NATIONAL BUREAU OF STANDARDS REPORT

5152

PROJECTS RELATED TO BUILDING RESEARCH

AT THE

NATIONAL BUREAU OF STANDARDS

FOR FISCAL YEAR 1957

Compiled by the

Building Technology Division

D. E. Parsons, Chief

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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 field laboratories in Boulder, Colorado, 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 reports and publications, appears on the inside back cover of this report.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Tubes. Electrical Instruments. Magnetic Measurements. Process Technology. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

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

Heat and Power. Temperature Measurements. Thermodynamics. Cryogenic Physics. Engines and Lubrication. Engine Fuels.

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

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Gas Chemistry. 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. Organic Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion.

Mineral Products. Ceramic Engineering. Porcelain and Pottery. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Heating and Air Conditioning. Floor, Roof, and Wall Coverings. Codes and Specifications.

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

Data Processing Systems. Components and Techniques. Digital Circuitry. Digital Systems. Analogue Systems. Applications 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.

Radio Propagation Engineering. Frequency Utilization Research. Tropospheric Propagation Research.

Radio Standards. High Frequency Standards Branch: High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Microwave Standards Branch: Extreme High Frequency and Noise. Microwave Frequency and Spectroscopy. Microwave Circuit Standards.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
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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 1957.

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.

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.

KEY TO ABBREVIATIONS
APPEARING IN THIS REPORT

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
CAA	Civil Aeronautics Administration
FCDA	Federal Civil Defense Administration
FHA	Federal Housing Administration
GSA	General Services Administration
IES	Illuminating Engineering Society
ISO	International Standardization Organization
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
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
QRDC	Quartermaster Research and Development Command
SEAC	Standards Electronic Automatic Computer

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: A study has been made of the reverberation chamber method of measuring the sound power output of sources. A theoretical treatment of monopole and dipole sources has been completed and checked experimentally. Some of the results of this work have been incorporated in the proposed revision of an ASA standard on the Measurement of Sound, (Committee Z24-W25). A technical paper on this work is being prepared. A supplement to BMS Report No. 144 was prepared and published during the year. The supplement listed the sound transmission loss data for 13 wall and floor constructions. The supplement also introduced a new measure of impact sound reduction which is considered superior to that used previously. Work on a standard for a reverberation chamber method of measuring the sound absorption of acoustic materials was continued. Several points in the theory of the edge diffraction effect of a patch in a reverberant sound field have been clarified.

ACOUSTICS (con.)

0601-12-0632 (con.)

Contributions were made to an ASTM proposed Tentative Method of Test for Impedance and Absorption of Acoustical Materials by the Tube Method (ASTM Committee C-20) and also to an ASA proposed standard for the Measurement of Sound Transmission Loss (ASA Z24-W12). Maps of the sound pressure distribution over the walls of a reverberation chamber have been computed using SEAC.

Plans for Fiscal Year 1957: 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.

Importance of the Project: Large quantities of acoustic materials are used annually by the Government and 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 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 is a continuing project that was started about 30 years ago. During Fiscal Year 1956 the following tests were reported: 4 reverberation room tests, 9 sound transmission loss tests, 1 microphone calibration, and 1 test of acoustical impedance of a sample of sound absorbing material.

Plans for Fiscal Year 1957: To continue the program along the same lines as above.

CEMENT, CONCRETE, AND MASONRY

0900-11-0914 The Chemistry of Portland Cement

Objectives: To obtain fundamental data on the structures and mechanisms involved in the burning of portland cement clinker and the hardening of concrete, leading to improved understanding of these processes and ultimately to technological improvements; to develop new experimental techniques needed in obtaining the required data.

Importance of the Project: The technology of portland cement is an important foundation of our national economy. It is an essential in industry, housing, and public works of all kinds. The testing of cement alone is one of the Bureau's largest single projects.

This research project, carried on by the Portland Cement Association Fellowship since 1924, has developed a number of different types of basic information which have had great importance in cement technology. Among these are formulas of the major cement clinker constituents, their heats of hydration, and the effect of cooling rate on crystal growth in clinker. The results of those investigations now affect almost all cement manufacture.

Activity Summary: This is a continuing project and formerly was numbered 0907-10-0914. During the year the work has been concentrated in the fields of high-temperature phase equilibria, X-ray crystallography, and electron microscopy.

In the study of the quaternary system CaO-$2CaO.SiO_2$ $12CaO.7Al_2O_3$ $2CaO.Fe_2O_3$, which forms the important iron-bearing constituent of cement clinker, the determination of equilibria in the ternary boundary CaO-$12CaO.7Al_2O_3$-$2CaO.Fe_2O_3$ was completed. Tie lines sufficient to establish the composition of the iron-bearing solid solution in any equilibrium mixture were determined. A method of differential thermal analysis developed for this work was found to have advantages of simplicity, speed, and economy which should make it valuable with a wide range of materials.

The study of the senary system K_2O-Na_2O-CaO-Al_2O_3-Fe_2O_3-SiO_2 in relation to cement clinker was continued. Selected mixtures whose course of crystallization had been established by the high-temperature centrifuge technique were also investigated by differential thermal analysis and X-ray diffraction, in order to determine the nature and order of appearance of the crystalline phases.

CEMENT, CONCRETE, AND MASONRY (con.)

0900-11-0914 (con.)

X-ray intensity data were obtained by the integrating Weissenberg method from a crystal of calcium hydroxide ground to spherical shape, in order to carry out a precise redetermination of the crystal structure.

The study of cement hydration by electron diffraction and electron microscopy was continued. Diffraction patterns suitable for structural interpretation were not obtained, but the application of the newer replica techniques to electron microscopy of hydrated cement was found promising for future morphological studies.

A beginning was made in the possible application of infrared spectroscopy to characterization of clinker minerals. The initial steps of assembling apparatus and finding experimental procedures suitable for routine use were completed.

Publications incidental to the program included "Research on Cement Clinker and Concrete" by R. H. Bogue (Rock Products 59, 86, 1956), "Efficient Design of Count-Rate Computers," "The Use of Stereoscopy in the Study and Teaching of Crystallography," and "Apparatus for High-Temperature Crystallography" by Fred Ordway (presented at American Crystallographic Association meeting, Pasadena, 1955), "Differential Thermal Analysis Above 1200°C" by T. F. Newkirk and "A New Study of Phase Relations in the Cystem CaO-CaO.Al_2O_3-2CaO.Fe_2O_3" by T. F. Newkirk and R. D. Thwaite (presented at American Ceramic Society meeting, New York, 1956.)

9903-20-4428 Properties of Concrete at Elevated Temperatures

Objectives: Study the mechanism responsible for spalling and failure of concrete when exposed to intense thermal shock. Attempts will be made to reduce the water permeability of concrete both in the cement and aggregate.

Importance of the Project: Refractory concretes for jet aircraft warm-up aprons have been tested for various properties to evaluate their usefulness for that purpose. In order to complete the evaluation of such concretes it would be desirable to learn whether the bonding cement has rehydrated during weathering, thereby increasing the strength of the concrete which had been subjected to heat treatments. Because concrete aprons are subjected to both thermal shock and weathering the information gained from the tests of weathered specimens could be correlated with actual service conditions.

CEMENT, CONCRETE, AND MASONRY (con.)

0903-20-4428 (con.)

Activity Summary: This is a continuation of a project started in July, 1951. The work includes the study of hydraulic cements and aggregates and the design and testing of concretes that might be suitable for jet aircraft aprons. During the past year a model jet has been constructed and used to simulate heating conditions of 1200°F at a velocity of 1200 ft/sec. Concrete slabs 18 x 18 x 6" are used for the test. Preliminary results indicate that failure of the slab under the jet is related to the extent of drying of the slab.

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, such as 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 in the hardening processes. 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, but the relation between chemical and physical properties and performance in service, but it is increasingly evident that more fundamental knowledge is required.

Activity Summary: Work on the system lime-silica-water has involved the following: an extensive literature survey, a study of phase equilibria in the system at 180°C, a thermochemical study of reactions in lime-silica gel pastes, and a study of rate of reaction between lime and silica gel in excess water. These tasks are in various stages of completion. Hydrothermal studies have been made of the formation and the composition of the hydrogarnet phase in the system lime-alumina-silica-water. A related study, in which strontia was substituted for lime, has been completed. Measurements of the surface areas of hydrated cements have been made by water

CEMENT, CONCRETE, AND MASONRY (con.)

0906-11-0923 (con.)

and nitrogen sorption, and the causes of the observed reduction in surface on storage are being sought. Studies of the alkali-aggregate reaction in concrete have demonstrated large volume increases and the development of considerable pressure. Microscopic studies have been of aid in observing the course of the reaction. The setting of oxychloride cements has been studied by thermochemical methods. A study has been made of the chemical reactions occurring during the hydration of aluminous cements.

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 $700,000,000 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: Some preliminary work on measuring volume changes in concrete during freezing and thawing by means of imbedded SR-4 strain gages has been done which indicates the feasibility of the method. An automatic strain-temperature scanner recorder has been acquired, which will permit following and recording of rapid changes of strain during fast or slow cycles. Preliminary tests and calibration curves are being made with this instrument.

Freezing-and-thawing tests in this laboratory on the cooperative series with ten other laboratories have been completed, and some preliminary work has been done on correlating the data and the performance characteristics of the apparatus of the laboratories. A report is being published by the ASTM on a previous project of this nature conducted in this laboratory.

Work has continued on the long-time study of concretes made from 200 samples of portland cement.

CEMENT, CONCRETE, AND MASONRY (con.)

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.

0906-30-4415 Cement Reference Laboratory

Objectives: To standardize and improve the testing of portland cement at laboratories throughout the country.

Importance of the Project: The NBS carried 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 makes an important contribution to this need.

Activity Summary: The Cement Reference Laboratory sends qualified men, together with calibrating equipment, to cement-testing laboratories throughout the country. Upon request, these men check and calibrate cement-testing equipment, demonstrate testing methods, and observe the methods used in other laboratories. The laboratory also distributes chemical and physical cooperative test samples throughout the industry

CEMENT, CONCRETE, AND MASONRY (con.)

0906-30-4415 (con.)

and analyzes the test results reported. It also makes contributions to test methods and apparatus and takes an active part in technical committee work.

Over 250 cement-testing laboratories take advantage of this service, and each is visited at approximately 3-year intervals.

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 substandard cement.

Activity Summary: This project has been in continuous operation for over 40 years. Currently, samples representing approximately 15 million barrels of cement per year are being tested in laboratories located in San Francisco, California; Seattle, Washington; Denver, Colorado; Allentown, Pennsylvania; and Washington, D. C. A statistical testing plan was put into effect which is expected to reduce the cost of testing to some extent.

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 Washington D. C. laboratory, although a few tests each year are made in the Seattle and San Francisco cement-testing laboratories.

CEMENT, CONCRETE, AND MASONRY (con.)

1001-11-4812 Stresses in Masonry

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

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

Activity Summary: This is a continuing project which was initiated in 1953. During the past year, the development of elastic theory was completed and numerical solutions were obtained for a partially restrained wall having a length of twice its height. Numerical solutions for completely restrained walls with two other ratios of length to height were completed in part. The theoretical results were verified by means of an aluminum wall-steel foundation model.

Plans for Fiscal Year 1957: (1) Theoretical work: Computation of stresses will be completed for walls in which the ratios of length to height are one and four; these computations are to be based on the assumption that the foundation is sufficiently rigid to prevent all shortening along the line of attachment. (2) Experimental work: Further experimental work will be carried out with models consisting of aluminum plates representing walls with attached steel members representing the foundations. The difference in the thermal coefficients of expansion of the two components will be utilized in simulating the contraction of a wall undergoing shrinkage. A final report to the Sponsor will be prepared.

CEMENT, CONCRETE, AND MASONRY (con.)

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 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. During the past year the effect of the strength of concrete on the width and spacing of tensile cracks in reinforced concrete beams was investigated in collaboration with the American Iron and Steel Institute Fellowship. The report presenting the results of a more general previous investigation of cracking was published. Progress was made in developing a new type of bond test specimen in which the bonding efficiency of the bar is measured by the tensile stress transferred to the concrete. Progress was also made in the development of an accelerated test method to measure the drying shrinkage of concrete masonry units. The study of bond strengths of masonry assemblages with both concrete masonry units and clay brick as component materials is continuing in collaboration with Masonry Research Fellowship.

Plans for Fiscal Year 1957: (1) Width of cracks in reinforced concrete beams: Analyze and prepare for publication the data obtained in the tests of a series of beams in which the major variable was strength of concrete. (2) New bond test for deformed reinforcing bars: Continue the development of a bond test method which measures the ability of a deformed bar to transfer its stress to the surrounding concrete. Preliminary tests indicate better reproducibility

CEMENT, CONCRETE, AND MASONRY (con.)

1001-12-1000 (con.)

than the currently used pull-out and beam tests. (3) Durability of brick and stone: Continue periodic examinations of stone exposure test wall and analyze observations from long-term masonry exposure tests. (4) Property of masonry: Continue bond strength tests of masonry assemblages in collaboration with Masonry Research Fellowship and initiate the study of compressive, transverse and shearing strength of full scale masonry walls.

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 checker-board fashion and prestressing them in two directions. Slabs consisting of plain and reinforced concrete cells and some consisting of structural clay tile blocks were included in the study. In collaboration with the Fire Protection Laboratory, the fire resistance of several thin-shell concrete constructions, both prestressed and non-prestressed, was determined. An experimental 16- by 30-ft building of precast thin-shell concrete panels cast in the Bureau laboratories was erected for the purpose of studying the adequacy of water-tightness of various calking materials installed in the joints between roof and wall panels.

Plans for Fiscal Year 1957: (1) Further evaluation of prestressed cellular assemblies: Prestressed slabs consisting of cellular units of various types, with either grouted or ungrouted joints will be studied with regard to their stiffness, flexural strength, resistance to shear and loss of prestress with time. (2) Water-tightness of joints between

CEMENT, CONCRETE, AND MASONRY (con.)

1001-12-4811 (con.)

precast elements: The joints in the 16- by 30-ft panel frame structure will be examined periodically to determine the suitability of various calking materials for long-term service. (3) 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: 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 first phase of the experimental work in this project was completed. This consisted of determining the effect of yield strength and stress-strain characteristics of reinforcement of five different types on the resisting moment and mode of failure of beams in which the reinforcement was proportioned to give a constant total yield strength.

Plans for Fiscal Year 1957: (1) Strength of beams in shear: The second phase of the project will be initiated to determine the effect of increased steel stresses on the shearing strengths of beams having no web reinforcement; (2) A final report on the findings in this study will be prepared for publication.

CEMENT, CONCRETE, AND MASONRY (con.)

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 as thermal insulation "fill" for roofs, cavity walls, and underground steam lines. Satisfactory specifications are not available and current construction specifications for the quality of these materials are arbitrary and unrealistic. There is an immediate need for an improved specification based on a study of properties of insulating concretes.

Plans for Fiscal Year 1957: Conduct a laboratory investigation of properties of various insulating concretes. Determine such properties as thermal conductivity, compressive and indentation strengths, drying shrinkage and rate of drying as functions of composition, proportions, density and size and shape of test specimens. Methods of testing suitable for use in specifications will be adapted or formulated. The laboratory phases of the program are restricted to tests that will be most helpful in supplementing information from previous tests at the NBS and that obtained in reviews of the literature.

CODES AND SPECIFICATIONS

0400-40-0497 Recommendations for Radiation Protection

(See Miscellaneous)

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 1955 specifications for brushing lacquer and alkyd flat wall paint were completed by the inclusion of departmental comments and were subsequently promulgated as Federal Specifications TT-L-26 and TT-P-30, respectively. A substantial number of specifications prepared by others under the "assigned agency" system were reviewed and comments submitted. The international program on standardization of lac resins was continued in addition to participation in other ASTM projects.

Plans for Fiscal Year 1957: (1) Continue development of new specification for polyvinyl acetate emulsion paint and review of other Federal Specifications as required. (2) Cooperate with ASTM and ISO in preparation of standards for organic coating materials and component raw materials.

CODES AND SPECIFICATIONS (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 non-governmental 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 the acceptance of responsibility for the preparation of detail specifications and test method standards. In the field of organic and fibrous materials, the NBS has accepted responsibility for Federal test methods for rubber, textiles, paper, leather, plastics, adhesives, and floor coverings.

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. 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. The 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.

Activity Summary: In addition to the preparation of standards, the NBS was called upon for information and advice in connection with the activities of numerous bodies engaged in work on building and plumbing codes, including New York State Building Code Commission, the Joint Committee on Building Codes, the Building Officials Conference of America, and the Coordinating Committee for a National Plumbing Code. An active part has also been taken in the revision of many of the current American Standards.

CODES AND SPECIFICATIONS (con.)

1005-40-1022 (con.)

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

1. A complete revision of the National Electrical Code, which has been finished.

2. Revision of the National Electrical Safety Code, with completion of the rules on grounding.

3. A major revision of the Code for Head, Eye, and Respiratory Protection, which has been completed and is to be submitted to the Joint Sponsors.

4. A study of wind pressures on buildings, with application to specific types of structures.

5. Studies of capacities of horizontal drains and plumbing stacks, which serve as a basis for code requirements.

6. The Refrigerator Safety Project, with development of safety criteria for evaluating safety release devices and conduct of tests.

7. Minimum Requirements for Design Loads in Buildings and Other Structures, ASA A58.1-1955, were completed and published.

Plans for Fiscal Year 1957: Work has been started on the revision of the Elevator Inspector's Manual, a companion volume to the Elevator Safety Code. A program of the work of revision has been developed. A new sectional committee for the Safety Code on Electric Fences will be formed and the fundamentals for a new code prepared in draft form. Work on part 2 of the National Electrical Safety Code will be continued with completion of the work on conflicts and interpretations. The Safety Code for Head, Eye, and Respiratory Protection will be submitted to the American Standards Association and editorially reviewed and published. A Code on Radio Installations will be undertaken under a new sectional committee which is being reorganized to conform with ASA Procedure. Development of requirements for design loads in buildings and other structures will be continued. Coordination of requirements of building codes (in cooperation with the Joint Committee on Building Codes) will be continued.

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 is a continuing project, started in December 1954. Samples of cotton, cotton hydrocellulose, and viscose rayon, both by themselves and also impregnated with flame retardants, were pyrolyzed in a high vacuum in the temperature range 250° to 397° C. The volatile and non-volatile fractions were evaluated qualitatively and quantitatively, using mass spectrometry, infrared absorption, and cryoscopy. Rates of degradation and activation energies were determined in the temperature range 245° to 305° C. It was found that the flame retardants caused an increase in rates of degradation and a decrease in activation energies of degradation and resulted in a higher yield of carbon dioxide, water, and char material, and a lower yield of tar.

Plans for Fiscal Year 1957: (1) Extend the pyrolysis, which has previously been conducted only in a vacuum, to conditions in which there are present (a) an inert gas such as nitrogen or helium, or (b) air or pure oxygen. (2) prepare a final report on the results of the complete research program.

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 the ignition, combustion, and explosion characteristics resulting from contamination of combustible materials with propellants or their component materials.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-11-4873 (con.)

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: This is a new project. It will permit a continuation with considerable enlargement of the scope of work done in Fiscal Year 1955 for the U.S. Coast Guard. This work dealt with the mechanism of extinguishment of flammable liquid fires by means of dry powder. Measurements were made of the extent to which material particles interposed between the flame and the fuel prevented the transfer of radiant energy. The results indicate that this effect plays a significant part in the extinguishment process. It is also supposed that potentially reactive ions and free radicals will not propagate the combustion chain reaction if they encounter particles of powder. The rapidity of the extinguishing action and the small powder concentration required, as measured in these experiments, are in accord with this hypothesis.

Plans for Fiscal Year 1957: (1) A review will be made of all recent technical work relating to the general field of mechanism of fire extinguishment. This material will be studied in the light of results of recent work on extinguishment with dry powders. (2) An effort will be made to study the effect of powder particle size on the quantity required for extinguishment of flammable liquid fires. An attempt will be made to determine whether the observed behavior can be related to heat transfer between fuel vapors and powder, or whether a more likely explanation might involve chemical kinetic effects. (3) It is expected that some studies will also be initiated on the behavior of water sprays as a means for control of flammable liquid fires.

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 the 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. A fair portion of the tasks proposed for completion in 1956 have been achieved. Study of ignition characteristics of materials has progressed well but not far enough to permit preparation of a paper on the subject. A paper was prepared and presented to the American Society for Testing Materials on the newly developed flame spread test method.

Investigation of the fire resistance of cellular concrete floor constructions was emphasized during 1956. This work is now nearing completion. A preliminary investigation was also possible on the feasibility of a new test method for evaluating the combustible content of materials. The previously proposed work on effectiveness of fire retardant treatments and test methods did not progress as anticipated largely because of difficulties encountered in procurement of fabrics and application of finish.

Plans for Fiscal Year 1957: (1) Fire resistance: Work will be completed on the behavior of cellular concretes and a report prepared for publication. A small scale research study will be made on the effect of gypsum perlite plaster composition on transient thermal behavior. This latter will be studied with the aid of the small research furnace and the use of heat flow transducers. (2) Ignition characteristics of materials: Work will continue on study of the self-heating characteristics of materials by the use of the adiabatic furnace and, if practical, a paper will be prepared on the method developed. (3) Combustibility test method:An effort will be made to further develop this new method. This consists essentially of an adiabatic furnace calorimeter with provision for burning the combustible content of the material at

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-12-1029 (con.)

variable temperature. (4) Fabric flammability: When the twenty-five different treated fabrics are returned from the finishers the study will be completed of the effect of fabric finish on flammability as evaluated by several methods of test. It is expected that this study may ultimately assist in development of improved test methods.

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 the Project: In 1953 fire resistance tests were performed for the Corps of Engineers on specimens involving use of a reinforced concrete beam associated with concrete channel slabs forming a roof deck. The fire endurance of these specimens was much less than that anticipated by the designers. Because of this the NBS has initiated a theoretical study of performance of monolithic structures. Such calculations are at best, however, only approximate indicators of fire endurance performance. The work proposed is intended as a check on the applicability of the theoretical calculations and also for the purpose of developing basic fire endurance data to be used for design purposes.

Activity Summary: The proposed work on completion of analysis of SEAC data has been accomplished and a report has been prepared for submittal to the Sponsor. Fire resistance work on the beam specimens has been delayed by other studies being conducted in the furnace.

Plans for Fiscal Year 1957: (1) A study will be made of the fire endurance performance of the beam specimens now on hand. (2) A report will be prepared on the results of these tests with the objective of correlating them with theoretical predictions based on SEAC calculations. (3) The first few of a group of specimens will be prepared for the purpose of determining the effect of size of beam (scale size) on fire endurance.

1002-20-4875 Fireproofing Structural Steel

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

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1002-20-4875 (con.)

Importance of the 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.

Plans for Fiscal Year 1957: (1) A review will be made of materials and application procedures proposed for this purpose. (2) A variety of materials will be selected and samples secured for small scale preliminary experimental purposes. These will include: (a) measurement of thermal properties, (b) performance of small scale fire studies, and (c) consideration of methods for evaluating the permanence and character of the bond developed between the insulation and steel.

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

Plans for Fiscal Year 1957: The eight unfinished investigations will be completed. These include studies on pyrotechnic smoke signals and fire extinguishers. A new project will cover work authorized by the Sponsor in 1957.

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 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.

Plans for Fiscal Year 1957: Examinations, performance tests, and development of new test procedures will be performed as requested by the Sponsor.

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: Because of a relatively great increase in the use of thermal insulation in residential and commercial construction with ungrounded metal roofs and sidings, there is a fire hazard involved. Many of these insulation materials are of a combustible nature, and where panels of metal foil or metalized insulation are used beneath the ungrounded metal, there is a possibility of ignition by an electric discharge or by drops of molten metal from the fuzed foil; or possibly dust on a highly heated foil surface may become ignited.

FIRE PROTECTION AND EXTINGUISHMENT (con.)

1005-12-1005 (con.)

Plans for Fiscal Year 1957:

Task 1. To investigate experimentally 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. To investigate the effect of the discharge of a heavy current (at least 10,000 amps) on metallic roofing of gages (thicknesses) now in common use.

Task 3. To investigate the possibility of ignition 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 4. To investigate the possibility of ignition of flammable material under metallic roofs by increasing the current until the roofing is punctured.

HEATING AND REFRIGERATION

0603-30-0613 Testing Wind Equipment

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

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.

Activity Summary: During the past year 22 items were received for calibration. Six were vane anemometers, nine were cup anemometers, and seven were thermal-type airmeters. Reports have generally been mailed within a month of receipt of the instrument. There is no backlog.

1003-11-1015 Heat Transfer Measurements

Objectives: To determine the thermal conductivity and heat transfer properties of materials and building constructions, and make calibration measurements on specimens for reference use by other laboratories; to improve apparatus and develop new methods; to furnish advisory technical information in the field of heat transfer to governmental agencies regarding design, specifications, standards and special applications.

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. Governmental, industrial, university and private laboratories utilize its services for calibration of reference specimens for standardizing their equipment. The services provided in regard to 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. The experience of its personnel is sought on an

HEATING AND REFRIGERATION (con.)

1003-11-1015 (con.)

advisory basis by an increasing number of governmental and private laboratories in regard to proposed methods and apparatus for measurements in this field.

Activity Summary: This is a continuing project. Measurements of the thermal conductivity of various insulating materials were made and calibrated specimens were provided for the use of other laboratories and in determinations on materials submitted by other governmental agencies. A new apparatus was designed and built for measuring the thermal conductivity of specimens of rock and similar materials by a comparison method, using as a reference a stainless steel bar, the conductivity of which was determined in our metals apparatus. Trials were made of a proposed method for determining the thermal conductivity of metals using a large electric current passed along a bar. Upon investigating this method, a number of problems have arisen which still require further study before the method can be considered a satisfactory standard.

A radial-flow cylindrical type thermal conductivity apparatus with the novel feature of an extruded ceramic core was constructed and a few measurements were made with it on molded-type pipe insulations and on a few granular materials.

Plans for Fiscal Year 1957: Continue studies of improved methods for thermal conductivity measurements and calibration of reference specimens; investigate further the electrical method for measurements on metals; conduct systematic measurements with the radial-flow apparatus to determine the thermal conductivity of granular insulations to provide data needed in connection with other determinations, such as those metals at high temperatures and for general information of value to other laboratories and industry. It is expected that the work planned with the radial-flow apparatus and with the apparatus for measuring the thermal conductivity of rocks will be carried to a point which will enable preparation of papers on both.

1003-11-4831 Air Conditioning of Underground Installations

Objectives: To determine by experimental results and theoretical approach, the necessary refrigeration required to maintain underground reservoirs at temperatures below their initial surrounding rock temperatures. For the case where there is ice in the reservoir, several design factors must be resolved, i.e., control of the amount of ice in the reservoir, effect of ice on heat exchange surfaces and circulation of water in and out of the reservoir.

Importance of the Project: Underground installations are recognized as important protective means for essential activities and for the storage of material and equipment for military purposes. Certain inherent advantages may lead to their use for other purposes. Design data for underground heating and air conditioning systems were inadequate and the present project has provided much data of engineering importance, such as heat exchanges to and from underground spaces, the effects of tunnels or shafts on air drawn through them, and the thermal properties of rock.

Certain types of underground installation, due to their importance for national defense, must be maintained in operation regardless of interruption due to attack on the outside services such as domestic water, cooling water and electricity. A problem that confronts the designing engineer as an outgrowth of this condition is to provide a means for dissipating heat from certain large heat producing sources within the protected area of the underground installation. The heat producing sources may be electronic equipment, personnel, electric generating equipment, refrigeration condensers, etc. A solution to this problem is to provide an underground reservoir filled with water; so that during an interruption in the outside cooling water service, heat is transferred to the water in the reservoir and part of the heat is absorbed by the surrounding earth mass.

The above system has already been investigated by this Bureau and shows considerable merit. The principal drawback is that for large amounts of heat to be dissipated and for prolonged periods of interruption to the cooling water services, the size of the reservoir becomes inordinately large. In order to reduce the size of the reservoir to comply with the requirements of heat load and time, the temperature of the surrounding earth mass and water may be maintained during normal operation somewhere below its initial temperature by the refrigeration

1003-11-4831 (con.)

process. A larger heat sink is then provided for the period of interruption. If most of the water in the reservoir is ice, the latent heat of fusion of the ice will add considerably to the heat sink and reduce the necessary physical dimensions of the reservoir.

Activity Summary: This is a continuing project. During fiscal year 1956, heat transfer phenomena and the performance of air conditioning equipment in two underground installations were observed; experimental data were gathered in the air conditioning effect of tunnels or shafts, and on the heat absorbing capacity of an underground reservoir used as a heat sink; Part V of the Engineering Manual for Protective Constructions was completed and submitted to the Sponsor.

Plans for Fiscal Year 1957: Install refrigerating machinery with a pipe coil in an available reservoir to provide experimental results for the refrigeration capacity necessary to maintain the reservoir at reduced temperature under the no-load or standby condition; to observe the capacity of the reservoir, after freezing, as a heat sink. Determine the effect of icing up of heat transfer surfaces upon the heat transfer and design proper control systems for an ice to water balance in the laboratory at the National Bureau of Standards.

1003-11-4886 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 -300F to temperatures approaching 1000F.

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 on the effect of nickel alloy steels are 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.

HEATING AND REFRIGERATION (con.)

1003-11-4886 (con.)

Activity Summary: This project was approved for Fiscal Year 1956, but no work was undertaken because of the pressure of other work and the lack of available personnel.

Plans for Fiscal Year 1957: Tasks proposed are:

1. To develop an apparatus for measuring the thermal conductivity of steels at temperatures from -300 to about 1000F.

2. Conduct trials of the method making a comparison of results with conductivities obtained in the Bureau's bar-type thermal conductivity apparatus for metals at moderate to high temperatures.

3. Prepare up to six specimens of nickel alloy steels and determine their thermal conductivity over the range of temperature desired.

4. Determine the composition of the several specimens with such other metallurgical determinations as may be necessary.

5. Prepare a summary of the findings in the form of a report to International Nickel Company, or a paper for publication, or both, on completion of the work.

1003-12-4881 Underground Pipe Insulations

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 for such materials by Federal agencies.

Importance of the Project: Central heating plants often require extensive underground piping systems for distribution of steam or hot water to the area of usage. Such piping systems are usually insulated to reduce heat losses and to prevent rapid corrosion of the pipe as a result of chemical and electrolytic action. Some of the characteristics desired for underground pipe insulation are low thermal conductivity, low moisture permeance, high crushing strength, suitable expansion characteristics, adequate stability at temperatures ranging from below freezing to 350°F, and long life. Many types of insulation and embedment have been

HEATING AND REFRIGERATION (con.)

1003-12-4881 (con.)

used in addition to various kinds of tunnel construction. The Corps of Engineers of the Department of the Army expends several million dollars each year for installtions of this type and requires information on the performance of such insulating materials in order to prepare adequate specifications for purchase. Their experience has indicated that not all of the 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 Fiscal Year 1955 and some tests of typical insulations were made as a guide to further operations. During Fiscal Year 1956, the thermal conductivity, heat transmission, and moisture resistance of an insulation made of portland cement and macerated rubber, and other specimens of materials made of fire clay and insulation in concrete, called Z-crete, were investigated. Various means for excluding water from the insulation were tried, but no entirely satisfactory means of accomplishing this were determined, either by ourselves or the manufacturers concerned.

Plans for Fiscal Year 1957: To continue studies of this subject, including tests of steam pipe imbedded in dry earths of various kinds, insulation made of light weight concrete and tests of conventionally accepted underground pipe insulation for comparative purposes.

1003-12-4887 Moisture in Roof Insulation

Objectives: To provide data for estimating or calculating the insulating value of various types of insulated roof deck constructions under similar service conditions; to evaluate quantitatively the degree of effect of known contents of moisture on the insulating value of specific insulated roof deck constructions, to determine the effectiveness of vents for the release of contained moisture, to ascertain if some particular types of insulated roof constructions have intrinsic characteristics favoring moisture release.

HEATING AND REFRIGERATION (con.)

1003-12-4887 (con.)

Importance of the Project: Concrete roof decks are commonly insulated by thermal insulations of various kinds laid between the deck and the built-up roofing. The latter is practically impermeable to water or water vapor, and moisture in the insulation, due either to its presence when the roofing was applied, or to accumulation by condensation or by other means, 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 determine these discrepancies accurately, information is needed concerning the effect of initially-present or accumulated moisture on the insulating performance of various types of roof-deck insulations.

Activity Summary: During Fiscal Year 1956, a study of the effect of moisture in insulated roof decks on their insulating performance under several simulated climatic conditions was in progress. Fifteen roof deck insulations, some with and some without vapor barriers, were exposed for periods of from two to four months to simulated conditions of (a) summer exposure, (b) mild winter exposure, (c) winter exposure, and a repetition of (a). Solar heating of the roof surface was simulated, for each condition, and daily observations of the thermal conductivities of the several insulations under the various conditions, by means of heat flow meters and thermocouples attached to the specimens, were made. Eleven of the specimens were removed from the test apparatus, of which five were oven-dried and reinstalled, four dried and reinstalled without the concrete roof deck so that data on intrinsic moisture accumulation could be obtained, and two were replaced by new concrete-insulated specimens. The quantitative data thus obtained provide a basis for estimating tolerable amounts, and relative effects, of moisture in insulations of various kinds in roof decks or similar applications.

Plans for Fiscal Year 1957: It is proposed to ascertain quantitatively the effect on the thermal insulating value of particular insulated roof deck constructions of known amounts of moisture within the construction, continuing and completing work to this end which started in the last third of Fiscal Year 1956; to investigate the moisture-release effect of vents to the outdoor side of some insulating concrete slabs strong enough to be used without a structural concrete roof deck; render a final report, and interim reports if requested.

HEATING AND REFRIGERATION (con.)

1003-20-1014 Heating and Air Conditioning Equipment

Objectives: To develop test methods for heating, air conditioning and air cleaning equipment and to provide the data essential for developing specifications, codes, and standards for heating, refrigerating, air conditioning and associated equipment.

Importance of the Project: Government agencies, professional societies, and industry need new basic data for preparing and improving codes and standards for heating, air conditioning, refrigerating, and air cleaning equipment. Purchases of air conditioning equipment by the Federal agencies, as well as the public, have increased materially, and it is recognized that the application of standard testing and rating procedures would result in great savings and convenience to all concerned. Considerable confusion about ratings now exists, questions continually arise among Government agencies, and there is pressure from industry for assistance in developing standards. Air infiltration remains the most important unknown in the computation of heating and air conditioning requirements for houses and buildings. This uncertainty results in errors in selection of equipment for size.

Air filters are being used increasingly in air conditioning and ventilating systems of buildings and in commercial and industrial equipment. As there are no standards for the rating of the filters, Government agencies and engineers generally are looking to the NBS to provide suitable methods of testing and rating.

Activity Summary: During Fiscal Year 1956, a Commercial Standard on Warm Air Furnaces Equipped with Pressure Atomizing or Rotary Type Oil Burners (CS195-54) was promulgated, the initial draft of which was written by a member of our staff, and which was completed in cooperation with the Subcommittee on Furnace Rating Codes of the Research Advisory Committee of the National Warm Air Heating and Air Conditioning Association.

The Testing and Rating Code for Heavy Duty Furnaces, published by the American Society of Heating and Air Conditioning Engineers, was completed. The initial draft was written by a member of our staff in consultation with the Heavy Duty Furnace Code Committee of the ASHAE.

HEATING AND REFRIGERATION (con.)

1003-20-1014 (con.)

Services were rendered to the Institute of Boiler and Radiator Manufacturers and the Convector Manufacturers Association in the application of the Commercial Standard on Convectors (CS140-47).

Preliminary studies of safety latches for refrigerator doors were completed by members of the Section. This included obtaining data on existing refrigerator latches, forces exerted by children who might be accidentally imprisoned in abandoned refrigerators during play, and possible designs of latches including safety features to prevent suffocation or other casualties.

Plans for Fiscal Year 1957: The Federal Specification on Self Contained Air Conditioners will be amended to make it concordant with current practices and techniques. A standard for domestic air conditioners will be developed in cooperation with the National Warm Air Heating and Air Conditioning Association and the Air Conditioning and Refrigeration Institute. The standard will be written in part and edited in its entirety by staff members of NBS.

Infiltration in houses and buildings and methods for measuring and controlling it will be considered in cooperation with the American Society of Heating and Air Conditioning Engineers. An apparatus calibrated at NBS is being used in experiments on infiltration in two research houses at the University of Illinois. The new apparatus developed by NBS will be used to measure infiltration in a few houses to obtain comparative data. A paper on this apparatus will be prepared.

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 occurence and effects of condensation of water within the component parts.

HEATING AND REFRIGERATION (con.)

1003-20-4832 (con.)

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. Available equipment changed greatly during World War II when designs were altered on an emergency basis, depending on the component parts that could be furnished by the industry. Since World War II, the change has been more evolutionary in character, and equipment of a greater variety of size and characteristics is now in use. Standardization is essential for minimizing the stock of necessary spare parts, especially since military operations are world-wide. 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 the last year, a modulating thermo-mechanical control system for portable refrigeration systems was brought up to a state of development such that its quantity production was discussed with industrial representatives. The device is of much interest to the Quartermaster General's Office, and its adaptation for quantity production is in prospect. Work completed on engine and refrigerating machine characteristics and on insulation of portable and mobile structures is contained in NBS Reports 4276, 4288, 4309, 4434, and 4472. Work on the design of exhaust gas heat exchanger for warmed warehouses for use in the Arctic is continuing. The thermal characteristics of three refrigerated trailers were observed as a means of checking the present specifications for such vehicles.

Plans for Fiscal Year 1957: Continue observations of the performance of prototype refrigerated trailers, portable refrigerated warehouses and refrigerating units of both portable and stationary application; attempt to attain quantity production by industry of the thermo-mechanical control system for warehouse units, the investigation to include study of both gasoline-engine and electric-motor-driven portable and stationary refrigerated units, evaluate the standardization procedure now in use by QM for refrigeration compressors by testing some specimens and making recommendations for modifications of the procedures; continue studies of vapor transmission in insulated warehouses and mobile structures; continue development of a gasoline engine-exhaust heat exchanger.

HEATING AND REFRIGERATION (con.)

1003-20-4838 Aircraft Engine Air Filters

(See Miscellaneous)

1003-20-4885 Life of Upper Air Tubes

Objectives of Project: 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 four sets of upper air tubes now available from OQMG, using three firing schedules, and (2) with the guidance obtained from these results and metallurgical information, to determine by tests, and to recommend material or materials for the upper air tube that will yield a satisfactory service life, taking into consideration, also, the following factors: (a) producibility by either 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 housings over a wide geographical distribution. Failure of the upper air tube incapacitates the stove; in addition, in failing, it may cause destruction of the pot burner, and thus multiply the problems involved in immediate replacement in the field. Development of an upper air tube of life commensurate with that of the stove, and of specifications for the material, taking into account the subsidiary factors mentioned above, is important from the standpoint of military reliability, and of economy and facility in procurement.

Activity Summary: This project was approved during the final quarter of Fiscal Year 1956, but only preliminary planning was accomplished.

Plans for Fiscal Year 1957: Metallurgical examinations will be made of specimens of the tubes showing premature failure and the following other tasks will be undertaken:

1. Prepare a temporary fireproof test structure adequate to house 12 stoves operating under test conditions, with necessary measuring equipment and automatic time controls for round-the-clock operation.

1003-20-4838 (con.)

2. If possible in the available time, initiate service tests of upper tubes as furnished with stoves by the OQMG.

3. Conduct and complete service-life tests of four sets of present stock upper air tubes.

4. In accordance with the results on the stock upper air tubes, and with the assistance of the Metallurgy Division, prepare upper air tubes of improved materials and subject them to service-life tests.

5. Submit quarterly reports on progress, and if the project is concluded in Fiscal Year 1957, submit a final summary report, including recommendations for materials to yield improved upper air tube service life.

PLASTICS

0707-11-0733 Research on Properties of Plastics

(See Properties of Materials)

0707-11-3862 Adhesion of Resins to Glass Fibers

Objectives: To investigate and evaluate the basic factors involved in obtaining high bond strengths between synthetic resins and glass fibers.

Importance of the Project: Glass fiber reinforced plastics have many important military and civilian uses. The degree of adhesion of the synthetic resins used as bonding agents to the glass fibers used as the high strength reinforcing medium is a vital factor in obtaining optimum performance characteristics in the reinforced plastic. The present method for evaluating new glass fibers, fiber treatments, and bonding resins is by the empirical process of molding and testing reinforced panels. This is a time-consuming and costly method and provides no fundamental data as a guide for future development or research. Therefore, the Navy Bureau of Aeronautics initiated this work to provide the fundamental data necessary to predict the properties of glass fiber laminates and hence to serve as a basis for the selection of suitable materials to produce reinforced plastics of high strength and durability.

Activity Summary: The project was started in July 1953. During the past year the specific problems involved in utilizing three techniques for evaluating the basic factors in glass-resin adhesion were investigated. These techniques are (1) Contact angle measurements on low energy surfaces; (2) Monolayer characteristics using Langmuir balance methods; and (3) Measurement of adsorption isotherms. Some data have been obtained using (1) and most of the experimental problems have been solved for (2) and (3).

Plans for Fiscal Year 1957: (1) Measure the contact angle for a comprehensive group of resins on low energy surfaces and design experiments to extend the data to high energy surfaces. (2) Determine adsorption isotherms for various liquid-resin systems. (3) Determine monolayer properties for a group of well characterized resins. (4) Using the mass spectrometer, investigate the effects of elevated temperature on Type E - glass.

PLASTICS

0707-12-3817 Evaluation of Plastic Materials

Objectives: To provide information on the properties of commercial and experimental plastic materials used in Quartermaster equipment; in particular, to study the basic erosion properties of plastic and metal-clad laminates.

Importance of the Project: The QRDC uses many plastic items. A knowledge of the properties of these materials and correlation of performance with laboratory methods of evaluating them is necessary to insure adequate procurement of plastic commodities. The mechanism of surface breakdown on plastic laminates must be known, for example, in order to develop products with superior resistance to conditions involving wetting-drying cycles coupled with abrasion.

Activity Summary: A study was made of the erosion factors, e.g., moisture, abrasion, heat, etc., on reinforced thermosetting plastics. A wide variety of resins, fillers, and metal surfaces was tested. The results show that few commercial molding powders or resins have high resistance to factors involved in erosion. Plastic sheets protected by overlays of metal or resistant films have the most promising characteristics. A final report was prepared.

0707-20-0732 Methods of Testing Plastics and Adhesives

Objectives: To develop methods for testing plastics and adhesives; in particular, measurements of tensile strength, fracture energy on impact, and abrasion resistance.

Importance of the Project: The increasing number of new types of plastics and new applications for existing plastics makes it necessary to develop new and improved methods for measuring the properties of these materials. This activity is carried out in close collaboration with other Government agencies, industry, 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 both Government purchasing and industry. Direct results of this work are Federal Specifications L-P-406 and MMM-A-175, covering methods for testing plastics and adhesives, respectively; these are being enlarged and converted to Federal standards.

0707-20-0732 (con.)

Activity Summary: A paper entitled "Index of Refraction and Particle Size as Factors in the Infrared Spectrophotometry of Polyvinyl Chloride" was published in the Journal of Research of the National Bureau of Standards (RP2670). A method for making solid-phase infrared spectral measurements on insoluble plastics and the factors pertinent to such measurements are described. A method of test for laboratory aging using fluorescent sunlamps was submitted to ASTM Committee D-20 on Plastics for consideration as a standard method. Drawings of this apparatus were prepared so that industrial laboratories could build comparable equipment needed for round robin test programs. The Porcelain Enamel Institute Abrasion Tester was evaluated for use with transparent plastics, such as polymethyl methacrylate. Results to date indicate that the abradant consisting of a mixture of steel balls, glass sand, and distilled water will provide more uniform abrasion and thus overcome a serious limitation of previous methods employing rigid abradants. Programs on speed of testing and aging of adhesives were conducted in cooperation with ASTM Committee D-20 on Plastics and D-14 on Adhesives.

Plans for Fiscal Year 1957: (1) Study the effect of rate of stressing on measurement of tensile properties of plastics. (2) Evaluate the PEI Abrasion Tester for use with transparent plastics. (3) Develop a method for measuring the energy to fracture on impact. (4) Conduct cooperative test programs with the American Society for Testing Materials, Society of the Plastics Industry, the Society of Plastics Engineers, and other governmental agencies.

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 the 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 connecting the physical properties of the fluid and the forces which induce flow both in the body of a fluid and in the neighborhood of boundaries. This project is devoted primarily to the investigation of such fundamental processes, where by the very nature of the problem long-term continuity of effort is required, or where a line of investigation must be pursued before phenomena are sufficiently well understood to see the scope and promise of the undertaking. The latter provides the means whereby originality of thought and method are directed toward devising new methods of attack and the discovery of new phenomena.

Activity Summary: One task carried over from previous years was completed and a paper was prepared. This was the problem of the action of severe wind storms on the form of the surface of a reservoir. Several new investigations were started, but the work on these has been primarily preliminary analysis, setting up of equipment, and making some preliminary and exploratory measurements. These are: (1) Resistance to flow of a dense layer of water under still water; (2) Coexistence of laminar and turbulent flow over grooved surface and its effect on friction; and (3) Study of fluid friction on surfaces composed of hydrophobic materials. Under item (2) the difficult task of producing longitudinal grooves in a 6-foot length of brass pipe was finally completed successfully after several initial failures. The equipment for conducting the experiment with air flow has been partially set up. Under item (3) studies were made on teflon disks with surfaces prepared so as to retain a partial air cover between the solid and the water in which the disk is immersed. From tests made so far, such disks show the same damping as ordinary disks when oscillated in water. This is a surprising and puzzling result.

0603-11-0618 (con.)

Plans for Fiscal Year 1957: The experimental and analytical work connected with the resistance to flow of a dense layer of water under still water will continue during Fiscal Year 1957 with emphasis being placed upon the mixing at the interface and collateral problems arising from the interfacial stresses.

The experimental apparatus needed for investigating the coexistence of laminar and turbulent flow over grooved surfaces and its effect on frictional resistance will be completed and experimental work initiated.

Owing to its basic and fundamental significance, the problem of fluid friction on grooved hydrophobic materials in the presence of a partial air film will be more extensively investigated during Fiscal Year 1957, as well as the general problem of flow on hydrophobic surfaces.

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.

PLUMBING AND FLUID MECHANICS (con.)

0603-12-3586 (con.)

Activity Summary: During the past fiscal year the first progress report was issued to the sponsoring agency, covering the experimental work of the investigation on short smooth culvert barrels of 5.5-inch diameter. This report included the experimental results of the investigation for a wide variety of model inlet designs now in common engineering use, together with the results of an exploratory investigation of the effect of turbulence level in the approach flow on the hydraulic characteristics of rounded culverts. This latter phase of the investigation satisfactorily explained the wide divergence between the results of previous investigations and the present study for certain aspects of culvert flow, and led to a more exhaustive investigation of the effect of turbulence level on culvert operation at a 12-inch diameter model size. This portion of the investigation is now approaching completion and has indicated that turbulence in the approach flow whether developed by grids or boundary roughness can under certain conditions influence to a remarkable degree the efficiency of the culvert inlet.

In the simple one dimensional method of analysis for full conduit flow in culvert design it is necessary to have prior knowledge of several constants. Among these is the elevation at the outlet face of the piezometric gradient. During the past year an investigation was completed on the determination of this dimension for various types of outlet channels and at various rates of flow.

A culvert ordinarily does not flow full immediately after submergence of the inlet. This change in flow regime from part full flow to full conduit flow usually occurs after the inlet has been substantially submerged. During the past fiscal year, an investigation was initiated to determine the mechanics by which this change in flow regime occurred, and the effect upon this phenomena of conduit length, slope, and roughness. It was found that regime change from part full to full conduit flow is not the result of a single type of mechanism, but that regime change results from the occurrence of various hydraulic and pneumatic phenomena depending upon the slope, roughness and length of the culvert barrel. In the single length of culvert barrel for which experimental data are presently complete, it was observed that four separate and distinct control mechanisms for regime change existed with each control mechanism applicable to a distinct range of slopes.

PLUMBING AND FLUID MECHANICS (con.)

0603-12-3586 (con.)

Plans for Fiscal Year 1957: The principal activities of the project will be to develop a group of inlets of improved hydraulic efficiency and to complete the experimental work now underway on the phenomena controlling regime change for some of the commonly used culvert inlets.

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.

Plans for Fiscal Year 1957: (1) Information reports will be obtained from the cooperating organizations. (2) Reports will be edited, subject index and master copy prepared for off-set printing.

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.

Importance of the Project: With the increase in population and area, most municipalities recognize the acute need for an acceptable code of minimum requirements for plumbing. The need has been dictated principally by the requirements of public health and safety. However, accurate minimum requirements can be obtained only by means of laboratory research. For example, under the conditions of surging flow characteristic of plumbing drains in service, the known laws of steady, uniform flow have little application; therefore, a rational solution to this problem must be based on an investigation of flow capacities under surging-flow conditions.

PLUMBING AND FLUID MECHANICS (con.)

1005-12-1004 (con.)

Writers of plumbing codes have known for some time that the loading tables in current use for building drains, building sewers, and horizontal branches are based on very limited, unpublished data for drains 3 and 4 inches in diameter only. In developing the loading tables, it has been necessary to resort to extrapolation over a range much greater than is justified by the existing data.

It is considered that the proposed project will contribute much-needed information to the national committees responsible for developing and maintaining plumbing codes. Specifically, it is believed the most important contributions will be as follows:

1. Experimental data on flow capacities of horizontal drains of diameters larger than 4 inches under conditions of fully and partially surging flow will be available for the first time.

2. The data described in 1 above, together with similar unpublished data on 3- and 4-inch drains obtained earlier at the National Bureau of Standards will be published in a form usable by the writers of plumbing codes.

3. Insofar as is possible, the known laws of physics and fluid mechanics will be applied to the experimental data in order to develop a rational solution to the problem of surging flow in nominally horizontal drains.

Plans for Fiscal Year 1957:

Task 1. Investigate experimentally the effect of slope, diameter and surge duration on flow capacity over a suitable range, both in empty drains receiving surging flow and in partially filled drains receiving surging flow.

Task 2. Organize the experimenal data in a rational, meaningful manner by applying, insofar as is possible known laws of physics and fluid mechanics to the data described under Task 1 above and also to similar limited data obtained earlier at the National Bureau of Standards.

Task 3. Prepare for publication a report of the results obtained under Tasks 1 and 2 above. The form of this report should be such that it will be of maximum usefulness to the writers of plumbing codes.

PROPERTIES OF MATERIALS

0702-11-0731 Research on Properties of Textiles

Objectives: To provide basic information on the properties of textiles; in particular, on the effects of (1) corrosive atmospheres, (2) high energy radiation, and (3) impact loading at rates of straining up to critical velocity.

Importance of the Project: (1) With the increasing prevalence of smog conditions, more information is needed on the effect of atmospheric contaminants on textiles. This information will serve as a basis for selecting textiles for specific uses and for developing protective treatments for textiles. (2) Because of the highly oriented structure and relatively high ratio of surface area to volume shown by textile fibers, the effects of high energy radiation on textile fibers may open up new ways of modifying natural and synthetic fibers to obtain improved properties. (3) Increased use is being made of textiles under conditions where they are subjected to high speed impact. As a result more basic information on the stress-strain behavior of textiles at very high rates of straining by impact loading is needed. This information should aid in the design of textiles for civilian and military uses, such as tire cords, safety ropes, seat belts, parachute webbing, and flexible body armor.

Activity Summary: (1) During Fiscal Year 1956, studies on the effects of air containing low concentrations of dinitrogen tetroxide on cellulosic textiles were continued and similar studies were carried out with air containing hydrogen chloride. It was found that washing with water soon after exposure to these corrosive atmoshpheres restored a considerable amount of the original strength of the celluloses. (2) A variety of textile fibers was irradiated in air in a nuclear reactor and with beta radiation from an electron accelerator. Stress-strain behavior, infrared absorption, and softening temperatures of the irradiated fibers were determined. (3) For a summary of previous work on impact loading of textiles, see the report on Project 0702-11-3841.

Plans for Fiscal Year 1957: (1) Complete manuscript now being prepared on effect of low concentrations of dinitrogen tetroxide and hydrogen chloride on cellulose; study the effect of relative humidity on the reaction of cotton and rayon with dinitrogen-tetroxide-containing air; extend the work on corrosive atmospheres to noncellulosic

PROPERTIES OF MATERIALS (con.)

0702-11-0731 (con.)

textiles. (2) Complete manuscript now being prepared on properties of fibers irradiated in air; study the effect of high energy radiation in helium on fibers. (3) Continue analysis of transverse impact data; make additional measurements of limiting breaking velocity, using the longitudinal impact apparatus; measure dynamic moduli of elasticity on several textile yarns and compare with results obtained from transverse impact data.

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, the mechanism of fracture in polymers, and the effect of atomic gases on the properties of plastics.

Importance of the Project: The multi-billion dollar plastics industry continues to produce a phenomenal number of new materials each year, as well as radically different types of older materials. Basic information on the properties of these materials is necessary for their proper use, development and improvement. Studies of basic mechanisms, such as those involved in fracture and nuclear radiation resistance, and the relationships between the chemical structure and physical properties are needed to permit selection and utilization of these materials in specific military and industrial applications.

Activity Summary: Two papers, "Ultraviolet Initiated Degradation of Polyvinylchloride" and "Thermal Decomposition of Polyvinylchloride in a Vacuum," covering work done on the mechanism of degradation of this polymer, were presented at the September 1956 meeting of the American Chemical Society. A study of the properties of graft copolymers was initiated in cooperation with the Brookhaven National Laboratory. A series of polyamide substrates irradiated by gamma radiation (Co-60) is being evaluated with emphasis on determining the degree of grafting and evaluating the physical and chemical properties of graft polymers. A preliminary study of the rate of oxidation of polystyrene in the presence of ultraviolet radiant energy showed that the generation of degradation products interfered with the manometric measurement of the amount of oxygen sorbed by the polymer. Further development of the technique is required before further experimentation is feasible.

PROPERTIES OF MATERIALS (con.)

0707-11-0733 (con.)

Plans for Fiscal Year 1957: (1) Study graft copolymers in cooperation with the Brookhaven National Laboratory. (2) Investigate fracture mechanism in various plastics. (3) Study the effects of atomic gases on the properties of plastics.

0901-11-4400 Properties of Ceramics at Elevated Temperatures

Objectives: To obtain fundamental information on the properties of ceramic-type materials.

Importance of the Project: The data supplied to the Sponsor are used in various US AEC reactor design programs. The project emphasis is reviewed annually to meet both current and future needs. On the basis of the previous phase of this project, 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 that the basic objective remains the determination of fundamental information on the high-temperature properties of ceramic-type materials of interest to the Sponsor, although the emphasis may change. The previous phase of the program, the determination of the equilibrium phase relations of ceramic-type materials, was completed upon publication of NBS Circular 568, "High-Temperature Reactions of Uranium Dioxide with Various Metal Oxides." The first paper of the current phase, the determination of the strength properties of materials of interest, "The Effects of Particle Size on Bulk Density and Strength Properties of Uranium Dioxide Specimens," published in the Journal of the American Ceramic Society, 39 (5), 181 (1956), describes the study of the properties of fused UO_2.

Similar studies, but more detailed in certain respects, are in progress for other types of UO_2 and for some types of ThO_2. Early in the reorientation of this project, the Sponsor asked that the program be interrupted for the rapid determination of a number of properties of a special

PROPERTIES OF MATERIALS (con.)

0901-11-4400 (con.)

form of ThO_2. A paper describing this work, "Some Physical Properties of High-Density Thorium Dioxide," was submitted in February 1956 for publication in the Journal of the American Ceramic Society. The preliminary determinations of the elastic constants--Young's modulus, shear modulus, Poisson's ratio, and bulk modulus--have been completed for some 35 different materials of interest to the Sponsor. A paper is being prepared describing these results.

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. Furthermore, there is a lack of information on the relative volatility of the fluxes present in alumina-silica refractories and the effect of such volatilization at high temperatures on the properties and mineralogical changes of such materials. Conversely, information is necessary on the relative rate of absorption of different alkalies by the refractory at high temperature. Investigation in this field should supply information which will clarify previously unexplained phenomena. This clarification will be of considerable value to the consumer of refractory materials. The pyrometric cone equivalent test is one of the important industrial indices of refractories. A basic study of cone behavior is needed.

Activity Summary: During the past year a study of the effect of temperature and cement ratio on the thermal expansion of a large number of castables has been carried out and reported. The modulus of rupture of these castables has been determined by the transverse method. Plans for a basic study of the Pyrometric cone equivalent test are under way.

PROPERTIES OF MATERIALS (con.)

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

(See Cement, Concrete and Masonry)

0907-11-0917 Properties of Crystalline Solids

Objectives: To study the effect of changes of chemical composition on the stability and thermodynamic properties of inorganic solids and related glasses.

Importance of the Project: In inorganic materials where the composition can be widely and continuously varied, as in glasses or in members of isomorphous series, a study of the relation of such changes to physical properties is particularly rewarding. This is true because in such series all factors, such as structure and chemical surroundings, remain unchanged, while one factor alone, one element, is varied. From studying such a series we can determine the effect of the change of a single element on properties such as density, melting point, primary phase, transition temperatures, unit cell size, decomposition temperature, and energy of decomposition or transition. From data of these types information on bond type and strength and atomic or ionic size may be obtained, as well as information on how to vary chemical composition to obtain crystals or glass with particularly desirable and useful properties.

Activity Summary: During the past year, papers on the thermal decomposition of Fe and Mn carbonates and on the calculation of activation energies were prepared. The "Compilation of Phase Diagrams" was published by the American Ceramic Society. A number of montmorillonite clays with controlled and varied compositions have been synthesized and the method of preparation perfected. The use of electron diffraction for the identification of clays has been explored and developed. An analysis of immiscibility in known binary and ternary oxide systems led to a structural interpretation of immiscibility whereby starting with ionic radii the compositions of immiscible liquids could be estimated in general to within 4 mole %. A paper describing this work has been submitted to the American Ceramic Society.

SURFACE FINISHES AND COVERINGS

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

Objectives: (1) To develop and maintain spectrophotometric standards; (2) to study improvements in spectrophotometric instruments and techniques, particularly for the standardization and specification of color; (3) to determine the permanence of standard samples of ceramics, glasses, pigments, paints, papers, plastics, textiles, and other materials of special interest in colorimetry; and (4) to correlate (a) instrumentally obtained data of spectral transmittance or spectral directional reflectance of materials converted mathematically into psycho-physical terms of color specification with (b) similar data of the same materials either obtained visually by the human eye, directly or with the aid of instruments, or photoelectrically by means of additive or subtractive colorimeters, color-difference measurements, or by means of 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 nearly 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 National Bureau of Standards 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.

Activity Summary: This is a continuing project which started in approximately 1905. During the past year, because of lack of funds, most of the personnel and equipment identified with this project were diverted to another project,

SURFACE FINISHES AND COVERINGS (con.)

0201-20-0203 (con.)

in which some of the same methods were applied. However, progress was made in the following: (1) Two NBS reports were issued on the American Society for Testing Materials petroleum oil products standard color scales, and (2) three items were published on the comparison of the Safety Color Codes of the American Standards Association and the International Standardization Organization.

Plans for Fiscal Year 1957: A comparison will be made of the Japanese and the American Standards Association safety color codes. Plans have been made to work on papers for publication as follows: (1) a national safety color code; (2) spectrophotometric permanence study of the NBS standard samples of paint pigments; (3) spectrophotometric and colorimetric analyses of the standards of the Porcelain Enamel Institute; (4) the specification of national school bus chrome; (5) the specification of railroad signal target enamel colors; (6) the colors for molded urea and polystyrene plastics; (7) the artists' oil paint pigments; and (8) the Federal color card for paint.

0201-30-0207 Standards of Light and Color

Objectives: 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.

Activity Summary: During Fiscal 1956 more than 500 standards and calibrations were supplied as requested.

Plans for Fiscal Year 1957: Standards are to be calibrated and issued as demanded and as the budget permits.

SURFACE FINISHES AND COVERINGS (con.)

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 1956.

Plans for Fiscal Year 1957: (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.

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.

SURFACE FINISHES AND COVERINGS (con.)

0501-30-3240 (con.)

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.

Activity Summary: This is a continuing project. During the past year approximately 470 samples were tested for compliance with specifications. Test reporting has been kept approximately current during the year. The future workload is difficult to predict because it depends largely on factors over which the testing laboratory has no control.

Plans for Fiscal Year 1957: Continue testing program in accordance with needs of Government agencies.

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.

Activity Summary: This project was started in May 1956. A survey of commercially available wall coverings was completed and a tentative test program was designed.

Plans for Fiscal Year 1957: (1) Test commercially available plastics wall coverings for required performance characteristics. (2) Prepare procurement specifications in consultation with the Sponsor.

SURFACE FINISHES AND COVERINGS (con.)

1003-12-4887 Moisture in Roof Insulation

(See Heating and Refrigeration)

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:

1. Work on Asphalt: Work proposed for completion in Fiscal Year 1956 has been completed, namely (1) the chemical analysis of asphalts and components under study and (2) the determination of changes in the distribution of components when the same base flux is blown to produce asphalts of different softening points. Work has been started to determine the structure of the water-soluble degradation products of asphalt; an apparatus has been constructed to determine the gaseous products produced when asphalt and its components are exposed to ultra-violet light in the presence of oxygen and moisture.

SURFACE FINISHES AND COVERINGS (con.)

1004-11-1017 (con.)

Related to the work on asphalts, a B.M.S. report, "The Effect of Mineral Additives on the Durability of Coating-Grade Asphalts," was released. Three other major publications on asphalt deterioration appeared in trade journals, and several other publications are under editorial review.

2. Work on Flooring Materials: Work on flooring materials during Fiscal Year 1956 was confined almost entirely to that under other projects.

Plans for Fiscal Year 1957:

1. Work on Asphalt: (1) Initiate work to determine the chemical changes that occur in the components of asphalt when exposed separately and in different combinations to ultraviolet light in the presence of oxygen and moisture. (2) Determine the effect of coating thickness on the chemical degradation of three asphalts exposed outdoors for four years. (3) Continue work by chromatographic methods to separate and determine the structure of the water-soluble degradation products of asphalt. (4) Determine, by means of the apparatus recently constructed, the rate of oxidation of asphalt as a function of its source and method of treatment; the wavelength of light to which it is exposed and the temperature of exposure. (5) Determine the gaseous products formed when asphalt and its components are exposed to ultraviolet light in the presence of oxygen. (6) Determine the optical activity of water-white oils from representative asphalts from different sources. (7) Make further fractionations of asphalt components by means of molecular sieves.

2. Work on Flooring Materials. Project 4846 has been planned to cover a period of five years and will engage flooring personnel practically full time during Fiscal Year 1957.

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. The classification would indicate the suitability of each flooring for each of a variety of service conditions. The first rating would of necessity be incomplete and highly tentative because of the inadequacies of existing methods of testing and the lack of

SURFACE FINISHES AND COVERINGS (con.)

1004-20-4846 (con.)

data indicating quantitative 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 is planned to cover several years of work. It is divided into two parts, the first dealing entirely with conductive flooring for hospital operating rooms; the second with flooring materials in general. The part dealing with conductive floors has been planned and work on it will be carried out cooperatively with Division 1.

Activity Summary:

Work on Conductive Floors: Preliminary to initiating this project late in Fiscal Year 1956, visits were made in this country and Canada to research laboratories concerned with work on electrical conductivity of flooring materials. A thorough literature search was made and samples of conductive flooring materials were obtained from various manufacturers in the United States. Initial measurements of conductivity were performed on these samples and new instruments were modified and calibrated for special use in making conductivity measurements.

SURFACE FINISHES AND COVERINGS (con.)

1004-20-4846 (con.)

Work on Flooring Materials in General: A study was made of the methods for making determinations of ease of maintenance, dimensional stability and resistance to wear of vinyl plastic flooring.

Plans for Fiscal Year 1957:

1. Work on Conductive Floors: The study of methods of measuring electrical resistance of floors will be extended and correlation of established methods with tendency of conductive floors to reunite electric charges will be made. These studies involve the effects of magnitude of applied voltage, type of voltage wave, and size, shape and weight of electrode. They will include actual tests of floors with electrostatic generators.

   A program will be initiated to determine electrical resistance by currently available methods on specimens of each type of conductive flooring with consideration for the following variables: effect of aging, wear, sealers, waxes, detergents and other maintenance materials, spillage of reagents, and other effects as the work progresses.

   Studies of vinyl plastic operating room floors in the Washington area will be continued with attention to the effect of aging, wear, maintenance methods, etc., on conductivity.

   Upon completion of the above-mentioned studies, specifications for conductive floors will be prepared, including requirements for electrical characteristics as well as requirements for resistance to normal wear and maintenance.

2. 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

1004-40-4847 Standards for Built-Up Roofs

Objectives: To determine the relative merits of asphalt and coal-tar pitch when used in built-up roofs on which water collects and stands and to develop improved methods of testing asphalt and coal-tar pitch for built-up roofs. To compare the performance of double-slagged, asbestos felt, glass membrane and cold-process built-up roofs with that of conventional built-up roofs.

Importance of the Project: Government specification writers have been under pressure in recent years to accept asphalt and coal-tar pitch on an equal basis for the construction of built-up roofs on dead-level decks. So-called double-slagged and cold-process built-up roofs and roofs constructed with asbestos-felt and glass-fiber membranes are being used increasingly. Single-application materials are frequently recommended for concrete decks. A definite need exists to evaluate the merits of these materials and application methods and to revise current guide specifications in the light of the findings.

Activity Summary: Work on this project was not authorized until late in Fiscal Year 1956. However, specimens of so-called dead-level asphalt and specimens of coal-tar pitch have been obtained from roofing manufacturers and are being subjected to accelerated weathering tests. Component analyses of the asphalts indicate two distinct types distinguished in composition by the resin content and in performance by differences in ductility and self-healing characteristics at normal temperatures. A list of 85 asphalt roofs more than ten years old and another of 331 roofs up to three years old, the latter constructed of dead-level asphalts, have been obtained from the roofing manufacturers for field inspections.

Plans for Fiscal Year 1957: (1) The two lists of roofs (85 and 331) have been segregated by States and by manufacturers. These lists will be turned over to the Mathematics Division for a statistical study to determine the extent of the field survey necessary to secure conclusive data. Following this determination the field survey will be made. Included in the field study will be observations, where possible, of the behavior of double-slagged, cold-process, asbestos-felt and glass-fiber built-up roofs. (2) Continue work on the study of the physical and chemical characteristics of the vacuum reduced and blown, dead-level asphalts, including self-healing, low-temperature ductility and water absorption, all in comparison with representative coal-tar pitches. (3) Prepare specifications for asphalt and coal-tar pitch for built-up roofs in which the requirements reflect the new data obtained.

TESTING MATERIALS AND PRODUCTS

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; also to conduct qualification tests of prospective bidders not currently supplying lamps to the Government.

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.

Activity Summary: During Fiscal 1956 samples inspected represented over 4,000,000 lamps of which approximately 4.0% were rejected on initial inspection at the factories of the suppliers. Lamps of current suppliers started on life test totaled 4416 and those represented approximately 3.2% of those accepted on initial inspection.

Plans for Fiscal Year 1957: (1) The inspection and qualification testing of all groups of all brands of lamps supplied to the Government for which qualification requirements are specified. (2) Qualification tests of lamps manufactured by prospective bidders not currently supplying lamps to the Government, as requested by General Services Administration.

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

(See Surface Finishes and Coverings)

TESTING MATERIALS AND PRODUCTS

0702-20-0709 Development of Methods for Testing Textiles

Objectives: To provide physical and chemical methods for evaluating textiles, in particular, methods for the identification and quantitative analysis of textile fibers and their degradation products and of textile finishes and coatings.

Importance of the Project: Because of the variety of new products being developed, a continuing effort is necessary to develop textile testing methods needed for the evaluation and selection of textiles for specific applications by the Government and industry. Methods for the identification and quantitative analysis of textile fibers, finishes, and coatings are required for checking textiles bought by the Government and checking the accuracy of labels for the Federal Trade Commission. In studies on the deterioration of textiles, methods are needed for the identification and quantitative estimation of functional groups and degradation products. Recent developments in spectrophotometric techniques suggest that spectrophotometric measurements may serve as a basis for these analyses.

Activity Summary: During Fiscal Year 1956, the library of infrared reference spectra of textile fibers and their degradation products and of components of textile finishes and coatings was substantially enlarged. A procedure involving a series of extractions was developed for separating textile finishes and coatings into fractions suitable for spectrophotometric measurements. Preliminary results obtained with the method indicate that it will prove useful in the analysis of unknown coatings.

Plans for Fiscal Year 1957: (1) Record reference spectra of textile fibers and their degradation products and of the many materials used in textile finishes and coatings. (2) Modify the extraction method for fractionating textile finisnes and coatings in order to effect a more complete separation of the components. (3) Test the extraction - spectrophotometric method of analysis on a series of coatings of known composition.

0707-20-0732 Methods of Testing Plastics and Adhesives

(See Plastics)

TESTING MATERIALS AND PRODUCTS

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 materials submitted for acceptance testing required the assignment of one employee full time to this project. A total of 572 tests were performed on 74 samples.

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 .

Activity Summary: Six assignments were made by OCE during Fiscal Year 1956. Examples of these are:

(a) Thermal Insulation of Roofing Materials. This task continuing from Fiscal Year 1956, involves an investigation of the effect of dampness on the performance of thermal insulation for roof decks. Typical insulating panels were subjected to accelerated vapor conditions and conditions simulating exposure to the sun. Both summer and winter conditions were considered.

TESTING MATERIALS AND PRODUCTS

1000-30-4801 (con.)

(b) Temperatures in Nike Installations under Arctic Conditions. By means of a model construction and study of actual operation at a Nike site, the NBS assisted the OCE in finding information on temperature change and infiltration into a Nike installation when the hatches are opened. It is possible that such temperature changes may affect personnel efficiency, equipment operation, or ice accumulation on delicate parts of equipment due to dew formation.

(c) Miscellaneous. Tests were made on door closures, shower heads, protected metals and aluminum for reflectivity properties.

Plans for Fiscal Year 1957: This is a continuing project. The project level will depend upon the number and the nature of the tasks selected during conferences between representatives of the OCE and the NBS. Such conferences will be held throughout the year as new problems arise in the design, operations, and maintenance of buildings. Continuance of the roof insulation task as a means for determining the effects of moisture on the thermal conductivity of insulation in built-up roofs is contemplated under a separate project. (See Project 1003-12-4887)

1000-40-4804 Miscellaneous Investigations

Objectives: To perform investigations on building materials and methods of construction, or to serve in a consultative capacity, as requested by Federal agencies.

Importance of the Project: This is a continuing project in which the NBS performs investigations for other agencies on such fields as heating, air-conditioning, fire prevention, specifications for elevators, flooring and structural engineering.

Activity Summary: During Fiscal Year 1956 this work was accomplished under Project 1000-30-4800, but because most of it is of investigative or advisory nature rather than testing, it was assigned to this new project.

Plans for Fiscal Year 1957: Investigations will be conducted and consultative services will be rendered when the NBS can give assistance quickly in solving miscellaneous technical problems of other agencies by conducting minor investigations.

TESTING MATERIALS AND PRODUCTS

1004-30-4845 Testing, D. C. Government

Objectives: Control testing of bituminous highway materials.

Importance of the Project: In 1933, the Congress directed that the testing of highway materials for the District of Columbia should be done by the National Bureau of Standards. Since most of the bituminous testing is for the purpose of controlling materials in daily use, it is required that tests and reports be handled as expeditiously as possible, usually the day the materials are received.

Activity Summary: This work has been carried on at approximately the same level for several years.

Plans for Fiscal Year 1957: It is expected that work will continue at approximately the same level as in Fiscal Year 1956.

MISCELLANEOUS

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.

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: One conference took place between NBS and CAA to discuss lightning problems at airports. There was a telephone consultation at which time CAA asked advice on specifications on lightning arresters.

Plans for Fiscal Year 1957: 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.

0201-30-0208 Specifications for Lamps and Color

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

Importance of the Project: The qualification testing of lamps under Project 2320 which provides the basis for the purchase of lamps by the Government depends upon this project to provide necessary specifications. New specifications must be formulated and existing specifications revised periodically so that the qualification tests may 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 are coordinated so that there will be no avoidable disagreement or duplication.

MISCELLANEOUS (con.)

0201-30-0208 (con.)

Activity Summary: An amendment to the 1955 Supplement to Federal Specification W-L-101e for large incandescent lamps and a 1956 Supplement to Federal Specification W-L-111b for miniature incandescent lamps were formulated. Cooperation with the American Standards Association in the development of American Standards resulted in the revision of American Standards C78.100 for general-lighting service lamps, C78.101 for high-voltage lamps, and C78.140 for miniature lamps and the development of American Standards C78.252 for 200-watt lamps, and C78.253 for 150-watt lamps.

Plans for Fiscal Year 1957: The Federal Specifications for incandescent, fluorescent, and photographic flash lamps will be revised so as to keep them current and cooperation will be given the American Standards Association in the development of American Standards covering interchangeability of lamps and lamp auxiliary equipment.

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 determine thermal expansion of various materials submitted by Government agencies; to calibrate thermal expansion apparatus for Government, university, and industrial laboratories. Work of this nature in calibrating surveying equipment for the Inter-American Geodetic Survey on a working fund basis is under Project 0204-30-2312, calibrations of length and angle for Government agencies on a refund basis are under Project 0204-30-2332, and calibrations for the U.S. Coast and Geodetic Survey are under Project 3630-30-1801.

MISCELLANEOUS (con.)

0204-30-0218 (con.)

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.

0205-30-0225 Standardization of Screw Threads and Threaded Components

Objectives: To develop unified standards for screw threads and threaded products with the United Kingdom, Canada, and other inch-using countries; to develop standards for screw threads for use in the design of defense material and other threaded products used by the Government; to develop standards and specifications for bolts, nuts, screws, and other threaded or associated products.

Importance of the Project: The securing of interchangeable and otherwise satisfactory mass-produced threaded products in times of national emergency has long been a major problem of procurement for defense. Its solution depends on the development and maintenance of dimensional standards for screw threads, as embodied in codes and specifications, and standard practices relating to dimensional control. This is accomplished by cooperative action of Governmental agencies and private engineering organizations and is carried forward for the Government by the Interdepartmental Screw Thread Committee, of which the Chairmanship and Secretaryship are in NBS. This work is coordinated with that of industrial standardization committees, particularly ASA Sectional Committees B1 on the Standardization and Unification of Screw Threads, B2 on Pipe Threads, and B18 on Dimensional Standardization of Bolts, Nuts, Rivets, Screws, and Similar Fasteners. Standards are published as NBS Handbook H28, Screw Thread Standards for Federal Services; Federal Specifications for various standard types of threaded fasteners; and American Standards issued under the auspices of the American Standards Association and sponsored by The American Society of Mechanical Engineers and other engineering or trade associations.

MISCELLANEOUS

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: Two handbooks have been published: X-ray Protection, Handbook 60; and Regulation of Radiation Exposure by Legislative Means, Handbook 61. A study of the problem of protection against neutrons has been largely completed and the manual is about ready for publication. A report of the Subcommittee on the Disposal of Radioactive Wastes by Incineration is in the final draft stage. A new subcommittee was organized for the purpose of establishing the maximum permissible exposures to personnel under emergency conditions, for both military and civilian defense applications. Substantial progress has been made on this task. Another new committee was organized to study the problem of protection against high-energy, high-intensity electrons for food sterilization. An initial report by this group is nearing completion. Other new subcommittees which have been formed for the purpose of developing recommendations on the various aspects of radiation standards and measurements are: (1) Subcommittee on Standards and Measurements of Radioactivity for Radiological Use, (2) Subcommittee on Standards and Measurements of Exposure Dose, (3) Subcommittee on Standards and Measurements of Absorbed Radiation, and (4) Subcommittee on Relative Dose by Biological Effectiveness.

MISCELLANEOUS (con.)

0400-40-0497 (con.)

Plans for Fiscal Year 1957: Studies will be completed on the Incineration of Radioactive Wastes and on the Protection against Neutrons. Active work by the six new subcommittees is expected to be underway and it is hoped that initial reports may be issued during the current year. Assistance to States in radiation-control legislation will be continued.

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: This project was approved in February 1956. The first step was to begin a preliminary survey of available information. This effort is hampered by classification difficulties. In particular, the problem of obtaining essential data on the primary sources of radiation has not yet been resolved. In addition, the established transmittal procedures for those classified reports which are made available causes considerable delay in obtaining a comprehensive collection of pertinent information. Substantial progress was made, however, in tasks involving the penetration of radiation. The NBS Building Technology Division completed a rough survey of small-frame dwellings and supplied data for preliminary calculations of the penetration of radiation through such structures. The assumptions and methods of calculation in a report on shelters which was submitted to us by the FCDA have been reviewed and evaluated and recommendations were made on the limitation of the validity and applicability of this material.

Plans for Fiscal Year 1957: A gradual buildup of the effort and assignment of permanent staff will take place so that by the beginning of Fiscal Year 1958 full scale operation

MISCELLANEOUS (con.)

0400-40-3001 (con.)

on all phases of the work can be expected. The major effort during the first half of the year will continue to be on studies of the penetration of radiation in various kinds of shelter. As personnel becomes available, work on instrumentation problems will begin.

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: In order to obtain more economic solutions to the protection problems for diagnostic applications, data must be obtained on the dose delivered to walls and ceilings in X-ray rooms of hospitals and clinics. The results obtained indicated much smaller amounts of radiation than are computed by the approximate conservative methods usually used. Studies were carried out in a number of institutions for many diagnostic rooms, at a large number of measurement positions in the rooms. Usually, there were about 70 measurement fractions in each of the twenty rooms in which measurements were made, and the measurements were carried out for from four to six weeks in each room. An electronic milliampere-second integrating device was developed for determining the workload without depending on the technician to record the individual exposures. The milliampere-second workload is basic to the evaluation of the data. In addition, sets of filter cylinders were constructed to permit the determination of the stray radiation quality from attenuation curves in lead and aluminum. These curves permit the computation of heavier requirements in terms of lead and for common building material such as concrete, tile, brick, plaster, etc.

MISCELLANEOUS (con.)

0410-20-3135 (con.)

Plans for Fiscal Year 1957: The results of the study for diagnostic X-ray rooms will be assembled into a report suitable for publication. The dose to the walls of X-ray therapy rooms will be measured in a manner similar to the study for diagnostic X-ray rooms, with such modifications in the procedures as are required due to the difference in dose rate, quality of the radiation and operating procedure.

0507-20-0532 Utilization of Fuel Gases

Objectives: To conduct research on fuel gases and gas-burning appliances, their use and control.

Importance of the Project: Since 1910, NBS research on methods of testing gases to determine their useful properties and on the design adjustment and use of gas-burning appliances has been the basis of many State Public Utility regulations, a large part of the American Gas Association's appliance approval program, and of various safety codes. A continuation of the work is needed to meet the needs of Government, industry, and public for standards and technical guidance in this field.

Activity Summary: Work on the project has been mainly devoted to the factors affecting the accuracy of the recording gas calorimeter and a program for supplying the industry with cylinders of gas certified as to heating value. A publication on the accuracy and proper maintenance of the recording gas calorimeter is now being completed. All of the plans for distributing the certified gas have now been completed and a number of cylinders are ready for shipment.

Plans for Fiscal Year 1957: Plans include a continuation of the certification program, assistance in revision of the gas code of the District of Columbia, a possible revision of "Standards for Gas Service," the basis of most of the official State regulations on this subject, and a continuation of our calorimeter studies, and various committee activities concerned with standardization in the field of safety and appliance performance.

MISCELLANEOUS

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: Impact tests were completed on three tempers of AISI 4140 steel (NBS Report No. 4254). Three channels of electronic and photographic equipment have been designed and assembled for recording strain-time phenomena at three stations simultaneously. A pulse method for measuring stress-strain relations under dynamic conditions in long bars is being developed by using a velocity pick-up (a coil in a magnetic field) and two strain gage stations. This method shows promise for use on non-magnetic materials.

Plans for Fiscal Year 1957: (1) Continue the investigation of the pulse method for determining dynamic stress-strain relations for structural materials and study other methods that may be devised. (2) Study the propagation of strain energy in long bars by analyzing strain-time records made simultaneously at three locations along the bars with particular attention to attenuation as a function of strain amplitude, strain rate and microstructure. (3) Determine some of the effects of specimen shape and size on the delay-time-before-yielding relationships for steel.

MISCELLANEOUS (con.)

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 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 is a continuing project. During the past year 817 devices were received for calibration. During the year 784 devices were calibrated for private organizations.

Plans for Fiscal Year 1957: (1) Calibrate elastic calibration devices and calibration cells by dead weights or other calibrated devices, (2) Determine the absolute value of electrical input to output ratio as a function of load for basic laboratory standards used to control production of industrial load weighing equipment. (3) Calibrate strain and displacement measuring equipment. Calibrate displacement, velocity and acceleration pick-ups.

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.

MISCELLANEOUS (con.)

0604-20-3601 (con.)

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.

Activity Summary: The performance of rubber gaskets bonded to the hollow aluminum modules designed and furnished by the Bureau of Yards and Docks was investigated and reported in NBS Report No. 4425. Tests have been made to determine the force required to punch through the center element of 9-module segments with different pre-loads in the tension rods and with various joint sealants on the edges of the modules. Also, punching shear tests were made on 36-module segments. The equipment and instrumentation were devised and one uniform load test was made on a 36-module segment.

Plans for Fiscal Year 1957: (1) One additional test will be made on a segment whose elements are filled with a resilient "foam in place" material. (2) A final report will be prepared.

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

(See Codes and Specifications)

0804-11-0815 Mechanism of Corrosion Processes

Objectives: To determine the nature, mechanism and rates of the corrosion of metals by different processes in various corrosive media and environments.

Importance of the Project: Corrosion costs billions of dollars annually through the destruction of metal and the necessary replacement of parts. Corrosion is not a simple process and little is known of the fundamentals of its operation. It may occur as a simple general over-all attack, as very deep local pitting, by a combination of stress and corrosion or in other ways possibly closely related or interconnected. When the fundamental nature of corrosive attack is understood, effective means to prevent it can be undertaken with considerable savings to the national economy.

MISCELLANEOUS (con.)

0804-11-0815 (con.)

Activity Summary: (1) A paper containing the results of the investigation of stress corrosion of alpha and beta brasses was published. Additional data on the relative orientation of crystals bounding stress corrosion cracks in low carbon low alloy steels in nitrate solutions and on the susceptibility of these steels to stress corrosion cracking in metal vapors have been obtained. (2) The study of the corrosion of monocrystalline aluminum in various media was continued. The difference in behavior of the aluminum in KOH and NaOH solutions was found to be significant, and varied with the crystal orientation. (3) The study of the conductivity of the electrolyte and its effect on corrosion was continued. A study of the effect of carbon content and of heat treatment on the corrosion of low carbon steels using polarizing techniques was completed and the results are being analyzed.

0900-40-0999 Consultative and Advisory Services

Objectives: To provide consulting services on a wide variety of ceramics problems of interest to Government agencies, industry, and the public.

Importance of the Project: The National Bureau of Standards has, in areas within its competence, responsibility for providing advisory and consulting assistance to other Government agencies. The Mineral Products Division implements this responsibility in the general field of nonmetallic minerals through its staff of specialized scientists and engineers.

Activity Summary: In addition to the normal, continuing calls for advice on relatively routine applications of ceramics in industry and Government there has been an increasing interest in higher-temperature problems and in materials for use in atomic power plants. Many of these consultations are of a classified nature, involving ordnance and military aircraft.

MISCELLANEOUS (con.)

0901-11-4468 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 the measurement.

Importance of the Project: Clay-water systems, 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. This is one phase of the broad field of rheology. So long as objects were formed from plastic materials by manual operations, a basic knowledge of plasticity was scientifically interesting but not a necessity. Now, however, with the increasing use of automatically-controlled mechanical devices, it is imperative that this knowledge be developed. Mechanization of the ceramic industry is dependent upon the "workability" of clay, which in turn results from the application of plasticity. 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. The work has been divided into two categories. The first category is concerned with the evaluation of the property-determining attributes of clays and includes the identification, characterization, and purification of clays. This work is essentially completed. Methods for the mineralogical, chemical, and physical characterization of clay have been studied, and electrodialysis, fractionation, particle-size determination, and base-exchange procedures have been established. The second phase deals with the development and use of a method for relating these attributes to the plastic behavior of clays. This work is in the literature survey state.

MISCELLANEOUS (con.)

1000-20-4800 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.

Activity Summary: Examples of the work performed under this project during Fiscal Year 1956 are shown below:

(a) Physical tests were performed on samples of rock (granite and grabbo) for the Bureau of Ordnance, Department of the Navy. These included flexural strength, compressive strength, porosity, toughness, modulus of elasticity and Poisson's ratio.

(b) Inspections of buildings at Fort Belvoir, Virginia, for the Department of the Army were made to determine the cause of plaster failure. Analytical tests were subsequently performed in collaboration with the Mineral Products Division.

(c) Acceptance tests were performed on such items as marble, slate, brick, fire-retardent paints, air filters, safety matches, fire-proofed canvas, and bituminous roofing and waterproofing materials.

Plans for Fiscal Year 1957: No increase in activity is expected, as the agencies tend either to employ their own laboratories or to decrease the amount of acceptance testing.

MISCELLANEOUS (con.)

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 and unbiased 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, as 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 or 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 to the Government of the advice given cannot be made. Nevertheless, the relatively 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 1956 under the project is as follows:

At the request of the Office of the Chief of Engineers, the Chief of the Building Technology Division served as a consultant to assist in determining the cause of structural failures of the reinforced concrete girders in a number of widely separated buildings. Inadequate resistance to diagonal tensile stress was determined as the primary cause of the failures. Although the girders were constructed in full accordance with generally accepted

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codes and specifications, it was determined that these codes and specifications do not contain adequate requirements for continuous girders of more than one span. A sequel to the studies was an important revision of the generally used building code for reinforced concrete construction. There were many other services of this nature. However, a portion of the consultative services consisted of work with committees of technical societies such as the American Society for Testing Materials, American Standards Association, and the American Society of Heating and Ventilating Engineers.

Because of the expanding building program in the Nation, the rapid development of new materials and types of construction, and an increasing desire to apply scientific knowledge to problems of buildings, inquiries by telephone, letter or personal visit tend to increase each year.

Plans for Fiscal Year 1957: 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 National Research 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 and constructions and in standards for air cleaners and convectors. The committee on masonry of the American Standards Association of which the NBS is the sole sponsor is expected to complete the drafing of a new code on reinforced masonry construction. Substantial assistance will be given also to the American Society for Testing Materials in the preparation of improved standards for thermal insulations, masonry units and mortars and bituminous roofings.

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.

MISCELLANEOUS (con.)

1000-40-4802 (con.)

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 the advancement of building research and technology. From time to time, technical reports are prepared for common use by the sponsoring agencies and other Government agencies. 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 construction and maintenance in Government 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 1956 follow:

(a) Roof Decks and Built-Up Roofing - A study of conditions and practices that lead to failures of built-up roofing. This includes a survey of roofing construction practices among ten Federal construction agencies and a special summary account of three industry-government conferences attended by ninety designers, manufacturers, contractors, and building owners.

(b) Space Allowances for Offices and Ceiling Heights in buildings - A review of practices and opinions of agencies regarding design of work spaces and ceiling heights for office buildings.

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(c) Cooling Towers and Evaporative Condensers - A summary of practices and opinions of agencies on the performance and ratings of cooling towers and evaporative condensers.

(d) Selection of Windows - A survey of agencies' practices in the selection and use of windows. The report is expected to cover design features such as types, arrangement, operation and materials used, as an aid to proper selection.

(e) Electrical Loads for Buildings - A survey of engineers' opinions and practices on estimating electrical loads for buildings for the present and near future.

(f) Testing of Paints - A survey of agency practices on specifying, sampling and testing of paints.

(g) Maintenance and Operating Problems Affected by Design and Construction - A survey of problems that relate to the design of structures.

(h) Waterproofing Masonry Walls Above and Below Ground - A study of problems involving leaks in masonry, poured-in-place concrete, and pre-cast concrete walls, both new and existing.

(i) Resilient Floor Finishes - A study of features, limitations, and recommended uses of resilient floor finishes.

Plans for Fiscal Year 1957: Reports on studies (e) to (i) inclusive in the foregoing list will be completed and work will be initiated on new tasks, including the following:

(j) Working Drawings and Specifications - Review Government and industry practices and prepare recommended practices.

(k) Summary of Tests of Air Filters - Prepare and distribute to interested Government agencies summaries of the results of performance tests of air filters for ventilation systems of buildings.

(l) Underground Conduits and Pipe Insulations - Review Government practices and prepare program for needed research.

MISCELLANEOUS (con.)

1003-20-4838 Aircraft Engine Air Filters

Objectives: To study the air-borne 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: 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 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, and adequate sampling methods have not been developed to secure representative samples for analysis. Currently used air filters in the induction air systems of helicopters are too low in efficiency and are inadequate in dust-holding capacity. The work has been requested by the Office of 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 of the continuing work on air cleaning devices for heating and air conditioning systems for buildings.

Activity Summary: This is a continuing project which was started in December 1953. During Fiscal Year 1955 and Fiscal Year 1956, a survey of the literature on the subject was made, a novel test apparatus was built utilizing glass fiber paper made at this Bureau as an absolute filter and a number of commercial air cleaners were performance-tested. Studies were also made of the dust distribution around helicopters operating on dusty landing fields and two worn-out engines were examined for causes and extent of wear by dust.

During the Fiscal Year 1956, further types of commercial air cleaners were tested and examined for usefulness in helicopters. Modifications were made on several models to improve their performance. An experimental cyclone dust separator was studied, an investigation was made of

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1003-20-4838 (con.)

numerous porous materials, as foam rubber and felt, to be used as air cleaners. The advantage of precleaners for certain types of air cleaners was determined experimentally. Tests were made to determine the vertical and horizontal concentrations and particle size distribution of dust around helicopters. A prototype precleaner for an L-19 aircraft was laboratory tested and furnished the OCT for field testing.

Plans for Fiscal Year 1957: (1) A summary report on the investigations is to be completed to indicate the merits of the various types of air cleaners. (2) The utilization of heavy fabrics as dry air cleaners will be investigated. It is planned to make several prototype designs of different fabrics, and possibly felt, and furnish them for flight tests. (3) Improvement on commercial air cleaners will be negotiated with manufacturers. (4) The practicability of pre-filters will be investigated further for the purpose of improving the first design and broadening its application to other types of air cleaners. (5) Cooperate with OCT on above investigations. (6) Devise a simple apparatus to determine the operational condition of the air cleaners with regard to need of maintenance. (7) Devise an apparatus to determine the performance of an air cleaner with regard to filtering efficiency and pressure loss during flight.

Underground Corrosion

Objectives: To Investigate the corrosion of metals, behavior of pipe coatings and asbestos cement pipe, in soils. (For details, contact Metallurgical Division, 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 front 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[1] ($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.


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