code-writing activities understand the basis on which the current drain-loading tables were developed.

Activity Summary: The work to date has included the completion of the following tasks:

1) Procurement of transparent methyl methacrylate plastic tubing of diameters 2 and 4 inches, procurement of necessary tools, metal pipe, valves, tanks, and miscellaneous supplies.

2) Finding and assigning a laboratory mechanic to full-time duty on the mechanical phases of the project, and an electronics engineer to part-time service on a work-order arrangement.

3) Construction and assembly of the initial test system, including a test drain approximately 100 feet long, a supporting structure for the test drain, a stack-flow simulator for introducing water into the drain, a metering and distributing system to deliver water to the simulator, a system of electro-chemical remote control of the flow introduced into the drain, a system of tanks for measuring or returning the flow to the source basin, and a system for measuring and recording the depth of water in the drain for any desired time. The existing high-level constant-head tank and pump in the Hydraulics Building is being used for this project.

4) Calibration of the flow-metering equipment and the depth-measuring equipment.

5) A progress report has been prepared for the information of the Division Office, giving in some detail the progress of the project during Fiscal Year 1957.

Plans for Fiscal Year 1958:

1) Complete studies on flow in 4-inch drain, to include data on effect of following factors on capacity: (a) Surge duration; (b) Relative rates of uniform and superimposed surging flow occurring simulataneously in drain; (c) Entrance velocity of surging flow; (d) Drain slope; (e) Solids in discharge; and (f) Drain roughness.

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2) Conduct studies on flow in 6-inch drain, following generally the procedure under 1) above. In addition, data will be obtained for effect on drain capacity of ratio of stack to drain diameter and of drain diameter at point where uniform and surging flows are joined.

3) It is expected that laboratory results will be reported quarterly in the form of progress reports, and that an annual report of similar form will be prepared for information purposes. It is not expected that a formal publication can be completed in Fiscal Year 1958, because of lack of time and personnel, as well as the need for a careful study of the results in comparison with the preliminary data of 1939 on which current loading tables are based.

0603-40-0623 Hydraulic Bulletin

Objectives: To compile and prepare master copy for publication of bulletin listing hydraulic research in progress in the United States and Canada.

Importance of the Project: The bulletin is a standard reference work on current hydraulic research to universities, Government Agencies, and to industry. It serves to keep others informed about research being conducted in other laboratories and thus provides a guide for the planning of research programs and for the avoidance of needless duplication. It was initiated in 1933 and has been issued each year since, except for the years 1943-1946.

PROPERTIES OF MATERIALS

0604-11-0636 Dynamic Properties of Materials

Objectives: To provide basic information on the mechanical properties of materials when subjected to high rates of loading, develop methods of testing, evaluate current theories as related to dynamic properties and develop a more exact theory of strain energy propagation in materials.

Importance of the Project: Investigations of the behavior of structures when subjected to rapidly applied loads have increased the need for more exact knowledge of the dynamic properties of structural materials. Studies of the fundamental mechanisms of propagation of the elastic and anelastic components of strain energy will provide information for deriving the elastic constants and stress-strain characteristics of materials. Accurate information of the dynamic properties of structural materials will greatly reduce the uncertainty in current analyses of the response of structures to dynamic loading.

Activity Summary: A pulse method for measuring stress-strain relations under dynamic conditions in long bars was developed to the extent that preliminary tests with elastic pulses were made on aluminum alloy and lucite rods. This method required the use of a velocity pick-up (a coil in a magnetic field) and two strain gage stations. A paper which described the method, its application and limitations was presented at the Ninth International Congress for Applied Mechanics in Brussels, Belgium during September 1956. A method of measuring transient stress waves in long bars through the use of a capacitive pick-up is being studied. It appears that each method has preferred applications. Refinements were made in the three channels of instrumentation required for recording and measuring dynamic strain waves in long bars.

Plans for Fiscal Year 1958: 1) Study ways for improving the pulse method for determining dynamic stress-strain relations for structural materials. 2) Continue the investigation of the capacitive pick-up for recording transient stress waves with particular emphasis on its use in determining dynamic stress-strain relations for metallic materials. 3) Extend the delay time before yielding data for AISI 4140 steel that was reported in NBS Report No. 4254. 4) Study the propagation of strain energy in long bars by recording strain pulses as a function of time at three sections of the bar simultaneously with the three recording channels.

PROPERTIES OF MATERIALS

0702-11-0731 Research on Properties of Textiles

Objectives: To provide basic information on the structure and properties of textiles required for a better understanding of their behavior and for the solution of important problems in industry and the Government.

Importance of the Project: Textile fibers, natural and synthetic, exhibit unique combinations of properties that enable them to be made into products that surpass all others for specific household, clothing, industrial, and engineering uses. The most efficient or effective adaptation of textiles to modern needs continues to be dependent upon more accurate measurements and increased understanding of the basic properties. Currently, information is needed on the action on textiles of atmospheric contaminants that occur in smog, on changes in properties of textiles resulting from exposure to high energy radiation, and on dissipation of energy by textiles when subjected to high speed impact.

Activity Summary: The resistance of cotton to air containing dinitrogen tetroxide, one of the reactive constituents of smog, was found to be the same for cotton of reduced crystallinity as for the cotton from which it was prepared. The results of the study of changes in properties of different kinds of textile fibers resulting from exposure to gamma radiation in a nuclear reactor and to beta radiation from an electron accelerator were assembled in a paper. The properties measured were stress-strain relations, infrared absorption, and viscosity of solutions. Some preliminary measurements were made of the velocity of sonic strains in nylon yarn. The results agreed well with those previously obtained for velocity of strains in impact tests.

Plans for Fiscal Year 1958: Complete a paper on the effects of low concentrations of gaseous dinitrogen tetroxide and of hydrogen chloride on cotton and rayon. Extend the work to other fibers. Complete the evaluation of fibers that have been exposed in argon to beta radiation. Complete the development of special equipment and measure the velocity at which sonic strains are propagated in different kinds of filament yarns. Derive dynamic moduli for comparison with similar moduli obtained in impact tests.

PROPERTIES OF MATERIALS (con.)

0707-11-0733 Research on Properties of Plastics

Objectives: To provide basic information on the physical and chemical properties of plastics; in particular, properties of graft copolymers produced by nuclear radiation, effects of nuclear radiation on the properties of transparent polymers, and Poisson's ratio for various plastics.

Importance of the Project: The multi-billion dollar plastics industry produces new materials and radically different types of older materials each year. Studies of basic mechanisms, such as those involved in the degradation of plastics, in the changes produced by nuclear radiation, and measurement of properties, such as Poisson's ratio, are needed to assist in the best utilization of these materials and to extend the borders of scientific knowledge of plastics and related materials.

Activity Summary: Investigation of the degradation of polyvinyl chloride showed that the primary decomposition product below 300°C is HCl; at 400°C it is HCl and various aliphatic and aromatic hydrocarbons. A kinetic study shows that the dehydrochlorination is a first order reaction up to about 50 percent of the HCl content. The activation energy, about 30 kcal, is temperature dependent; this is attributed to the melting of crystalline areas. The decomposition on exposure to heat and to ultraviolet radiant energy is explained by a free radical mechanism. The work on graft copolymerization by nuclear radiation showed that the water sorption of polymers with high water sorption coefficients is reduced by grafting a less water sensitive polymer on the surface, such as styrene on polyamides.

Plans for Fiscal Year 1958: 1) Study graft copolymers produced by nuclear radiation. 2) Determine the effects of nuclear radiation on transparent polymers. 3) Measure Poisson's ratio of several plastics.

0901-11-0942 Engineering Properties of Ceramics

Objectives: To devise methods and equipment for, and to determine the properties of, ceramics.

PROPERTIES OF MATERIALS (con.)

0901-11-0942 (con.)

Importance of the Project: Progress and advancement in the use and development of any material have been based upon a backlog of information on the chemical and physical properties of that material. This backlog does not exist for systems of ceramics, nor is it available even for the more common ceramic materials over extended temperature ranges. Until such accumulations of information can be obtained, particularly the engineering properties, the utilization of ceramics in high-temperature applications such as rockets, jet aircraft, nuclear-powered units, and others cannot be effectively accomplished. However, before such systematic studies can be launched, both the methods and the equipment must be developed for these physical property determinations.

Activity Summary: An apparatus for the measurement of dynamic elastic properties of ceramics in the range 1000°C to 1700°C was designed and constructed in collaboration with project 0901-11-4416. This apparatus consists of a furnace of special design which permits a rod- or bar-shaped specimen to be heated while it is simultaneously caused to vibrate and the aplitude of its vibration is measured. The specimen is suspended horizontally from two fine wires. One of these wires is connected to a driver and is used to excite the vibrations; the other wire is connected to a crystal pickup and is used to measure the amplitude of vibration. The furnace is heated by a cage of 12 parallel tungsten wires spaced on a 1-inch circle with the specimen in the center. This heater is surrounded with radiation shields and a water-cooled shell with provision for the free passage of the specimen support wires through the top. This entire assembly is placed into a bell jar and operated in vacuo.

This apparatus, together with the auxiliary electronic equipment for supplying the driving voltage and detecting the pickup signal, was used to determine the resonant frequencies of flexural vibrations of ceramic specimens up to a temperature of 1700°C. From these measurements, Young's modulus as a function of temperature can be calculated.

Plans for Fiscal Year 1958: It is intended to modify the apparatus described above to extend its temperature range to 2000°C and to adapt this apparatus or design another for the measurement of internal friction at high temperatures.

PROPERTIES OF MATERIALS (con.)

0901-11-4400 Properties of Ceramics at Elevated Temperatures

Objectives: To increase the understanding of the interrelationship of the physical properties of ceramic oxides and of the mechanisms and parameters which influence these properties and to evaluate these mechanical properties for a wide variety of ceramics as a function of temperature.

Importance of the Project: Ceramic materials have great potentialities in a wide variety of applications because of their nuclear, thermal, and structural characteristics. However, as progress in nuclear and high-temperature technology is made, the demands on materials are becoming more and more stringent. An increased understanding of the factors affecting material properties is essential for the continued improvement and development of materials required to meet these demands. In addition, during the course of the study, much data of immediate interest to the sponsor and others interested in reactor design are obtained. The project emphasis is reviewed annually to meet both current and future needs. Certain members of the project staff act as consultants to the Division of Research, US AEC, particularly with regard to the equilibrium relations of oxide systems containing UO_2 as one component. Although the work itself is not classified, the application of the data is, in general, classified.

Activity Summary: This is a continuing program in the sense that the basic objective, the determination of fundamental information on the high-temperature properties of ceramic-type materials of interest to the sponsor, remains the same. However, the emphasis may be changed, either to meet the needs of the sponsor or as indicated by the results of previous phases of the investigation. During the current year, this project has proposed and provided some verification for an expression relating the brittle strength of polycrystalline materials to their porosity and grain size. A detailed report of this phase of the work is being prepared for publication in the Journal of the American Ceramic Society. A second phase of the work has studied the strength-related properties of four varieties of chemically-prepared UO_2. This has provided information on the flexural strength of this type of UO_2 at both room and elevated temperatures and in addition has shown the effect of minor additives on strength

0901-11-4400 (con.)

and porosity. A paper describing the results is currently in preparation. The third phase of this project has been concerned with the determination of elastic constants by sonic methods for a wide variety of ceramic materials. It has been shown by statistical analysis that the sonically-determined elastic properties yield a more efficient evaluation of merit of groups or lots of ceramic specimens than do measurements of their bulk densities. The elastic properties are preferred over bulk densities in the comparison of various fabrication methods. Some of the temperature dependence of the elastic properties of oxide-type materials have been determined. Some cermets, bonded-carbides, and intermetallics have been evaluated by room-temperature sonic tests before and after oxidation at various temperatures.

0906-11-0923 Chemical Properties of Cementing Materials

Objectives: To provide basic information leading to a better understanding of the mechanism of hardening of cement and related materials, and of the reactions attending the deterioration of these materials under various conditions of use.

Importance of the Project: Cementing materials, including portland and other cements, lime, plaster, and the aggregates employed therewith, are used in great quantities in the construction of highways, dams, and nearly all types of buildings. Portland cement production in the United States alone amounts to about 50 million tons a year. Occasionally these materials fall short of standard performance in service, and considerable economic loss results from deterioration of concrete, mortar, and plaster. In many cases the causes of failure are not entirely understood, perhaps because of imperfect knowledge of the reactions that normally occur during, and subsequent to, hardening. The various cements and plasters have in common the property of reacting chemically with water, thereby hardening and developing strength. Much is already known, in an empirical way, about the relation between chemical and physical properties and performance in service, but it is increasingly evident that more fundamental knowledge is required.

PROPERTIES OF MATERIALS (con.)

0906-11-0923 (con.)

Activity Summary: In a general program of surface and sorption studies of cements and cement compounds, the following studies are essentially completed: surface changes taking place in cement subsequent to hydration; some factors affecting the magnitude of the surface of hydrated cement as determined by nitrogen and water vapor adsorption; vacuum drying characteristics of hydrated cement. The effect of carbon dioxide on subsequent hydration of unhydrated portland cement has been studied. The carbonation of hydrated cement, as influenced by water content and age, has also been investigated. A physicochemical study of the destructive alkali-aggregate reaction in concrete was completed, as was an experimental study of the pressure developed by such a reaction. In a further study of the mechanism of the reaction some preliminary observations of ionic charges on hydrated cements were described. These observations led to a similar study of separate cement constituents, which is not yet finished. A hypothesis was offered for the observed increased activity at the surface of certain solutions used in the aggregate studies. An investigation of the hydration of aluminous cements and its relation to the phase equilibria in the system lime-alumina-water has been completed. A study of phase equilibria in the same system at 1°C is under way, and the general areas of stability have been determined. The literature on the chemistry of supersulfated cements has been reviewed, and a few thermochemical determinations have been made on cements of this type. A thermochemical study of lime-silica-water pastes has been completed. Heat-of-solution determinations have been made on a number of samples of calcium sulfoaluminate and its dehydration products. A study has been made of a number of methods of determining uncombined calcium hydroxide in lime-pozzolan-water pastes.

Plans for Fiscal Year 1958: (1) Effect of admixtures on the hydration rates of cement compounds. (2) Effect of admixtures on the hydration rate and colloidal structure of hydrated cement. (3) Surface properties of the hydration products of cement compounds. (4) Infra-red studies of hydrating cement compounds. (5) Microscopic studies of the diffusion of sodium and calcium ions into aggregates. (6) Studies to identify the source of the ionic charges developed by cements during hydration. (7) Expansion studies on a series of soda-silica, potash-silica, and lithia-silica glasses used as aggregates in mortar bars.

PROPERTIES OF MATERIALS (con.)

0906-11-0923 (con.)

(8) A study of the ionic charges exhibited by freshly broken aggregate surfaces. (9) Studies of the durability of decorative aggregates in relation to the alkali aggregate reaction. (10) Study of phase equilibria in the system lime-alumina-water at 1°C. (11) A study of the calcium sulfoaluminates and other closely related compounds. (12) Studies of hydrothermal reactions of certain cement constituents. (13) Determination of heats of formation and hydration of various materials, including hydrated calcium silicates, the alkali-bearing constituents of portland cement, the strontium aluminates, and magnesium oxysulfate. (14) Continuation of the study of activity of pozzolans.

0907-11-0917 Properties of Crystalline Solids

Objectives: To study in detail the polymorphism, mechanism of phase change, and thermal stability of inorganic crystalline solids, and the effect of structural changes on the physical-chemical properties of the material.

Importance of the Project: The development of new methods and improved materials is often hampered by inadequate knowledge of the properties of the substances involved. When the process includes the thermal decomposition or melting of a crystalline solid, it is important to know the mechanism by which this change takes place, the crystalline form of any solid products, and the temperatures of the reactions which occur. This information, while often available for end-members of solid-solution series, is usually sketchy for intermediate compositions.

The clay minerals in particular are subject to variations in composition and in physical-chemical properties. These minerals are important in ceramic industries, in petroleum production, and in agriculture. The correlation of composition, structure, and properties of these materials is at present under study by many investigators, and much work remains to be done before the clay minerals are fully understood.

PROPERTIES OF MATERIALS (con.)

0907-11-0917 (con.)

Activity Summary: A study of the effect of controlled changes in the composition on the physical-chemical properties of synthetic clay minerals has been continued. Clays have been synthesized in which Mg^{++} has been substituted for Al^{+++} in controlled amounts. The change in unit cell dimensions with composition has been studied. The results, while not yet conclusive, appear to confirm the results of similar studies by others on natural mineral samples.

The thermal decomposition of natural montmorillonite clay saturated with various cations has been studied. For some cations the decomposition reaction is of markedly different character, a difference that cannot be readily explained by the presence of the exchangeable cation external to the crystal lattice. The magnitude of this effect varies with the length of time the clay is in contact with the saturating salt solution. The possibility that some of the structural ions are also exchanged is suggested. Evidence that such an exchange may take place has been reported by others. A further study now underway, was begun to clarify this aspect of the problem.

0707-12-3893 Design Criteria for Glass Fiber Reinforced Plastics

Objectives: To obtain engineering design criteria values for glass fiber reinforced plastics through cooperation with other laboratories.

Importance of the Project: Engineering design criteria are badly needed for all types of plastics so that materials may be used more efficiently in structures such as boats, aircraft and buildings. This is the first program that has been organized to obtain such criteria. The initial part is concerned with glass fiber reinforced polyester plastics made in 5 thicknesses with 5 reinforcements by 4 fabricators. Four laboratories will work together to obtain reliable property values. Design engineers from a naval architectural firm will set the design values on the basis of the measured values. A large number of properties are being measured. Some test methods will be evaluated prior to their use.

PROPERTIES OF MATERIALS (con.)

0707-12-3893 (con.)

Activity Summary: This is a new project for Fiscal Year 1958. Members of the staff participated in planning the statistical and testing programs.

Plans for Fiscal Year 1958: 1) Measure properties of glass fiber reinforced polyester plastics sheets. 2) Assist in making statistical analysis of test results obtained by this and other laboratories.

0903-12-0903 Physical Properties of Refractory Materials

Objectives: To investigate the physical properties of refractory materials for the purpose of obtaining data that will be useful in revising existing standards, including Federal specifications or forming the basis for the technical requirements of new specifications for such materials. To study the physical and chemical changes which occur when the various refractory ingredients of pyrometric cones are heat treated.

Importance of the Project: New refractory products are continually being developed by industry, improvements made in existing ones, and new applications found for these products. In order to keep abreast of such developments, both from the standpoint of current Federal specifications and the inauguration of new ones, a knowledge of the properties of the products under service conditions is highly desirable. There is a dearth of information on the properties of refractory castables. The principal test of refractory material for engineering purposes is the PCE (pyrometric cone equivalent) which is a measure of thermal refractoriness. The ASTM test for PCE does not specify the furnace to be used but merely insists on neutral or oxidizing atmosphere. It has been established that the furnace atmosphere to a high degree determines the PCE. It is essential that evaluation of the various commercial and laboratory furnaces be made to assist ASTM in specifying a furnace. This study has a theoretical background in the study of the influence of atmosphere on liquid formation in these silicate compositions.

Activity Summary: During the past year the mineralogical changes in refractory castables on heat treatment have been studied and reported. In addition, differential thermal analyses and thermal length changes were carried out. A comparison of four furnaces: electric, two commercial gas fuel furnaces and a special controlled atmosphere laboratory furnace for determination of PCE, is under way.

PROPERTIES OF MATERIALS (con.)

0906-12-0910 Physical Properties of Concreting Materials

Objectives: To provide basic information leading to a better understanding of the effects of environmental factors upon the performance of concrete and to relate the physical properties of concretes and their ingredients to performance.

Importance of the Project: Approximately $700 million worth of portland cement is used annually in the United States. By the time this cement is incorporated in concrete, a several-fold increase in cost is involved. Some of this concrete fails to give satisfactory service, with a consequent large economic loss. The mechanisms responsible for several types of disintegration are partially understood, but needed is additional fundamental information on the properties of concrete and concrete aggregates, as well as additional developments of techniques to measure these properties.

Activity Summary: The automatic strain-temperature scanner and recorder mentioned in the previous report did not possess all of the features contracted for and required for the tests planned. A newly engineered instrument, with the desired features, was finally furnished by the manufacturer as a replacement. After some modifications, the instrument was placed in service in January and experiments have been made with six concrete specimens in which strain gages and thermocouples were imbedded.

A report on results obtained by subjecting 6 types of concrete to 4 types of laboratory freezing and thawing cycles was accepted for publication by the ASTM and will appear in the 1956 Proceedings. Most of the data obtained from a similar investigation involving 13 laboratories and 22 laboratory-cycles, participated in and coordinated by the NBS staff, were received during the year. Reports on two phases of this investigation, relative abilities of the various laboratory-cycles to distinguish between concretes of different durabilities, and an attempt to correlate moisture loss during test with durability factors obtained in different laboratories were prepared and presented at the Highway Research Board meeting in January. Members of the staff organized and presided over the meeting of the HRB committee on Durability of Concrete, Physical Aspects, as well as the Off-the-Record Session sponsored by that committee.

PROPERTIES OF MATERIALS (con.)

0906-12-0910 (con.)

Plans for Fiscal Year 1958: Five of the portland cements found in a previous NBS investigation to yield quite durable concrete without the use of entrained air, and five cements found to produce low-durability concrete will be the subject of a series of tests which it is hoped will answer the question of why these groups of cement behave differently. These tests will utilize embedded strain gages to measure volume changes during freezing. They will also include tests on concretes containing entrained air.

Large cylinders with embedded SR-4 strain gages and thermocouples will be frozen and thawed under differing conditions to study the strain and temperature distribution.

Coordination of and participation in the preparation of the final report on the highway Research Board Cooperative Test Program on Freezing and Thawing will be completed.

0906-20-4473 Chemical and Physical Properties of Dolomitic Limes

Objectives: To provide information leading to a better understanding of the mechanism of the dimensional changes of dolomitic lime hydrates.

Importance of the Project: Partially hydrated dolomitic lime is used in large quantities in mortars for masonry construction. There is some question relative to the expansion and resulting deterioration of such mortars. An autoclave test has been proposed for determining the potential expansion of lime, but a controversy exists relative to the correlation of the laboratory tests and field experience. Walls are subjected to slow carbonation and to different structural loads, and creep or adjustment may take place in the mortar, which would not occur in the high-temperature steam laboratory test. Also, the nature of the hydration products and type of crystal growth may be different at the two temperatures. Before an adequate Federal specification for hydrated lime can be prepared, it will be necessary to obtain measurements of dimensional changes under different exposures of masonry walls constructed of limes of different expansive characteristics as determined by the autoclave test, and to obtain fundamental information on the nature of the hydration products under various conditions.

PROPERTIES OF MATERIALS (con.)

1000-30-4801 Properties of Building Materials

Objectives: To obtain data on the properties of building materials, equipment, and structural assemblies as a means for assessing their probable service performance and their value for use in military structures.

Importance of the Project: As requested by the Office of the Chief of Engineers, the National Bureau of Standards is requested to make specific investigations on the properties of building materials, equipment, and structural assemblies. Examples of these are protective coatings, flashings, walls, bricks, protected metals (protected against weathering and fire), door locks, and concrete structures. Since parts of assignments, and sometimes entire assignments, are accomplished best by Divisions other than the Building Technology Division, it has been found advantageous over the years to group all assignments under the subject project with one project leader.

Activity Summary: Examples of the work performed under this project during Fiscal Year 1957 are shown below:

(a) Protected Metals - Metals protected against fire and weathering were tested for resistance to salt spray, flames, shatter, and simulated weathering.

(b) Transparent Waterproofing Agents - Tests were initiated to determine the water permeability and vapor barrier properties of three proprietary products used by the armed services.

Plans for Fiscal Year 1958: This is a continuing project. The project level will depend upon the number and nature of the tasks selected during conferences between representatives of BYD, OCE, AF, and NBS. Such conferences will be held throughout the year as new problems arise in the design, operations and maintenance of buildings. Continuance of both of the tasks outlined above is planned and new projects are contemplated.

SURFACE FINISHES AND COVERINGS

1004-11-1017 Properties of Roofing, Waterproofing, Flooring, and Coating Materials

Objectives: To ascertain the causes and the chemical and physical processes of deterioration of asphalts when exposed to the weather and the relations between the chemical and physical properties of flooring, roofing and waterproofing materials and their performance in service.

Importance of the Project:

1. Work on Asphalt: At least 90 percent of the roofing used in this country contains asphalt. Asphalt used in roofing is a by-product of the petroleum industry, extremely complex in composition, with properties that vary with the source and the method of preparation. The Bureau has undertaken a fundamental study of the degradation of asphalt on weathering to be able to distinguish between good and poor weathering asphalts and to establish methods for improving the weather resistance of asphalts.

2. Work on Flooring Materials: The compositions and constructions of flooring materials have undergone appreciable change in the past several years, notably vinyl plastic floor coverings. Needed most are satisfactory methods for evaluating the resistance to wear and maintenance and the dimensional stability of floor covering materials. Comparable and up-to-date information on different types of materials and their installation is of interest to Government agencies, architects, builders and consumers.

Activity Summary: The effect of coating thickness on the degradation of asphalts exposed outdoors four years was determined and the results are being prepared for publication. Work on the structure of the water-soluble degradation products was continued with but little progress because it was determined that fractions separated continued to change after separation. Some of the separation methods tried were silicic acid, Celite, circular paper, and ascending paper chromatography, solvent extraction from aqueous solutions, pH extraction, anion exchange, sublimation, and solvent extraction from the solid phase. Since work on the water-soluble degradation products was carried on entirely by the Research Associates of the Asphalt Roofing Industry Bureau, it was decided, in conference with the Research Committee of the Industry Bureau, to abandon this approach for the time being, or until some of the newer investigating tools are available.

SURFACE FINISHES AND COVERINGS (con.)

1004-11-1017 (con.)

Two papers, "Water-Soluble Degradation Products of Asphalt" and "Asphalt Research at the National Bureau of Standards," were published in the Bulletin of the American Society for Testing Materials. "Method for the Controlled Burning of Combustible Materials and Analyses of the Combustion Gases," RP2715, was published in the Journal of Research. "Infrared Spectra of Chromatographically Fractionated Asphalts," RP 2759, was a product of this project. Another paper has been approved for publication and several more are in preparation.

Plans for Fiscal Year 1958:

1. Work on Asphalt: 1) Initiate a study of the degradation behavior of asphalts reconstituted from asphaltenes and maltenes from the same asphalts and from asphalts from different sources. 2) Attempt to characterize asphaltenes by a study of dispersions of asphaltenes in lube oils of varying paraffinic content. 3) Determine changes of component distribution in asphalts exposed in darkness to heat and thermal shock. 4) Continue study of degradation products of asphalt components exposed to ultraviolet light, by infrared, ultraviolet, and chemical analyses and the synthesis of derivatives of the water-soluble degradation products. 5) Study the gaseous decomposition products of asphalt. 6) Complete editorial work on reports for publication which describe the effects of light and water, heat coating thickness, and mineral additives on the degradation of asphalt.

0201-20-0203 Spectrophotometry and its Application to Colorimetry and Photometry

Objectives: To develop and maintain spectrophotometric standards; to study improvements in spectrophotometric instruments and techniques, particularly for the standardization and specification of color; to determine the permanence of standard samples of ceramics, glasses, pigments, paints, papers, plastics, textiles, and other materials of special interest in colorimetry; and to correlate instrumentally obtained data of spectral transmittance or spectral directional reflectance of materials converted mathematically or electronically into psychophysical terms of color specification with similar data

SURFACE FINISHES AND COVERINGS (con.)

0201-20-0203 (con.)

of the same materials either obtained visually by the human eye, directly or with instruments, or photoelectrically by means of additive or subtractive colorimeters, color-difference measurements, or physical photometers.

Importance of the Project: Spectrophotometry is a research and analytical tool in physics, chemistry, engineering, and technology. One of its most important uses relates to the subject of color. It is the fundamental basis of colorimetric analysis, standardization, and specification. It is the only fundamental means of analyzing a color for research or other purposes. It is the only means of standardizing a color that is independent of material color "standards", which are always of questionable permanence, and independent of abnormalities of color vision, existing among even so-called normal observers, and in this sense it is the fundamental basis for color specification. The NBS has applied the spectrophotometer to its color research, development, and testing, and to various other work for 50 years. It pioneered in the development of the photoelectric spectrophotometer and in its application to the colorimetry of diffusing materials. With the advent of commercial photoelectric spectrophotometers, the NBS began preparing and issuing spectrophotometric standards of various kinds, and hundreds of these standards are now in use, affording checks on the reliability of the various scales of these instruments in industrial, national, and international laboratories interested in colorimetry, photometry, and spectrophotometry. In recent years these same services have been extended beyond the visible spectrum into the near ultraviolet and the near infrared spectra.

0501-20-0567 Development of Methods of Testing and Analysis of Organic Coatings

(See TESTING MATERIALS AND PRODUCTS)

SURFACE FINISHES AND COVERINGS (con.)

1004-20-4846 Research on Flooring

Objectives: To prepare classifications or ratings of floorings that are of current and potential usefulness to the Department of Defense, wherein the classification would indicate the suitability of a flooring for a variety of service conditions. The first rating would of necessity be incomplete and highly tentative because of the inadequacies if existing methods of testing and the lack of data indicating quantitiative relationships between the results of tests and service qualities. As improved methods of testing are developed and correlated with service conditions, the reliability of the revised classification would be improved. There would then become available both the means for obtaining quick evaluation of new floorings and reliable guides for the selection of floorings for any purpose.

Importance of the Project: A need exists for the development of improved methods of testing and performance criteria for flooring in several categories including those for resistance to wear, dimensional stability, slipperiness, electrical conductivity (hospital operating room floors), moisture penetration, underlayment materials, effect of aging and maintenance practices, cleaning ability, comfort value (resilience and temperature), etc.

The establishment of satisfactory performance criteria must be preceded by the development of laboratory methods for evaluating floors and flooring materials in measurable quantitative terms correlated with performance in actual service. Some methods are well established; others are reasonably well established for some materials, but need to be perfected further; while still others need to be developed.

The project, covering several years of work, is divided into two parts, the first dealing entirely with conductive flooring for hospital operating rooms; the second with flooring materials in general. The work dealing with conductive floors has been underway since late in Fiscal Year 1956. This phase of the research has been carried out cooperatively with Division 1.

SURFACE FINISHES AND COVERINGS (con.)

1004-20-4846 (con.)

Activity Summary: Work on Conductive Floors: Studies of methods of measuring electrical resistance of floors and the correlation of established methods with the tendency of conductive floors to reunite electrical charges have been made. These studies have involved the effects of magnitude of applied voltage, type of voltage wave, and size, shape and weight of electrodes. The effects of aging, humidity, surface treatments, spillage and wear on the electrical resistance of the specimens were largely completed. A comparative study of slipperiness, indentation, and scratch resistance has been completed.

Work on Flooring Materials in General: A literature search was made for specific flooring materials for use in areas likely to be contaminated by radioactive particles. Assistance was given in the preparation of Federal Test Method Standard No. 501 for Floor Coverings.

Plans for Fiscal Year 1958: Work on Conductive Floors: An interim report on the first part of this project dealing with conductive floors will be issued after completion of the laboratory tests and field inspections of conductive floors. Specifications for some conductive floors will be prepared.

Work on Flooring Materials in General: Work will be continued on the development of laboratory methods for evaluating the resistance to wear of flooring materials. Studies will be initiated to determine the effects of various underlayment materials and of aging and maintenance treatments on the dimensional stability of flooring materials.

SURFACE FINISHES AND COVERINGS (con.)

0201-30-2322 Standards of Light and Color

Objective: The calibration and issuance of lamp standards of candlepower, luminous flux, and color temperature; spectrophotometric standards and standards of color, transmittance, reflectance, opacity, gloss, and luminance.

Importance of the Project: Standards of light and color are in continuing heavy demand by Government and industry for the calibration of instruments or working standards, or for the testing of materials and devices for compliance with specifications. Among the industries served are the following: lamp and lighting fixture, paint, paper, chemical, optical, plastics, enamel, photographic, textile, television, oil, and public utilities. In addition to the Army, Navy, and Air Force, Government agencies served include Agriculture, AEC, GSA, NACA, and VA.

Activity Summary: During Fiscal 1957, more than 600 standards and calibrations were supplied as requested.

0501-30-3240 Analysis and Testing of Paint, Varnish, Lacquer and Related Materials

(See TESTING MATERIALS AND PRODUCTS)

0707-30-3880 Standards for Plastics Wall Coverings

Objectives: To evaluate the properties of plastics wall coverings and to prepare specifications for these materials.

Importance of the Project: A variety of plastic materials is being used or proposed for use to cover walls in hospitals. The properties of some of these products, provided they are properly made, indicate that they should outlast materials now used in Government hospitals, thus resulting in a saving in replacement and maintenance. However, reliable comparative test results must be obtained and evaluated so that a decision regarding their use can be made on a sound technical basis. Information must also be available to write procurement specifications on the particular materials selected.

SURFACE FINISHES AND COVERINGS (con.)

0707-30-3880 (con.)

Activity Summary: Sixteen samples of commercial wall coverings from 14 manufacturers were tested to determine tensile strength, tear strength, coating adhesion, cold crack resistance, blocking, abrasion resistance, volatility, aging resistance, and flammability. The data will be used by the sponsor to prepare a purchase specification.

1004-40-4847 Standards for Built-Up Roofs

Objectives: To compare and evaluate the performance of the newer types of built-up roofs, including roofs constructed with asphalt purchased under the specification prepared in Fiscal Year 1957, also asbestos felt, glass membrane, cold process and plastic roofs. To initiate a long-time exposure test to evaluate asphalt shingles, with emphasis on the importance of applied weight per unit of area on the serviceability of asphalt shingles and the merits of various self-sealing features.

Importance of the Project: Increasing use of the newer types of built-up roofs places Government specification writers under constant pressure to accept systems that have not been in use for periods long enough to evaluate them properly. The enormous roof areas under agencies of the Department of Defense make imperative studies of these systems. A recent attempt by one agency to adopt a guide specification calling for greater applied weight per unit of area of asphalt shingles met with opposition from a large segment of the industry. Since damage by wind is one of the principal causes of failure of asphalt shingles, the merits of self-sealing shingles should be evaluated.

Activity Summary: Work outlined for Fiscal Year 1957 in connection with dead-level, built-up roofs was completed. This included the statistical selection and actual inspection and rating of built-up roofs in the Eastern, Western and Mid-Western States; the detailed laboratory examination of representative specimens of asphalt and coal-tar pitch; and the preparation of a report on this work, including a purchase specification for asphalt for use in the construction of mineral-surfaced, built-up roofs on slopes up to one inch per foot.

SURFACE FINISHES AND COVERINGS (con.)

1004-40-4847 (con.)

Plans for Fiscal Year 1958: 1) Work on asphalts for dead-level roofs has indicated a possibility that asphalts with a softening point lower than any previously specified might give superior service. It is planned to study the behavior of several asphalts of this type from different sources of crude oil. 2) Continue observations and laboratory studies of asbestos felt, glass membrane, cold process, and plastic built-up roofs. 3) Set up a long-time exposure of representative asphalt shingles of different weights and including the various systems of self-sealing currently available.

TESTING MATERIALS AND PRODUCTS

0501-20-0567 Development of Methods of Testing and Analysis of Organic Coatings

Objectives: To develop, for inclusion in specifications and standards, and for general evaluation purposes, methods for analyzing and testing paints, varnishes lacquer and related products.

Importance of the Project: Adequate methods of testing and analysis are essential to the success of a procurement program in which specifications are widely utilized. Test methods are useful, also, in assessing the probable worth of new products and in appraising other products for which no standards or specifications exist. Constant improvement in methods of test must parallel the development of new products in order to evaluate them properly.

Activity Summary: The first edition of Federal Specification TT-P-141 was issued in 1941 as a result of work at the Bureau. It was revised and enlarged in 1944 and again in 1949 in recognition of changes and advances in testing techniques. The first draft of a further revision was prepared in Fiscal 1955 and submitted (through GSA) to the Government departments for comment. Cooperation with ASTM was begun many years ago in the development of test methods and was continued through Fiscal 1957.

Plans for Fiscal Year 1958: 1) Complete revision of Federal Specification TT-P-141b, Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing. This involves coordination of departmental comments as they are received on first draft prepared in Fiscal 1955. 2) Continue cooperation with Federal, ASTM, ISO and other groups working on development of new and improvement of existing methods of test.

TESTING MATERIALS AND PRODUCTS (con.)

0707-20-0732 Methods of Testing Plastics and Adhesives

Objectives: To develop methods for testing plastics and adhesives; in particular, energy to fracture, abrasion resistance, and simulated weathering of glass fiber reinforced polyesters.

Importance of the Project: The increasing number of new types of plastics and adhesives, the development of different grades of older types, and new applications of plastics and adhesives make it necessary to develop new and modify present methods of test for measuring their properties. This activity is carried out in close collaboration with other governmental and industrial laboratories, and organizations such as the American Society for Testing Materials and the Society of the Plastics Industry. Standardization of methods is advanced to the benefit of plastics and adhesives science and technology, of Government purchasing, and of industry. Some of the methods developed are adopted as standards and included in the ASTM Standard Methods of Test, Federal Specification L-P-406 covering methods for testing plastics, and Federal Standard 175 covering methods for testing adhesives.

Activity Summary: A method for measuring the water vapor permeability of thick plastic laminates was completed and the first draft of the report describing the apparatus, procedure, and typical test results prepared. The first draft of a method that has been used for years in this laboratory for the determination of the Bierbaum scratch hardness of plastics, was prepared and submitted to ASTM Committee D-20 on Plastics; a procedure for coating transparent plastics with vacuum deposited thin metal films to improve the measurement of the width of the scratch is part of this proposed method. A report of the results of a collaborative test program on the effect of rate of straining on the tensile properties of plastics was prepared and submitted to ASTM Committee D-20 on Plastics. A test program on the effect of rate of loading on the tensile-shear properties of adhesives was completed. A report on the mechanical and electrical properties of a cotton fabric reinforced laminate was submitted to ASTM Committee D-9 on Electrical Insulating Materials as part of a collaborative test program. The test program to extend the present ASTM method for determining the effects of laboratory aging tests of adhesion for wood to other materials was completed.

TESTING MATERIALS AND PRODUCTS (con.)

0707-20-0732 (con.)

Plans for Fiscal Year 1958: 1) Develop a method for determining the aging (simulated weathering) of glass fiber reinforced polyester plastics. 2) Evaluate the PEI Abrasion Tester for plastics. 3) Develop a method for measuring the energy to fracture plastics on tension loading. 4) Conduct cooperative test programs with other governmental agencies and scientific and technical societies such as the American Society for Testing Materials, Society of the Plastics Industry, and Society of Plastics Engineers.

1003-20-4836 Standard Test Procedure for Soiling Acoustic Tile

Objectives: To establish a standard procedure for evaluating the soiling of acoustic tile by contaminated air by the mechanisms of impingement, filtration, and impingement and thermal precipitation combined and to measure the effect of painting procedures on the sound absorption of these tile.

Importance of the Project: Huge sums of money are spent each year for cleaning, reconditioning, and replacing interior surfacing materials in public buildings as a result of contaminants in the air in the buildings, part of which are brought in through the ventilation or air conditioning ducts. Little study has been given to basic mechanisms by which particles of dust become attached to surfaces, and little is known about the methods for preventing or inhibiting such deposition. Likewise, the control of dust brought in through ventilating and air conditioning ducts is variable, to say the least, because of disagreements on methods and requirements for air filters and the lack of a standard test dust for evaluating their effectiveness. Potentially great savings could be realized if better standards were available for air filters and if the principles of dust deposition in enclosed spaces were better understood.

Activity Summary: This subject was under investigation in Fiscal Year 1956 under the sponsorship of the Public Buildings Service and, through them, the Acoustical Materials Association. Two pieces of test equipment were constructed; one to correlate air flow or filtration through a specimen of wall material, and the pressure difference between its two sides, and the other consisting of a means

TESTING MATERIALS AND PRODUCTS (con.)

1003-20-4836 (con.)

for exposing samples of wall materials, eight at a time, to artificially contaminated air. Some test results on about a dozen specimens of acoustical tile were obtained with oil flame smoke, Cottrell ash, tobacco smoke, and commercial lampblack. The effects of thermal deposition, impingement, and dirtying by filtration of air through the specimens were demonstrated. Due to a lack of funds, this project was discontinued at the end of Fiscal Year 1956, but has been approved for Fiscal Year 1958.

Plans for Fiscal Year 1958: The following tasks are envisioned as necessary steps in developing a standard test procedure: 1) Modify soiling enclosure to provide octagonal shape for interior space, and insulate the walls. 2) Rebuild the dust injector and blower system to permit standardization of air flow rate and dust loading of the air. 3) Select or develop a standard air contaminant. 4) Select or determine standard air delivery rates and velocities. 5) Determine reproducibility of results, resolution of the methods, and length of exposure. 6) Prove method by evaluating soiling characteristics of about 24 types of commercial acoustic tile exposed to the mechanisms of impingement, impingement and thermal precipitation, and filtration. 7) Study the effect of a number of painting procedures on the sound absorption of commercial acoustic tile and the degradation of absorption caused by repetitive painting of the tile. Work done under this transferred fund project should be completed in from six to eight months at which time the study will be continued under Expenses Project No. 1003-12-1016, Air Cleanliness in Buildings.

0201-30-2320 Qualification, Inspection, and Testing of Lamps for the Government

Objectives: To conduct qualification tests of manufacturers currently supplying incandescent, fluorescent, and photographic flash lamps to the Government by inspecting and life-testing the lamps supplied in order to determine compliance with applicable Federal specifications; to conduct qualification tests of prospective bidders not currently supplying lamps to the Government; to formulate and revise Federal Specifications for lamps.

TESTING MATERIALS AND PRODUCTS (con.)

0201-30-2320 (con.)

Importance of the Project: In accordance with the procedure followed for over 40 years the contract between the Government (Federal Supply Service) and the suppliers of lamps to the Government specifies that the lamps supplied shall comply with the applicable specifications, and that the necessary inspection and testing to determine compliance with the specifications be performed by the National Bureau of Standards. Since 1935 contracts to supply lamps to the Government have been awarded only to suppliers who have passed qualification tests conducted at the National Bureau of Standards in accordance with the applicable specifications. This procedure has been found to be effective in obtaining for the Government delivery of specification-quality lamps with a minimum of delays resulting from rejections for failure of lamps to comply with specification requirements. In addition, it is essential that the specifications themselves be reviewed and revised to keep them current.

0501-30-3240 Analysis and Testing of Paint, Varnish, Lacquer and Related Materials

Objectives: To test and analyze paints, varnishes, lacquers, enamels, and ingredient raw materials for compliance with specifications. Also, to examine and evaluate organic coating materials for which no specifications exist; and to conduct special tests and investigations for regulatory agencies.

Importance of the Project: Testing of the delivered product to determine compliance with established requirements is the final essential step in a specification procurement program. Most Government paint purchases are made in such a manner. Tests are required also as evidence for Government agencies that have regulatory functions and for other special purposes.

0603-30-0613 Testing Wind Equipment

Objectives: To calibrate wind-measuring equipment to develop test methods.

TESTING MATERIALS AND PRODUCTS (con.)

0603-30-0613 (con.)

Importance of the Project: Wind-measuring instruments are widely used by the weather services and in the heating and ventilating field. Private users and manufacturers have need for calibrated instruments either for direct use or for checking the accuracy of other instruments. Instruments in the field are periodically returned for recalibration. Other instruments are checked for conformance to Government specifications. Manufacturers use calibrated equipment in the development of new instruments and as standards for manufacturing.

0604-30-3621 Miscellaneous Mechanical Testing and Calibration

Objectives: To conduct mechanical tests and calibrations on a reimbursable basis as requested by various Government agencies and the public.

Importance of the Project: The NBS tests specimens of engineering materials and other items for compliance with the requirements of purchase specifications. Tests are also made for private organizations when facilities and personnel are not available elsewhere. The NBS provides the only service available for the accurate calibration of elastic devices used for calibrating testing machines. Devices ranging in capacity from a few hundred pounds to several million pounds are calibrated by dead weights for loads not exceeding 111,000 lb and by means of other calibrated devices for loads exceeding 111,000 lb. The accuracies of the testing machines used by the Government and by producers and consumers are dependent on periodic calibrations with devices calibrated at the NBS. The accuracies of calibration cells used by manufacturers of aircraft weighing devices and load cells for measuring the thrust of jet engines and for industrial weighing applications are also dependent on periodic calibration at the NBS. Means for determining the performance of vibration testing equipment in Government and private laboratories are provided by the calibration at the NBS of vibration pickups on vibration standards which have been calibrated by the reciprocity method.

TESTING MATERIALS AND PRODUCTS (con.)

0604-30-3621 (con.)

Activity Summary: Since the initiation of this project 759 devices were received from private organizations for calibration. These included dynamometers, load cells and transducers, aircraft weighing kits, proving rings, Amsler boxes, vibration pickups, a vibration calibrator and other types of devices. Calibrations of 633 devices were completed under this project. Mechanical tests were made on 243 specimens of materials submitted by the Engineer Department, Division of Materials, District of Columbia. Approximately 64 items were tested for other Government agencies. These items included proving rings, load cells, bolts, wire, wire rope, hand trucks, wrenches, chairs, wire rope connectors, vibration pickups, hardness test blocks, window cleaner's safety anchors, and drill bits.

0707-30-3879 Standardization of Test Methods and Specifications for Adhesives, Elastomers, Sealants, and Molded Articles

Objectives: To standardize the methods of tests and specifications for various adhesives, elastomers, sealants, and molded articles now used by the Navy Bureau of Aeronautics.

Importance of the Project: The Navy Bureau of Aeronautics now uses a large number of adhesives, elastomers, sealants, and molded articles in the construction and maintenance of aircraft. The specifications for these products need revision and consolidation. This project consists of two parts. In the first part the methods of test will be investigated and standardized. It may be necessary to develop some new methods. Once this is accomplished, the second step consisting of the revision of and reduction in the number of current specifications for these products can be undertaken on a sound basis.

Activity Summary: The evaluation of several aircraft sealants is underway. A large number of properties and several variables in proposed test methods are being studied. The effects of the sealants on the crazing of transparent plastics were investigated. This is a cooperative project with the Rubber Section (7.1).

Plans for Fiscal Year 1958: 1) Complete the work on aircraft sealants. 2) Investigate other items as requested by the sponsor. 3) Develop standard methods of test.

TESTING MATERIALS AND PRODUCTS (con.)

0900-30-4447 Acceptance Testing of Ceramic Materials

Objectives: To test ceramic materials for compliance with the technical requirements of Federal or Departmental Specifications.

Importance of the Project: The Federal Government is a large purchaser of ceramic materials. Since a very substantial cost is involved in the erection of structures and in other fabrication from these materials, acceptance testing assumes a major importance in a number of cases. This is particularly true in the use of refractories for boilers, incinerators, and similar installations; therefore most of the testing work under this project is concerned with refractory materials.

Activity Summary: The material submitted for acceptance testing required the assignment of one employee for approximately one-third man-year to this project. A total of 150 tests were performed on 22 samples.

0906-30-4415 Cement Reference Laboratory

Objectives: To standardize and improve the testing of portland cement in laboratories throughout the country, and to assist in the refinement of cement testing methods.

Importance of the Project: The NBS carries on a large cement testing program, and in connection therewith, does work on the development and refinement of test methods. The tests are somewhat empirical in nature and, for this reason, comparable test results between laboratories are obtainable only through standardization of equipment and techniques. The work of this project is an important contribution in this respect. Also, the data resulting from these activities is used extensively by technical groups concerned with the development of test equipment and procedures.

Activity Summary: As part of its Eleventh Inspection Tour among cement testing laboratories of the United States, the Cement Reference Laboratory inspected cement testing equipment and test procedures in 71 laboratories, and 132 written confirmatory reports covering these inspections were prepared and distributed. Two special investigations undertaken led to the development of two new field inspection procedures which have increased the scope of many inspections. In a continuation of the Comparative Test Program, 224 chemical and 268 physical test samples of cement were sent out, and more than 1000 reports covering

TESTING MATERIALS AND PRODUCTS (con.)

0906-30-4415 (con.)

the results of these tests were prepared and distributed. A total of 78 samples of the standard mixture used in checking of 10-inch flow tables were mailed, and a new supply of the powdered silica for this mixture was ground. A narrative history covering the first 25 years of CRL operation was prepared. Vigorous participation in the activities of technical committees was continued , with all of the technical secretarial work of ASTM Committee C-1 on Cement being performed.

Plans for Fiscal Year 1958. It is anticipated that the rate of inspection of laboratories will be essentially as outlined above. The importance of the Comparative Test Program is increasing rapidly, and the potential of this service will be further developed. Some attention will be given to the use of photographic techniques for instruction in correct testing procedures. Plans will be formulated for the extension of the inspection service to cover concrete testing laboratories.

0906-30-4433 Acceptance Testing, Cement

Objectives: To make acceptance tests on portland cement used by the various Federal agencies throughout the United States.

Importance of the Project: Most of the projects for which cement is tested are of a permanent nature (large dams, air fields, etc.), and the cement-acceptance program prevents difficulties with the concrete resulting from the use of sub-standard cement.

Activity Summary: This project has been in continuous operation for over 40 years. Currently, samples representing approximately 11 million barrels of cement per year are being tested in laboratories in San Francisco, California; Seattle, Washington; Denver, Colorado; Allentown, Pennsylvania; and Washington, D. C. A mobile cement testing laboratory has been placed in operation at Duluth, Minnesota for the construction season. A statistical testing plan was put into effect which is expected to reduce the cost of testing to some extent. Measurements have been continued on the behavior of cements and concrete under prolonged outdoor exposure. Studies have been made to develop transverse strength tests and a nondestructive sonic test for cements.

TESTING MATERIALS AND PRODUCTS (con.)

0906-30-4433 (con.)

Plans for Fiscal Year 1958: It is expected that the work in this project will be at a slightly higher volume.

The volume of testing is somewhat seasonal. During slack periods, work will also be accomplished on development of test methods, both physical and chemical, and on cooperative test programs with other laboratories.

0906-30-4444 Miscellaneous Testing

Objectives: To make tests, both acceptance and of other types, on a variety of materials, such as hardened and fresh concrete, concrete aggregates, soils (engineering properties), bituminous aggregates, filter trickling media, floor hardeners, integral concrete admixtures, and spelters.

Importance of the Project: The information obtained from this project enables the various Federal agencies to control the quality of concrete and other materials going into Federal construction in the D.C. area. It furnishes information on soils required in engineering designs. It contributes to the determination of the causes of failure in performance of unsatisfactory concretes.

Activity Summary: This is a continuing project, with the major portion of the work being accomplished in the Washing D. C. laboratory, although a few tests each year are made in Seattle and San Francisco cement-testing laboratories.

1000-30-4800 Miscellaneous Testing

Objectives: To perform such tests on building materials, equipment, or structures, as requested by Federal agencies in accordance with appropriate fee schedules.

Importance of the Project: This is a continuing project in which the NBS carries out miscellaneous testing. Examples include: the testing of elevators and elevator parts, air filters, building stones, brick, masonry units, fire extinguishers, roofing slate, insulating materials, heating units, air conditioning units, and the testing of building constructions for strength, water permeability, fire resistance and heat transmission.

TESTING MATERIALS AND PRODUCTS (con.)

1000-30-4800 (con.)

Activity Summary: Examples of the work performed under this project during Fiscal Year 1957 are shown below:

A simple calorimeter was developed for measuring the capacity of window air conditioning units in the size range up to 1 hp. This calorimeter provides a means for a rapid check of capacity for the purpose of comparison with specification requirements. A study was made which showed that a sunshield on the exterior portion of a window air conditioner may have no measurable effect on its refrigerating capacity under average conditions and that the refrigeration capacity of such a unit may be reduced by no more than 1 or 2 percent under the most adverse conditions by solar radiation on the condenser section.

Limited studies were made of test methods for measuring the heat loss of refrigerated trailers by the reverse heat loss method. These tests produced data which will be useful in selecting control devices for the internal heat loads in the study of standardization of test methods for refrigerated enclosures that will be undertaken next year.

Assistance was given in a study of the causes of frost, ice, and water accumulation during winters in the interiors of walls, floors, and ceilings of buildings located at Thule and Sondrestrom Air Force Bases in Greenland. A field trip to the sites was made to inspect the buildings and determine factors contributing to the problem. Laboratory measurements of the water-vapor permeance of component materials taken from the buildings and from stock were completed to assist in evaluating the problem. A summary report containing the findings and conclusions of the investigating team was completed. Recommendations for remedial action were prepared for each of the two types of buildings investigated.

Fire resistance tests were performed on two cellular steel floor ceiling constructions. These specimens involved the use of direct sprayed mineral insulating material for protection of the steel. The constructions are representative of one of the types considered as useful for future military buildings where flexibility of wiring facilities is of prime importance.

At the request of the Architect of the Capitol, a study was made of the 150-year old exterior sandstone in the original portion of the United States Capitol. Nine samples, cored from the walls of the building were tested for such properties as compressive and flexural strength, hardness, toughness, specific gravity, porosity, and elasticity.

TESTING MATERIALS AND PRODUCTS (con.)

1000-30-4800 (con.)

Petrographic and chemical analyses were also made on several of the samples. The effect of 34 coats of paint applied to the "Aquia Creek" sandstone over the years was evaluated in relation to the durability of the stone, especially for future use.

MISCELLANEOUS

0804-11-0815 Crystal Structure and Corrosion

Objectives: To study the fundamental nature of the corrosion process and its relation to crystal and atomic structures of metals.

Importance of the Project: Corrosion is a very costly process, the loss of metal parts, products and labor involved in replacement totaling many billions of dollars annually. By far, the most of the research in the field is empirical, i.e., directed toward finding the comparative corrodibilities of commercially usable metals and alloys and devising means of mitigation. The basic mechanism by which metals corrode is not at all understood, and little fundamental work is being done to determine what physical and chemical processes and conditions are involved and what part the atomic and crystal structure of the metal plays in the initial formation of corrosion pits and their extension to general corrosion.

Activity Summary: During the past year a paper "Influence of Crystal Orientation on the Corrosion Rate of Aluminum in Acid and Alkalies" was published. Work on the difference in solution rates of monocrystalline aluminum in NaOH and KOH was continued. An extensive study of the atomic structure of thin layers of copper deposited on monocrystalline copper and their epitaxial relationships with the underlying base crystal was made as a part of the understanding of the fundamental nature of the corrosion of copper.

Plans for Fiscal Year 1958: The studies referred to above on thin layers of copper deposited on copper are virtually complete and a paper is in process of preparation. Studies of the differences in solution rate and nature of attack on aluminum in NaOH and KOH solutions will be continued.

0804-11-0836 Fundamental Corrosion Reactions at Metal Surfaces

Objectives: To investigate the basic reactions that influence the corrosion of metals.

Importance of the Project: By filling in some of the large gaps that exist in the fundamental understanding of the corrosion process, the staggering cost of corrosion can probably be reduced. Little is now known of the all-important films or adsorbed layers that form on metal when it is placed in contact with water and the part which these films play in controlling the passage of metal cations into

MISCELLANEOUS

0804-11-0836 (con.)

solution. Because of this lack of basic information and because of the fact that a great deal of the corrosion encountered in practice is aqueous or aqueous solution corrosion, a fundamental study is being made of the system metal-water-oxygen.

Activity Summary: A note to the Editor has been submitted to the Journal of Applied Physics for publication. Studies made on the system copper (single crystal) - water-oxygen have revealed the importance of illumination by white light, the presence of CO_2, and the crystallographic orientation on the oxidation process in the system under investigation. A technique for measuring film thickness by electrolytic reduction has been developed and is in use.

Plans for Fiscal Year 1958: A paper will be prepared for presentation at the meeting of the Corrosion Division, Electrochemical Society this Fall. The development of a method for measuring the thickness of a continuously growing film by measuring the change in reflectivity of an oxidizing polished surface will be completed early this year and will be used together with optical polarization techniques for making quantitative kinetic studies of oxide formation. The study of the nature and structure of oxide films formed on copper single crystals in water will be continued and extended to include iron single crystals. As a preliminary to the study of the influence of dislocations, lattice imperfections, etc. on corrosion, studies of more perfect crystals using iron and copper whiskers will be initiated. Work on this project is being carried out concurrently with Project 0804-11-4141.

0901-11-4468
0901-11-0947 The Mechanism of Plasticity

Objectives: To obtain a scientific understanding of the physical and chemical properties of matter determining plastic behavior in clay-water systems. Involved is a fundamental explanation of plasticity and a method for its measurement.

MISCELLANEOUS (con.)

0901-11-4468) (con.)
0901-11-0947)

Importance of the Project: Clays, partially because of their plastic nature, are the most widely used of all raw materials in the making of ceramic objects (approximately two billion dollars' worth of ceramic products are produced annually in this country). The so-called "plastic materials" are distinctly different in their behavior from viscous substances, and a scientific understanding of what plastic behavior is, and of the properties of matter determining, controlling, and measuring it, has not been developed. Mechanization of the ceramic industry is dependent upon the "workability" of clay, and can be fully realized only through an adequate understanding of "plastic" behavior. Furthermore, this dependence will become more acute, and scientific knowledge a virtual necessity,as the natural resources of the most desirable clays are exhausted; and scientific information will be required to so treat lower-quality clays that their plasticity will supply the desired workability.

Activity Summary: This is a continuing project. Detailed studies of the mineralogical, chemical and physical properties of several clays have been completed. On the basis of the results obtained, a single clay has been chosen and is being carefully fractionated into monodisperse fractions. The Rheological properties (viscous behavior of dilute clay-water suspensions and deformation behavior of clay-water "pastes") of these fractions will be determined. Apparatus for the determination of these properties is being designed.

An evaluation of purification methods; i.e., electrodialysis and ion-exchange resins, has indicated that the latter is to be preferred. This technique will be used in converting fractionated samples to the homoionic condition prior to testing.

Plans for Fiscal Year 1958: The fractionation of clay will be continued until sizeable quantities of a wide range of particle-size fractions have been accumulated. These samples will be converted to a homoionic condition with the aid of ion-exchange resins.

The study of the viscous and "plastic" behavior of the fractionated clay will be undertaken with special emphasis on the effect of systematic variations in particle size and surface area. Later, tests may be designed to study the effect of various types of exchangeable ions and dispersion media.

MISCELLANEOUS (con.)

1001-12-4817 Masonry Joint Sealers

Objectives: To obtain basic laboratory and exposure data on the properties of synthetic rubber-based calking compounds (joint sealers) for use in concrete and stone masonry; to develop test methods and to prepare specifications.

Importance of the Project: For the past ten years polysulfide synthetic rubber-based sealing compounds have been used successfully by the aircraft industry for integral-wing fuel tank sealing. Similar compounds may prove to be useful in masonry structures, around windows, between panels in curtain wall and pre-cast concrete construction, for sealing flashing and expansion joints, and for filling any joint where structural movement is expected and water-tightness is required. In recent years, polysulfide synthetic rubber based calkings have been used to some extent by private industry in concrete and curtain wall structures, and have been used to a very limited extent by some Governmental agencies.

Since failures of conventional oil and resin-based calkings as used in masonry have become common and extremely costly to the Government, including the defense agencies, it would appear advantageous for the NBS to study the properties of the polysulfide rubber-based calkings for use in concrete, stone and brick masonry; and possibly also in concrete runways, and structures in the Arctic regions. Other rubber-based compounds of silicones and neoprene bases might be included in the study.

Activity Summary: Not applicable.

Plans for Fiscal Year 1958: 1) Conduct a survey of masonry rubber joint sealers and obtain samples of the various grades from the producers; 2) Order special equipment needed to make certain tests such as a joint pulling machine, low temperature equipment, etc.; 3) Fabricate specimens of cast stone, normal concrete, limestone, brick, etc., for use as base material in testing the sealers; 4) Conduct adhesion, shrinkage, slump, tensile strength, hardness and other tests at normal, low and elevated temperatures.

MISCELLANEOUS (con.)

0410-20-3135 Radiation Shielding Problems

Objectives: To investigate various radiation shielding problems of particular interest to the Atomic Energy Commission.

Importance of the Project: Scattered radiation may produce radiation hazards for personnel or it may give unwanted low-energy components in radiation-instrument calibration work. In both it is necessary to evaluate the amount of radiation scattered under various conditions. In case the scattered radiation produces radiation hazards, attenuation curves must be available for most economical shielding of personnel.

Activity Summary:

1. Broad-beam attenuation curves for the complex gamma-ray spectrum of Ir^{192} were obtained and a paper prepared for publication.

2. The dose to the inner walls of therapy rooms was determined at a number of medical installations.

Plans for Fiscal Year 1958:

1. Measure such attenuations as are required. Attenuation of thulium-170 gamma rays is planned.

2. Analyze the results of dose-to-the-wall measurements in medical radiation rooms and prepare a publication on the results.

0604-20-0614 Developments of Techniques for Static and Dynamic Load Measurements

Objectives: To evaluate the performance of testing machines, elastic calibration devices for the calibration of testing machines, and strain measuring equipment under conditions simulating the actual conditions under which such equipment is used.

Importance of the Project: The importance of this project is attested to by the regular use of the calibration service available under Project No. 0604-30-3621 by other government, college and industrial laboratories. There is a continuing need for improved accuracy and for extension of techniques to provide results obtained under conditions more nearly simulating service conditions with respect to

MISCELLANEOUS (con.)

0604-20-0614 (con.)

such factors as rate of loading, temperature, etc. The efficient use of structural materials requires an accurate, detailed knowledge of their strengths under various conditions. This is especially true for aircraft and missile purposes where the highest possible strength-weight ratio is required. Tests of materials and structures are therefore made in testing machines having capacities ranging from a few pounds to several million pounds. These testing machines must be kept in proper operating condition. To this end a means of calibrating all machines over their entire range is badly needed. Rapid, accurate means of force measurement are also needed to measure the thrust of jet and rocket engines, to weigh highway and rail vehicles in motion and to weigh a large variety of industrial materials and products not only under static conditions but also in motion. Military and commercial requirements for increased range and accuracy of force measurements are constantly increasing. There is an urgent need for improved methods for calibrating elastic load-measuring devices at both low and high loads. Present dead-weight facilities should be extended to make possible the accurate calibration of devices above 111,000 lb. Hardness testing has an important part in modern production methods as a nondestructive control method which measures a combination of desirable engineering properties of materials. Development of microhardness test equipment during the past ten or twelve years has opened many new possibilities for research and has created problems of standardization of the instruments. There is need for improved methods for the calibration of the different types of hardness testing machines. There is also need for the development of techniques for measuring strain and deformation of specimens at low and elevated temperatures and for calibrating such equipment under conditions which closely simulate conditions of laboratory and field use. Another urgent need is for the development of suitable techniques for the evaluation of structural components such as riveted or bolted joints under alternating loads at elevated temperatures.

MISCELLANEOUS (con.)

0604-20-0614 (con.)

Activity Summary: This is a continuing project broadened to include a part of the activities previously carried on under Project No. 0604-30-0616. The study of dynamometers of 1,000,000 lb and 3,000,000 lb capacity was continued to observe their stability with time and use and to provide standards for the calibration of large capacity devices and thrust measuring systems under Project Numbers 0604-30-0616 and 0604-30-3621. Further work on the three commercial load cells of 100,000 lb capacity each and a totalizing indicator intended for use in calibrating devices from 111,000 lb to 300,000 lb showed that the errors of the calibration test loads measured with the load cells were substantially greater than the errors of proving rings used for the same purpose. It was concluded that for loads up to at least 500,000 lb, calibration by dead weights would be preferable to any other method in accuracy and would be far less time consuming. Study of the feasibility of constructing a larger dead-weight machine led to the conclusion that construction of a machine of at least 500,000 lb capacity would be practicable.

Plans for Fiscal Year 1958: 1) Evaluate the performance of testing machines and determine their errors due to rate of loading; 2) Study methods for calibrating hardness testing machines; 3) Evaluate the performance of strain measuring equipment at both low and elevated temperatures; 4) Evaluate and calibrate proving rings and dynamometers of all capacities and initiate the preparation of a general specification for such equipment; 5) Study the feasibility of constructing a machine for testing structural components under alternating loads at elevated temperatures.

0604-20-3601 Investigation of a Prestressed Cellular Drydock

Objectives: To provide experimental data on the mechanical performance of prestressed aluminum slabs of cellular construction, to assist with the development of gasketing systems and the mechanical components required for joining and assembling, and to make methods-of-assembly studies.

Importance of the Project: Seaplane operations of the Navy require considerable mobility of the bases of operations. A portable prefabricated drydock which can be assembled with a minimum of skills and tools would increase the mobility of seaplane operations.

MISCELLANEOUS (con.)

0604-20-3601 (con.)

Activity Summary: Tests made to determine the force required to punch through the center element of twelve 9-module segments with different preloads in the tension rods and with various joint sealants on the edges of the modules were completed. The results of these punching shear tests were reported in NBS Report No. 4992. Punching shear tests were made on three 36-module segments with different preloads in the tension rods. Also,uniform load tests were made on three 36-module segments with various materials in the joints between modules. A final report designated as NBS Report No. 5346, gives the results of the tests of the 36 module segments.

Plans for Fiscal Year 1958: Completed.

1000-20-4805 Design and Construction of Experimental Air Zero Locators

Objective: To design and construct devices for recording the location of a nuclear explosion and to make recommendations for the mass production of units for installation in potential target areas.

Importance of the Project: In order that FCDA personnel may direct rescue and survival operations effectively after a nuclear explosion delivered by an enemy, it is of utmost importance to know the location of the explosion at the earliest moment. The location of an explosion provides information as to the areas subjected to the greatest forces and amounts of radiant energy and for determining the areas where the fallout might be the least.

The assistance of the NBS was requested because its personnel had made previous studies of the effects of thermal radiation on materials.

Activity Summary: The project was approved about February 1, 1957 and 16 units were constructed and delivered to the FCDA by about May 1, 1957.

Each unit was provided with two different types of screen material and with three different sizes of aperture. No lenses were used.

MISCELLANEOUS (con.)

1000-20-4805 (con.)

The screen materials were paper selected from current stock at the Government Printing Office. Both screen materials were backed by aluminum plates. The direction of a nuclear explosion within the target area will be determined from the position of the aperture and the location of a scorched or charred area on the screens.

The screens were so graduated that the azimuth and altitude angles can be read directly in degrees.

Each unit was so constructed that it could be used in four different tests.

Plans for Fiscal Year 1958: After completion of the work originally planned and outlined in the previous section, the NBS was requested to furnish the services of technical personnel to supervise and inspect the installation and testing of the experimental air zero locators. This is in progress and is expected to terminate about August 1957.

According to present plans the project will be terminated upon submission of a final report summarizing the results of the tests and including recommendations for a production unit.

1003-20-4838 Air Filter Systems for Army Aircraft

Objectives: To study the airborne dust distribution around the rotor of an operating helicopter with respect to concentration and particle size, and to develop and construct models of air cleaners that will be more effective than presently-used devices in protecting airplane and helicopter engines from excessive wear in dusty atmospheres.

Importance of the Project: Wear of aviation engines, both airplanes and helicopters, has caused considerable expense and inconvenience in the past. Army aircraft, and especially helicopters, necessarily operate in dusty atmospheres much of the time, and available evidence indicates that present air cleaners for combustion air are inadequate to protect them from excessive wear. Reports of engine failure due to this cause in less than 100 hours are common. Experiments on this subject have been sporadically conducted by various agencies of the United States Government, as well as the governments of other nations. Information is lacking on the dust concentration and particle sizes that exist at various levels above the ground in the vicinity of an operating helicopter nor have adequate sampling methods been developed to secure representative samples for analysis.

MISCELLANEOUS (con.)

1003-20-4838 (con.)

Air filters currently used in the induction air systems of helicopters are too low in efficiency and are inadequate in dust-holding capacity. This work has been requested by the Office of the Chief of Transportation of the Department of the Army. It is an extension of the work done on air cleaners for tank engines during World War II and the continuing work on air-cleaning devices for heating and air conditioning systems for buildings.

Activity Summary: This project was started in December 1953. During fiscal 1957, studies were made of oil bath air cleaners and dry cloth media as air filters. The absolute filter described in U.S. Army Specification No. 90.21 was compared with a glass fiber paper developed by NBS, with the result that the latter was shown to remove more of the fine particles of dust than the former. Tests were made of nine knitted and woven fabrics of cotton, orlon, and dacron fibers. Four of these were commercial fabrics and five were made especially for these tests by the North Carolina School of Textiles. Some of these fabrics were promising and development of a multi-layer air cleaner using a dry cloth medium was undertaken. Modifications were also made of a commercial oil bath cleaner that increased its efficiency as it accumulated a dust load, increased its dust-holding capacity, and reduced its pressure drop. This modified air filter also shows promise for small aircraft engines.

Plans for Fiscal Year 1958: This project will be terminated in Fiscal 1958. Some further development work will be completed on the multi-layer dry cloth filter, which appeared to be the most promising type for this particular military application. A flight model of the dry cloth air cleaner is to be constructed and furnished for flight tests and the results of the flight tests are to be evaluated. A report of the studies of various types of air cleaners and filter media will be prepared for publication.

0103-30-2031 Lightning Protection

Objectives: To advise engineers of the Civil Aeronautic Administration on special lightning protection problems at airport and airway beacon installations and to test lightning arresters for the characteristics needed when they are used in such locations.

MISCELLANEOUS (con.)

0103-30-2031 (con.)

Importance of the Project: The failure of airport or beacon power during inclement weather may result in the wrecking of aircraft and consequent loss of life. Thus electric power distribution and communication circuits and facilities need to be of sound design to minimize possible lightning damage and the lightning arrester equipment must match the needs of differing installations if outages are to be avoided.

Activity Summary: The lightning project has been relatively inactive because there have been no unexplained failures and consequent need for corrective measures. However, help was given CAA on a pulsed beacon project.

Plans for Fiscal Year 1958: Installations will be examined for possible sources of trouble. Characteristics of selected lightning arresters will be studied by laboratory tests for suitability of specific applications.

0201-30-0207 Standards of Light and Color

Objective: The calibration and issuance to industry of lamp standards of candlepower, luminous flux, and color temperature; spectrophotometric standards and standards of color, transmittance, reflectance, opacity, gloss, and luminance.

Importance of the Project: Standards of light and color are in continuing heavy demand by industry for the calibration of instruments or working standards, or for the testing of materials and devices for compliance with specifications.

Activity Summary: Early in Fiscal 1957 this project was terminated and the work transferred to Project 2322. Before the termination of the project, 80 standards and calibrations were supplied as requested.

0201-30-0208 Specifications for Lamps and Colors

Objectives: Formulation and revision of Federal Specifications for lamps, auxiliary equipment, and colors, and cooperation with ASA in allied fields in order to attain coordination, particular stress being placed upon the development of improved qualification tests for lamps, on insuring interchangeability of lamps, and on the assignment of uniform designations to lamps.

MISCELLANEOUS (con.)

0201-30-0208 (con.)

Importance of the Project: The qualification testing of lamps under Project 2320 which provides the basis for the purchase of lamps by the Government depended upon this project to provide necessary specifications. New specifications had to be formulated and existing specifications revised periodically so that the qualification tests could afford the means for qualifying only manufacturers who can supply to the Government lamps of an acceptably high level of quality. Under this project also American Standards and Federal Specifications for the items covered by the project were coordinated so that there would be no avoidable disagreement or duplication.

Activity Summary: Early in Fiscal 1957 this project was terminated. The work on Federal Specifications for lamps was transferred to Project 2320 which makes use of the specifications. The cooperative work with ASA was transferred to Project 0299.

0204-30-0218 Calibration of Length and Angle

Objectives: To calibrate graduated length standards (National and State standards, NBS standards, master standards for manufacturers, etc.), base-line tapes for surveyors and engineers, leveling rods, engineers' transits and levels, optical flats, precision graduated circles, and miscellaneous items requiring precision length, angle, or area measurement, as, for example, sieves, haemacytometer chambers and cover glasses; to graduate special linear scales and length standards using interferometer type and precision screw type of dividing engine; and to graduate precision circles for theodolites, spectrometers, etc.; to calibrate thermal expansion apparatus for university and industrial laboratories. Work of this nature in calibrating surveying equipment for the U.S. Coast and Geodetic Survey is under Project 3630-30-1801, that for the Inter-American Geodetic Survey for Fiscal 1957 was under Project 0204-30-2312. During the early part of Fiscal 1957 Project 0204-30-2332 covered only government reimbursable tests, but for the greater part of the year it covered all reimbursable tests of the Length Section.

Importance of the Project: This project deals with a fundamental measurement in science. As the custodian of the primary standard of length of this country, it is our obligation to make precise lengths available to Government agencies, science, commerce, and industry. This is done by calibrating standards submitted here for test. This includes meter and yard bars, geodetic base-line tapes, surveyors' tapes, and many other items.

MISCELLANEOUS (con.)

0204-30-0218 (con.)

Activity Summary: This project was discontinued in the early part of the Fiscal Year and the activities continued under Project 2332. The report of the testing under Project 2332 includes that done under 0218.

Plans for Fiscal Year 1958: Discontinued in early part of Fiscal 1957 and merged with Project 2332.

0204-30-2312 Calibration of Surveying Equipment

Objectives: To calibrate precision base-line tapes, steel tapes, leveling rods, and other basic equipment used in geodetic surveys.

Importance of the Project: The equipment listed in the statement of objectives is used for precision surveys in Central and South America that are directly related to National Defense and development. The NBS provides the only reliable source of service available for the required standardizations of this equipment. These standardizations include the initial standardization of new equipment and subsequent restandardizations after use in the field.

Activity Summary: This has been a continuing project for several years. Since July 1, 1956, 17 invar base-line tapes and 5 steel tapes were calibrated.

Plans for Fiscal Year 1958: This project is being discontinued effective July 1, 1957. The work previously done under this project will thereafter be undertaken under Project 0204-30-2332 on a reimbursable basis.

0604-30-0616 Calibration of Mechanical Testing Machines and Apparatus

Objectives: To calibrate mechanical testing machines, dynamometers, load cells, force, strain, displacement, velocity and acceleration measuring equipment; to develop test equipment and methods; to assist in the formulation of specifications.

Importance of the Project: The NBS provides the only service available for the accurate calibration of elastic devices used for calibrating testing machines. Devices ranging in capacity from a few hundred pounds to several million pounds are calibrated. The accuracies of the testing machines used by the government and by producers

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and consumers are dependent on periodic calibrations with devices calibrated at NBS. Calibration cells used by manufacturers of aircraft weighing devices and load cells for measuring the thrust of jet engines and weighing the contents of bins and hoppers are calibrated in the NBS dead weight machines.

Activity Summary: This has been a continuing project but will be terminated at the close of Fiscal Year 1957. The work will be continued under Project Numbers 0604-30-3621 and 0604-20-0614. During the fiscal year, 177 devices were calibrated and reports and certificates were issued prior to the initiation of Project No. 0604-30-3621 under which the calibrations of 633 devices were completed.

1003-30-4889 Factors Affecting Efficacy of Cleanable Air Filters

Objectives: The objective of this investigation is to evaluate the factors which affect the efficacy of viscous impingement cleanable air filters and to develop information for use in Federal government specifications on these devices.

Importance of the Project: During the past three or four years this Bureau has conducted rather comprehensive investigations of the efficiency, pressure drop, and dust-holding capacity of electrostatic air cleaners, and throw-away types of air cleaners for the General Services Administration and has performed some tests of viscous impingement cleanable air filters for the Bureau of Ships. These results are widely distributed and widely used by various agencies of the Federal government. The Defense Department through the Tri-Service program of research and development being conducted at NBS, wants to expand the available information on air filters by comparing the performance of viscous impingement cleanable filters with media of one-inch and two-inch thicknesses, respectively, and develop data that will permit them to evaluate the relative economies of cleanable versus throw-away types of filters.

Activity Summary: New Project.

Plans for Fiscal Year 1958: I. Seven specimens of viscous impingement cleanable filters of two-inch thickness and an equal number of one-inch thickness made by the same manufacturers will be tested at a face velocity of 300 ft/min to evaluate initial pressure drop, and the efficiency and pressure drop for increments of dust load until the pressure drop reaches one-half inch W.G. Two

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consecutive tests will be made of each specimen with a thorough washing with a cold water spray between tests to determine the cleanability of the filters.

II. Interim reports will be provided during the program as the test of each filter is completed. At the conclusion of the project all of the test results developed at this Bureau during the last three or four years on viscous impingement cleanable filters, throw-away type filters, and electrostatic air cleaners will be assembled in one manual for distribution to the Defense Department and other government agencies who have sponsored portions of the program.

0400-40-0497 Recommendations for Radiation Protection

Objectives: To develop the basic principles for accomplishing radiation protection for all types of radiations, and to formulate these principles for presentation as NBS handbooks.

Importance of the Project: For more than 25 years, the NBS has been a national and international focal point for formulation of basic policy, rules, and recommendations in the field of radiation protection. Its ability to perform this service has been developed and maintained through the fact that the basic programs in standards and testing have been carried out in the same laboratory organization, with the result that the latest information on the properties of radiation is available for translation into practical working codes for radiation-protection. Considerable additional effort is required in preparing recommendations to expand the areas covered by the NBS handbooks. These handbooks, which are recognized as the primary standards in radiation protection by Federal and State agencies, present in a readily available and useful form the protection information necessary in order to safeguard properly the public and workers engaged in radiation fields.

Activity Summary: Work has been proceeding actively on several radiation protection handbooks. Because of the recent lowering of the maximum permissible radiation exposures, it has been necessary to undertake modifications of several existing handbooks. This has consequently resulted in the delay of the completion of handbooks which were scheduled for release during the past year. One of these handbooks dealing with neutron protection has been submitted for publication. This represents one of the most complete reports on neutron protection in existence.

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As a result of recommendations by the International Commission on Radiological Protection, it has been necessary to revise downward the permissible radiation exposure levels for man. The reduction by a factor of about 3, on the average, was subject to serious administrative difficulties. A new interpretation of the newly proposed levels associates the exposure with age and thereby eliminates some of the local and administrative difficulties.

Plans for Fiscal Year 1958. Fourteen of the eighteen subcommittees have active programs outlined for the coming year. Part of these are related to the revision of handbooks reflecting the lowered permissible exposure levels. Others will be dealing with new questions, particularly in the new field of radiological units and measurements. It is expected that these programs will result in the issuance of several handbooks during the coming year.

0400-40-3001 Radiological Physics for Civil Defense

Objectives. To establish a central point for work on ionizing radiations relevant to problems of civil defense.

Importance of the Project: This project provides a substantial and diverse scientific effort on radiation problems which is not otherwise available on an organized and continuing basis to the Federal Civil Defense Administration. It makes available specialists in radiation physics who act as a center for analysis, evaluation, and to carry out some limited research investigation which may be required.

Activity Summary: In the early stages of this project a preliminary survey was made of available spectral and penetration data on which shelter analysis must be based. This survey revealed that the most important input spectral data, namely that pertaining to delayed fission gamma rays, was in a very unsatisfactory state; furthermore, the most important experiments and calculations of gamma ray penetration for purposes of shelter evaluation had not been done. We have, therefore, this year attempted to get the spectral information, code the penetration calculations, and to perform an experiment in Nevada in a truly clean geometry. We have had moderate success: Theoretical data from which spectra can be ascertained has finally become available late in the year. We have some prospects now for obtaining from AEC additional data which we need to round out the picture. The programming for gamma ray penetration calculations, is nearly completed and the largest single part has been tested out. The experiment

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in Nevada is well under way. In addition, a survey of FCDA monitoring instruments is nearly complete; and some work has been done to develop instruments based on new principles. We have further attempted to work closely with people at NRDL, Oak Ridge, AFSWP, and the Army Chemical Center to get added information and help from these sources on penetration into shelter geometries.

Plans for Fiscal Year 1958: The work begun should bear fruit and become generally available this next fiscal year. The spectral information should become available, the penetration calculations should be completed, the study of monitoring instruments should be written up, and the experiment in Nevada should be analyzed. In addition, the work on this project should go much more strongly in the direction of experimentation. With the basis laid for proper interpretation, it now becomes desirable to test actual shelter-type geometries both with laboratory sources and in actual field tests.

1000-40-1099 Consultative and Advisory Services

Objectives: To provide technical information on materials, construction and equipment for buildings to governmental agencies, scientific, professional and industrial organizations and the general public.

Importance of the Project: Other governmental agencies, scientists and engineers depend upon the National Bureau of Standards to assist them in solving their technical problems by supplying accurate information on building materials and structures including that on strength, fire resistance and durability, and on heating and air-conditioning. Many of the inquiries are not answerable properly by reference to readily available publications or other source of information; scientists and engineers ordinarily appeal to the Bureau after their failure to obtain satisfactory answers to their questions from their immediate associates. Specialists of the Bureau often are able to provide the best available information as the result of their own researches, their studies of the scientific literature, and their wide and close association with other specialists in the subject.

The Bureau's assistance usually is given while expenditures for new construction, maintenance or repairs are being contemplated; hence, accurate estimates of the value of the advice given cannot be made. Nevertheless, the relatively

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large amounts indicated in the small number of instances for which the value could be estimated indicate that the total amount is many times the cost to the Bureau. The value of the Bureau's assistance in the preparation of standards for products and constructions is not measurable but is thought to be greater than the total of the advice on individual construction projects.

Activity Summary: This is a continuing project. An example of the type of service rendered in Fiscal Year 1957 under the project is as follows:

(a) Representatives of the NBS consulted with members of the trucking industry on means for establishing standard ratings for refrigerated trailers. A metering heat sink method for measuring heat transfer was devised and demonstrated. Then a joint industry-government research project to test the metering heat sink method and to establish rating conditions for refrigerated trailers was constructed. The results disclosed an urgent need for the development of rating methods and standards for mechanically refrigerated enclosures, especially trucks and trailers.

(b) In the study of air hygiene in tuberculosis, sponsored by the Veterans Administration, an isolation ward at the Veterans Hospital in Baltimore was used to provide evidence that the infectivity of tuberculosis can be quantitatively determined. Knowledge of the precise air leakage of this ward was required for this investigation. Using portable air infiltration measuring equipment, members of the NBS measured air leakage from the isolation ward, and as a result, the establishment of a project to determine the air flow pattern of the entire 300-bed hospital was suggested by the hospital officials.

(c) An extensive review and suggested revisions of five Federal Specifications relating to fire extinguishing devices were prepared for two Federal agencies.

(d) Consultative services were furnished to the Federal Housing Administration concerning requirements for vapor barriers in ceilings with loose-fill insulations, and in connection with the use of a vapor-impermeable insulation on the cold side of the framing of buildings.

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(e) An analysis was made for the Federal Trade Commission of the significance of certain test data on air filters submitted to FTC by a non-governmental laboratory.

There were many other services of this nature. Probably the service of most general value was the assistance of the staff to committees of technical societies such as the American Society for Testing Materials, American Standards Association, the American Concrete Institute, and the American Society of Heating and Air Conditioning Engineers. Scientific and engineering data were supplied to the committees and assistance was given in the formulation of improved standards and design manuals.

Plans for Fiscal Year 1958: Provide information as requested and continue to cooperate with scientific and technical societies in the formulation of improved standards for building materials and equipment. Services on committees of the Federal Construction Council will be frequent, as assistance of the staff is being sought increasingly on investigations for governmental agencies and industry. Current programs of the NBS are expected to make substantial contributions to improvements in methods of assessing the fire hazard properties of building materials, in testing methods, and improving the values appearing in model building codes. Substantial assistance will be given to the American Society for Testing Materials Committees on the revision of the guarded hot plate method for determining thermal conductivity, on the development of test methods and standards for reflective insulation as well as test methods and standards for bituminous roofing, for waterproofing material, and for other materials. Consultative services leading to standards, specifications and handbook values will be rendered to other societies, such as the American Standards Association and the American Society of Heating and Air Conditioning Engineers. Advisory services to the Federal Housing Administration, Office of Chief of Engineers, and other governmental and private organizations are anticipated in FY 1958.

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1000-40-4802 Federal Construction Council

Objectives: To provide a mechanism to assist Federal Agencies in exchanging technical information on the design construction, and maintenance of structures, and to facilitate interagency collaboration in this field.

Importance of the Project: In June 1953, the National Bureau of Standards negotiated a contract with the National Academy of Sciences "to provide the necessary committee and staff personnel to advise Federal Agencies on problems concerning the improvement of construction technology for buildings and other structures." Financing was accomplished by fund transfers to NBS from various agencies.

The Council serves as a forum for discussion, study, and evaluation of common problems and a clearing house for exchange of information between the various agencies on technical standards, design and construction practices, administrative matters affecting technical operations, technical investigations, and similar activities relating to building research and technology. The Chief of the Building Technology Division serves as "Agency Representative" and monitors the work done by the Council. The National Bureau of Standards, as a member of the Council, also participates in many of the technical phases of the program.

Activity Summary: During each fiscal year the Council assigns tasks to groups made up of members of the participating agencies and experts from elsewhere to conduct studies of current problems of design, construction and maintenance of buildings. Upon completion of the studies, reports are prepared and circulated to participating agencies and interested Government Agencies. Examples of studies either completed or underway during Fiscal Year 1957 follow:

(a) Waterproofing Masonry Walls Above and Below Grade - A survey of agency experiences and practices and of available methods of preventing leakage.

(b) Flexible Floor Coverings - A survey to determine practices of Government Agencies, manufacturers, and owners in the selection of flooring and on methods of bonding of flexible floor coverings.

(c) Cooling Towers and Evaporative Condensers - A survey of practices of Government Agencies regarding selecting, rating, testing, performance, and maintenance of cooling towers and evaporative condensers.

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(d) Paints for Structure - A survey to determine paint users' practices on specifying, sampling and testing of paint.

(e) Maintenance and Operating Problems Affected by Design and Construction - Identification of the design and construction factors having the greatest effect on the operation of buildings.

(f) Noise Control in Building Design - A survey leading to determination of successful methods for noise abatement through design and use of building materials.

(g) Electrical Load Growth in Buildings - A summary of information on the increase in the use of electrical energy in buildings and recommendations on allowances for future growth of demand.

Plans for Fiscal Year 1958: Reports on the following representative studies and others will be completed. Work will be initiated on new tasks.

(a) Working Drawings and Specifications - A review of Government and industry practices in the field of working drawings and specifications.

(b) Cathodic Protection as Applied to Underground Structures - An exchange of information on the effectiveness of Cathodic protection for various underground structures.

(c) Selection and Maintenance of Air Filters - A summary of available information including that from experiences of governmental agencies.

(d) Plumbing Research for Federal Construction Agencies - Identify the problems urgently needing research.

(e) Underground Pipe Installation and Systems - Summary of facts and opinions on the performance of various types of underground pipe constructions.

(f) Noise Control in Buildings - Identify agencies' noise problems, sources of noises and methods of noise abatement.

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major laboratories in Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside front cover.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

• Office of Basic Instrumentation.

• Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio Meteorology.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics. Microwave Circuit Standards.


NBS