U. S. Department of Commerce
Bureau of Standards

Visitors' Manual

of the

Bureau of Standards

A Brief Account of Its History, Functions, and Laboratory Facilities

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'ISITORS' MANUAL OF THE BUREAU OF STANDARDS[1]

HISTORY, FUNCTIONS, AND ORGANIZATIONS

The Bureau of Standards was established on Iarch 3, 1901, by act of Congress, taking over the uties of the former office of weights and measures f the Coast and Geodetic Survey. The bureau was riginally under the Treasury Department but was ransferred to the Department of Commerce and abor (now the Department of Commerce) in 1903. t is charged with the development, construction, ustody, and maintenance of reference and working tandards and their intercomparison, improvement, nd application in science, engineering, industry, nd commerce. The original staff numbered 14 and he laboratories were housed in temporary quarters ear the Capitol. Now there are about 1,100 emloyees, two-thirds of whom are scientifically and echnically trained, and the laboratories are among he best equipped in the world. There are 12 major nd 7 minor buildings on a site of 56 acres, situated t the intersection of Van Ness Street and Connecicut Avenue in the northwest suburbs of Washingon. The altitude of the lower floor of the Shop uilding is 335.69 feet above mean sea level, latitude 8° 56′ 32″ north, longitude 77° 03′ 59″ west.

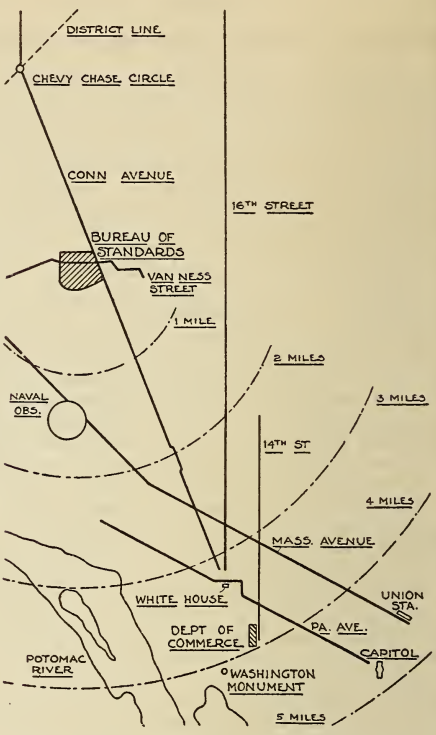
The director of the bureau is Dr. George K. Burgess. 'he bureau's telephone number is Cleveland 1720.

In addition to the regular staff, there are stationed t the bureau a number of research associates, sent y manufacturers and industrial groups to work on pecial problems of interest to the particular industry oncerned. The salary of a research associate is paid y the group which he represents; otherwise his status s that of a bureau employee. Results of the work f research associates are public property.

The bureau is organized in three principal groups—he first dealing with research and testing; the secnd with commercial standardization; and the third ith the administrative work, operation of plant, nd construction of laboratory instruments and pparatus. There are nine divisions of the first roup, made up of 68 sections, and four divisions ith a total of 19 sections in the second group.

[1] Prepared by Hugh G. Boutell, chief, information section.

The bureau's services are available to the Nation and State Governments without charge. Wo other than that for the Government is undertak under certain conditions, the main considerati being the value of the work to the Nation as whole. For private tests a fee is charged, whic



Location of the Bureau of Standards in relation to a few of the principal streets and public buildings

however, is turned into the United States Treasur and is not available to the bureau.

The results of the bureau's investigations ar made available through its Journal of Research an by articles in scientific and technical journals Other series of papers are also issued by the burea covering various phases of the work. A list of thes papers will be supplied on request to the Bureau o Standards. The bureau's publications are availabl

y purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The Bureau of Standards Journal of Research may be obtained on a subscription basis at $3 per ear ($3.75 foreign). Semiannual volumes of the ournal of Research (approximately 1,100 pages), ound in cloth, may also be purchased from the uperintendent of Documents at $3 per volume.

Progress of work in the laboratories, important onferences, and new publications issued can be fol-owed in the bureau's Technical News Bulletin, hich may be obtained by subscription at 25 cents er year (40 cents foreign) from the Superintendent f Documents.

Progress in the field of commercial standardiza-on in this country and abroad is recorded in the ommercial Standards Monthly, an illustrated mag-zine, the subscription price of which is $1 per year $1.25 foreign).

A complete illustrated description of the Bureau f Standards has been published as Circular No. 1 nd may be obtained from the Superintendent of)ocuments at 50 cents per copy.

POINTS OF SPECIAL INTEREST

The laboratories in the following list have been hosen because they have been found to be of great-st interest to visitors. Likewise they are repre-entative of the bureau's work, which includes fun-amental and applied research and testing.

Special arrangements can be made to visit other aboratories not listed.

A scheduled trip through the laboratories starts om room 300 Physical Building at 2.15 p. m., daily xcepting Saturday afternoons, Sundays, and holidays. pecial arrangements must be made several days in dvance for groups of 10 or more. It must be borne in ind that it is only possible, on any one trip, to visit few of the places listed. The sequence of buildings ere given is that in which visitors are ordinarily)uted.

HYSICAL BUILDING.

Room 101.—Mass section.

Weights of many different classes are sent here to have their accuracy determined. The balances used in this work include several of the highest precision. One of these will determine the difference between two weights of about 1 kilogram (approximately 2 pounds) each, with an error of less than 1 part in 100,000,000. This section has the custody of the national standard of mass, kilogram No. 20.

PHYSICAL BUILDING—Continued.

Rooms 108 and 109—Dimensional variations.

Investigation of dental materials; expansivity of solids.

Room 114 and corridor—Interferometry.

A demonstration apparatus is arranged to show the bending of a 5-inch steel bar under the pressure of one finger. Optical methods are employed by the bureau in making all sorts of precision length measurements.

Room 116—Length measurements in terms of light waves; identification.

Precision screws and dial indicators are calibrated in terms of light waves. Identification of questioned documents, guns, and bullets (will be open only by special arrangement with the section chief).

Rooms 201 and 202—Capacity and density.

Tests of glass volumetric apparatus and hydrometers; determination of density and thermal expansion of liquids.

Room 209—Length measurements.

In this laboratory length-measuring instruments of all kinds are checked against the working standards of the bureau. These in turn have been compared with the national standard—meter bar No. 27—which is kept in the vault on the first floor of this building. High-precision length measurements are made in a special underground room, where temperature is practically constant. (Open only by special arrangement when no work is in progress.)

Room 212—Spectroscopy.

In this section the spectra of the various elements are photographed, and the position and intensity of the lines determined with high precision. The spectra of rare gases occurring in the atmosphere may be viewed through a small spectroscope.

Room 218—Time section.

Watches and clocks are here compared under controlled conditions with the standard clock, which is installed in a special room in the basement. The clock does not vary more than two one-hundredths of a second per day.

HEAT BUILDING.

Room 102—Engineering instruments.

Pressure gauges, water-current meters, anemometers, and fire extinguishers are among the instruments and appliances tested in this laboratory. A standard test for elevator interlocks was developed by this section.

Room 203—Testing of thermometers.

Mercury-in-glass thermometers are compared with the bureau's standards by immersing both instruments in a bath, the temperature of which can be kept at any desired point.

Room 212—Pyrometry.

Devices for measuring high temperatures are tested in this laboratory. These include thermocouples, and optical and radiation pyrometers. The apparatus and method necessary for the realization of a new absolute standard of light (the Waidner-Burgess standard) were developed in this section.

Room 306—Optical testing of sugar.

The standard test for purity of a sugar solution is made by means of an instrument known as a saccharimeter. This instrument measures the rotation of a beam of plane polarized light passing through the solution. The bureau also carries out research work on the properties of sugar.

CRYOGENICS LABORATORY.

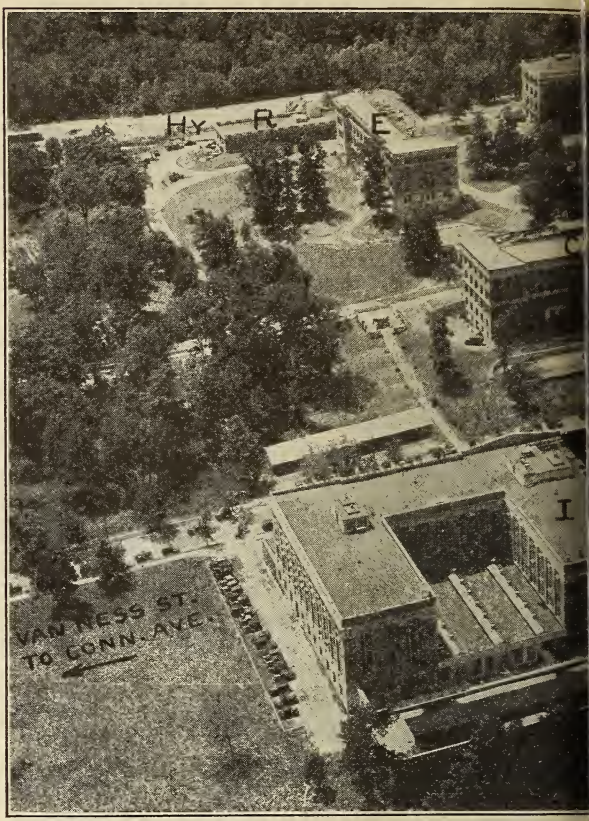
Room 11—Plants for producing liquid air and hydrogen used in determining points on the low-temperature scale.

Helium has been liquefied in this laboratory, the temperature being $-456°$ F. Liquid air is usually on hand as it is used in many of the laboratories. Its temperature is $-310°$ F. At this temperature the characteristics of ordinary substances are entirely changed. Soft rubber becomes as brittle as glass, lead may be used as a bell, while mercury may be frozen into the form of a hammer-head and used to drive nails.

WIND-TUNNEL BUILDING.

Main laboratory—Aerodynamics.

One of the three wind tunnels at the bureau, employed in studying the characteristics of air flow in the tunnel itself as well as the behavior of model airplanes, airships, bombs, buildings, chimneys, etc., in an air stream. This tunnel is 54 inches across at smallest section, and in it a wind speed of 75 miles per hour can be obtained.



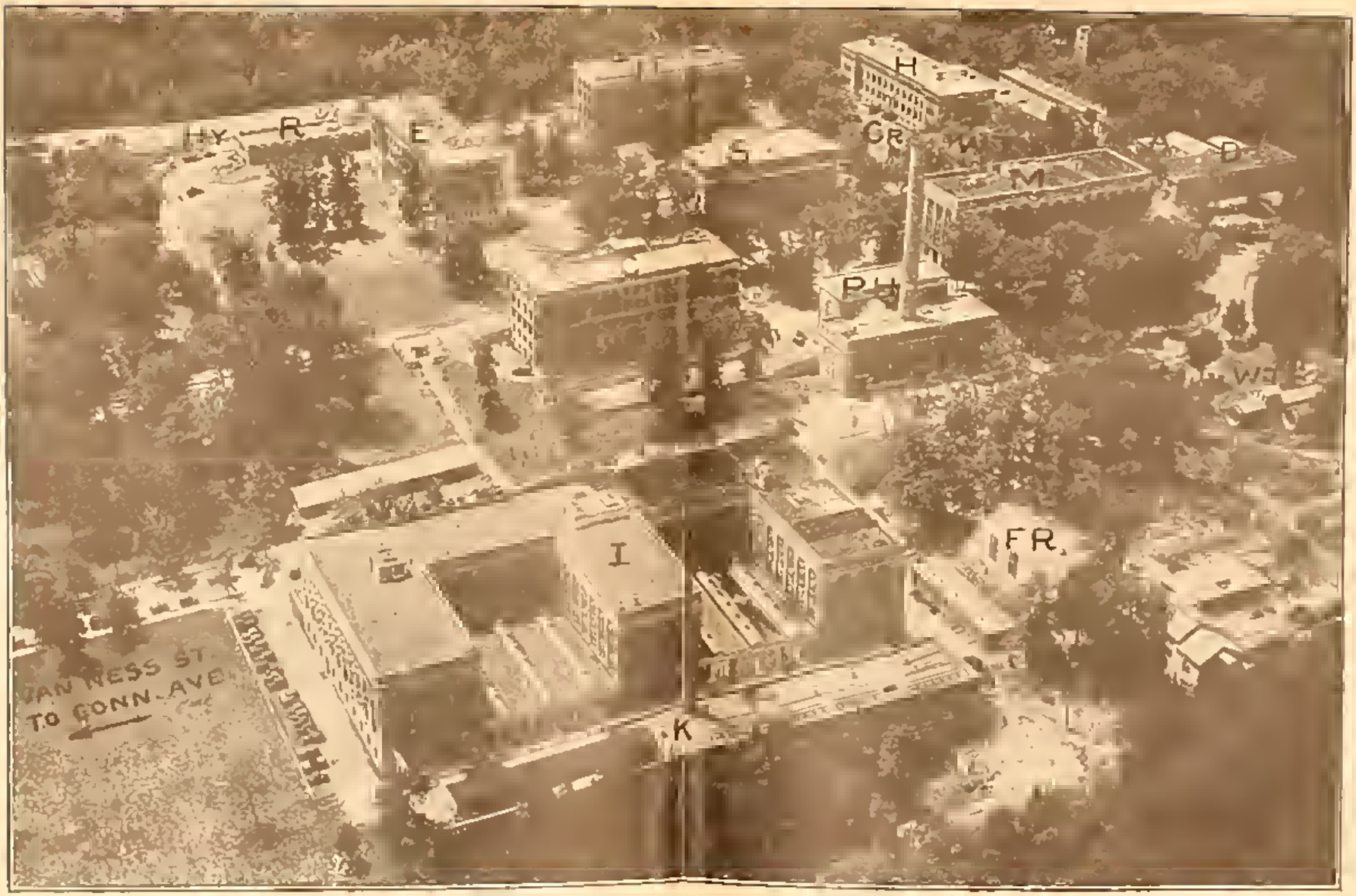
Photograph by Army Air Corps.

Airplane view of the Bu

The principal buildings, the names of which are indicated in the pictur
Electrical Building, Physical Building, Heat Building, Shop Building
eter Building, Chemistry Building, Power House, Metallurgical Bu
Wind Tunnel. The main entrance to the bureau's grounds is on Con
from the third floor of the Physical Building, shown near the top cen

andards, looking south

, are, starting from the top left: Hydraulic Building, Radio Building, ; Laboratory, Wind Tunnel Building, Altitude Laboratory, Dynamom- strial Building, Kiln Building, Fire Resistance Group, and Ten-Foot enue, to the left of this picture. The trip through the laboratories starts



Photograph by Army Air Corps.

Airplane view of the Bureau of Standards, looking south

The principal buildings, the names of which are indicated in the picture by letters, are, starting from the top left: Hydraulic Building, Radio Building, Electrical Building, Physical Building, Heat Building, Shop Building, Cryogenics Laboratory, Wind Tunnel Building, Altitude Laboratory, Dynamometer Building, Chemistry Building, Power House, Metallurgical Building, Industrial Building, Kiln Building, Fire Resistance Group, and Ten-Foot Wind Tunnel. The main entrance to the bureau's grounds is on Connecticut Avenue, to the left of this picture. The trip through the laboratories starts from the third floor of the Physical Building, shown near the top center.

ALTITUDE LABORATORY.

Studies of airplane engine performance unde flight conditions. The low air pressures an temperatures encountered at altitudes up t 30,000 feet can be duplicated.

DYNAMOMETER BUILDING.

Main laboratory—Automotive power plants.

Investigation of performance of internal-com bustion engines with special reference to fuel and lubricants. The bureau is the principal test ing laboratory for the Aeronautics Branch of th Department of Commerce. Before commercia airplane engines are licensed by the departmen they are given an endurance test in a special test ing plant at Arlington, Va.

METALLURGICAL BUILDING.

Basement—Experimental foundry and metal-work ing equipment.

Alloys can be prepared by melting in induction electric-arc, or gas-fired furnaces and cast, rolled forged, or drawn into the shape desired. Th equipment employed is similar to that used i actual mill practice but on a smaller scale.

Room 105—Microstructure of metals.

The crystalline structure of metals and alloy is studied in this laboratory. The effect of work heat, treatment, corrosion, etc., can be determined

Room 202—Gages.

Testing of precision gages used for controllin the dimensions of machine parts. Optical meth ods are often used in testing gages, and thei lengths can be determined to one-millionth o an inch.

Room 311—Aeronautic instruments.

Testing of all types of aeronautic instrument for scale errors, effect of temperature and pressure elastic defects, vibration, and other factor affecting the performance of these instruments Fundamental research and a certain amount o development work on special instruments ar are also being carried on.

CHEMISTRY BUILDING.

Room 8—Electrochemistry.

Small electroplating plant, used for preparin specimens for exposure and laboratory tests.

Room 112—Electrochemistry.

Equipment for measuring conductivity an hydrogen ion concentration.

HEMISTRY BUILDING—Continued.

Room 205—Gas chemistry.

Equipment used in the testing of gas appliances, including several devices for the rapid analysis of products of combustion and of mixtures being burned, which are of interest to those engaged in the study of the utilization of gas.

Room 208—Gas chemistry.

Here will be seen a considerable variety of apparatus for the analysis of gases, especially some very well-designed equipment for volumetric analysis, and elaborate apparatus for the fractionation of gases by distillation.

Room 211 and shaft in corridor—Petroleum.

Laboratory stills for determining the chemical composition of petroleum.

Room 303—Organic chemistry.

Pure crystalline rubber has been produced in this section by distillation.

Room 410—Accelerated weathering equipment for organic protective coatings.

Apparatus for determining breakdown of protective coatings.

Apparatus for determining hiding power of paint.

Room 417—Protective coatings.

Chamber large enough for a man to work in where humidity can be controlled by saturated solutions of salts.

NOTE.—A special mimeographed guide to the laboratories in this building may be obtained on application at the chief chemist's office, room 215.

ECTRICAL BUILDING.

Rooms 106 and 107—Tests of electrical measuring instruments.

Special switchboard for connecting different circuits and optical device for accurate reading of scale of instruments.

Room 109—Heavy-current testing.

Tests are made up to 1,200 amperes. Current supplied from a special storage battery.

Room 111—Resistance measurements.

The oil bath in which wire standards of resistance are immersed during test includes a special stirring arrangement and temperature control. Precision standards for other laboratories are

ELECTRICAL BUILDING—Continued.

thus compared at a constant temperature with th standards which represent the bureau's bas unit of electrical resistance.

Room 307—Life tests of incandescent lamps.

Each year several thousand lamps representin Government purchases of about 3,000,000 lam per year are tested to ascertain whether the comply with the Government's specifications.

Room 314—Integrating sphere for determining th mean spherical candlepower of lamps.

By means of a hollow sphere the inside surfac of which is painted white, and at the center which is placed the lamp, the total amount light given off in all directions by any electri lamp is determined by a single measurement.

Room 317—Tests of radium.

Practically all radium sold in the United State is tested in this laboratory. The rate of radiatio is compared with that of a standard sample.

Room 408—Standard cells.

Weston normal saturated cells, by which th standard of voltage is maintained for the Unite States.

RADIO BUILDING.

Main hall—Museum and library.

Various types of electron tubes.
French and American radio sets used in Worl War.
Miscellaneous apparatus developed for research
Publications, reports, and books.

Room 214.

Fundamental standard of radio-frequency, con sisting of four quartz oscillators and auxiliar apparatus. Good to 1 or 2 parts in 10,000,000.

NOTE.—Other parts of the radio work may be seen upon special arrangement with the section office.

HYDRAULICS BUILDING.

This building, which is 285 feet long and from 60 to 92 feet wide, contains supply and measuring basins, flumes, pumping, and metering equipment for every variety of hydraulic investigation, including experiments with models of large structures. A maximum flow of 250 cubic feet per second is possible in the main flume, which is 12 feet square and 200 feet long. (Open to visitors on special arrangement with chief of the section.)

DUSTRIAL BUILDING.

Basement, west end—Cement and concrete testing equipment.

Samples of about 70 per cent of all cement which the Government buys are tested by the bureau.

Basement, center—Large testing machines for structural materials.

The vertical machine on the left, the largest in the world, has a capacity of 10,000,000 pounds in compression. On the right is a 600,000-pound machine for either tension or compression, and specially designed for testing beams. In the room next to this machine on the right is the Emery high-precision testing machine with a capacity of 2,300,000 pounds in compression and 1,150,000 pounds in tension.

Room 25—Optical glass.

Examples of glass produced by the bureau. Examination for striæ and strain.

Room 106—Textiles.

The equipment includes a complete cotton mill and representative machines for special work. Tests of textiles and paper are made in a room in which the humidity and temperature are automatically kept constant.

Room 107—Paper.

The bureau has a complete paper-making plant, including a paper machine for making a sheet 29 inches in width, with which improvements in processes and the use of new materials can be studied.

Room 138—Experimental sugar plant for the production of levulose on a semicommercial scale.

The method used for the recovery of this sweetest of all sugars was developed by the bureau.

Room 227—Rubber.

The work of this section occupies several laboratories on this floor and in the basement. Automobile tires are tested for power loss and endurance, on special machines which greatly shorten the time needed for a service test.

Room 319—Leather.

Samples of leather made from various kinds of hides. Machine for measuring the durability of sole leather. Work on tanning solutions. Means for increasing the life of leather, and for combating deteriorating influences, such as sulphuric acid in the atmosphere, receive particular attention.

KILN BUILDING.

East end—Optical-glass plant.

The bureau operates one of the few plants n making optical glass in the United States. M of the glass made here is used by the Na Department for binoculars, gun sights, pe scopes, and similar instruments. Equipme includes machinery for making pots, melting a annealing furnaces, and instruments for det mining quality of glass.

Center.

Furnaces for ceramic material, enameling metals, etc.; fire tests of wall panels.

West end.

Rotary cement kiln and ball mills for grindi cement.

FIRE-RESISTANCE GROUP.

West of the Industrial Building is a group structures in which tests are made to determi the intensity and duration of fires and the fi resistance of building materials and construction The equipment includes a large furnace for w panels and another for testing safes.

TEN-FOOT WIND TUNNEL.

This outdoor wind tunnel, which is located ju west of the fire-resistance group, has a diameter 10 feet and a maximum wind speed of 75 miles p hour. Tests on large models of buildings, chi neys, full-sized airplane wing sections, etc., a made in the tunnel.

A FEW OUTSTANDING ACCOMPLISHMENTS

The Bureau of Standards—

Constructed the first altitude laboratory f measuring the performance of airplane engines und flight conditions.

Produced the first practicable model of the eart inductor compass, now universally used in lon distance aircraft flights.

Developed the radiobeacon which, in combinatio with a special aerial and receiving set on the ai plane, gives the pilot a visual indication whether h is following the correct course.

Discovered that a thin coating of pure aluminu will greatly decrease the atmospheric corrosion duralumin, the special light alloy largely used i aircraft construction.

Worked out successful process for plating ste and other metals with chromium, the hardest met known, and thus more than doubled the life printing plates used by the Government.

Developed a new paper for printing United States currency with a life 50 per cent greater than paper formerly employed.

Discovered that certain waste water from paper mills makes a satisfactory material for tanning leather.

Established the dextrose (corn sugar) industry and is now experimenting on production of levulose (sugar from Jerusalem artichokes) on a commercial scale.

Made three standards of planeness flat to within one five-millionths of an inch. These are fused quartz disks about 11 inches in diameter. If enlarged to be 1,000 miles in diameter, the surface would not differ from a true plane by more than 1 inch.

Commenced experiments in making optical glass in 1914 and at last solved the difficult technique, so that optical glass of many grades is now produced as a routine matter. Cast the largest disk of optical glass ever made in this country and the largest ever produced anywhere at one pouring—69.75 inches in diameter and 10.5 inches thick; used as the mirror for the Perkins telescope at Ohio Wesleyan University.

Ruled several steel scales directly from light waves, so that there was no measurable error in the finished scales.

Assisted in securing the adoption of a uniform international temperature scale by the International Conference on Weights and Measures.

Published books on house construction and repair, home ownership, zoning regulations, and plumbing requirements.

Helped to reduce unnecessary variety of sizes and styles of articles in common use, securing agreement of manufacturers to concentrate on production of those in greatest demand, thus lowering cost of manufacture and distribution.

Assisted industry in agreeing on satisfactory standards of quality for many products, and published the results as commercial standards.

Published first directory of commodity specifications and has started a series of publications in which all recognized specifications for a given class of commodities are to be published in full. Developed certification and labeling plan for making available to small purchasers the benefits of buying by specification.

NUMBER OF PUBLICATIONS ISSUED

During the fiscal year 1931 the number of papers published in the Bureau of Standards Journal of Research was 146. In addition, two other periodi-

cals, the Technical News Bulletin and the Comme cial Standards Monthly, were issued each mont Forty-eight papers were published in the other seri of the bureau, including simplified practice recor mendations, building and housing, commerci standards, circulars, handbooks, and miscellaneo publications. The total, including 12 numbers each of the three periodicals, 146 reprints, and other publications, was therefore 230. In additio 170 papers were published in scientific and technic journals.

VOLUME OF TESTING

In one year the Bureau of Standards teste approximately—

2, 350 electrical standards and instruments.
2, 430 electric batteries.
4, 000 electrical lamps, representing purchases 2,970,000 lamps by the Government.
2, 400 gages and samples of gage steel.
10, 100 weights and balances.
1, 230 scales.
430 timepieces.
14, 700 pieces of glass volumetric apparatus.
1, 400 hydrometers.
4, 500 laboratory thermometers.
92, 000 clinical thermometers.
2, 050 samples of engine fuels and lubricants.
1, 900 samples of sugar.
2, 700 samples of radium and radioactive material determining a sale price of $1,500,000.
1, 450 engineering instruments.
1, 000 aeronautic instruments.
2, 300 specimens of engineering materials.
400 fusible boiler plugs.
1, 500 samples of metals and alloys.
20. 000 samples of cement and concrete, represent ing purchases of 2,300,000 barrels o cement.
12, 000 miscellaneous samples of ceramic materials
1, 600 samples of rubber.
6, 600 samples of textile materials.
2, 800 samples of paper.
350 samples of leather.
3, 000 samples of paint and varnish.

In addition to the above, 900 miscellaneous chemi cal tests were made and 6,500 standard sample were distributed.

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