ANNUAL REPORT

OF THE

DIRECTOR

OF THE

NATIONAL BUREAU OF STANDARDS

FOR THE

FISCAL YEAR ENDED JUNE 30, 1902.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

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Treasury Department,

Document No. 2316,

National Bureau of Standards.

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Treasury Department,
National Bureau of Standards,
Washington, D. C., February 19, 1903.

Sir: I have the honor to submit the following report of the operations of this Bureau for the fiscal year ended June 30, 1902:

ESTABLISHMENT AND PURPOSE.

By an act of Congress approved March 3, 1901, the Office of Standard Weights and Measures of the Treasury Department was, on July 1, 1901, superseded by the National Bureau of Standards, the functions of which may be briefly stated as follows: the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions, with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials. The Bureau will also furnish such information concerning standards, methods of measurement, physical constants, and the properties of materials as may be at its disposal, and is authorized to exercise its functions for the Government of the United States, for State or municipal governments within the United States, for scientific societies, educational institutions, firms, corporations, or individuals.

SELECTION OF SITE.

The act of Congress establishing the National Bureau of Standards provided for the purchase of a site and the erection of suitable laboratories.

The site selected consists of about $7\frac{1}{2}$ acres in the most desirable section of the suburbs of Washington, in a neighborhood particularly free from mechanical and electrical disturbances, but sufficiently easy of access. The fund available for the purchase of a site, while sufficient to secure the area necessary for the buildings, was hardly sufficient to purchase the area necessary to insure freedom from disturbance when the neighborhood in which the Bureau is situated becomes more completely settled. The Government should secure as soon as possible the remaining portions of the block in which the site is situated, bounded on the north by Shepherd street, on the east by Connecticut avenue, on the south by Quincy street, and on the west by Idaho avenue.

PLAN OF THE WORK.

After the selection of a site, the problems confronting the Bureau were the organization of the working force; the preparation of the plans of the laboratories and their permanent equipment; the preliminary work in the many lines of work in order that the apparatus might be designed and constructed or purchased, and methods decided upon by the time the buildings were ready for occupancy; the comparison and testing of such standards and measuring instruments as could be undertaken in temporary quarters and with the facilities at the disposal of the Bureau.

TEMPORARY QUARTERS.

During this year the quarters occupied by the Bureau consisted of eight rooms in the third floor of the middle and south Butler buildings, which have been used for offices and laboratory purposes, and eight rooms which were formerly used by the office of Weights and Measures in the United States Coast and Geodetic Survey building, which were retained for laboratory purposes. It soon became evident that this amount of space was not sufficient for even the most elementary work, and that the new laboratories would not be ready for occupancy as soon as expected. Steps were therefore taken to secure additional quarters. A large four-story residence building at 235 New Jersey avenue SE. was secured, and became available for laboratory purposes July 1, 1902. This building will provide space for the organization of several new lines of work and for the collection and testing of the apparatus to be used in our own equipment and to be moved later to the new laboratories. It will also provide space for an instrument shop, which is of the utmost importance, since much of the apparatus to be used in the Bureau is special in character and must be designed and built under the supervision of experts. The ordinary testing of standards and instruments is necessarily attended by the adjustment of weights and measures and other work of a mechanical nature.

PERSONNEL.

The limited number of positions provided for by the act establishing the Bureau was only sufficient to begin the solution of the problems enumerated above. The list is as follows, including the additional positions available July 1, 1902:

The Director.

Scientific Division.—One physicist, two assistant physicists, five laboratory assistants, and two laborers.

Engineering Division.—One engineer, one assistant engineer, two mechanicians, one skilled laborer, and one watchman.

Office Division.—Secretary, two clerks, one storekeeper, one messenger, and one laborer.

PLANS FOR THE NEW LABORATORIES AND THEIR EQUIPMENT.

The work for which the National Bureau of Standards was established includes research and testing in the domain of physics, extending into the field of chemistry on the one hand and of engineering on the other. The union of research and testing in one institution is of supreme importance, the investigations being, of course, primarily designed to carry the work of standardization and testing to the highest possible efficiency. The Physikalisch-Technische Reichsanstalt of Germany is an illustrious example of how much can be accomplished where research and testing are combined in one institution. The laboratory requirements are, therefore, those of a research laboratory plus whatever special facilities may be needed for commercial testing. In addition to the workers themselves, there is then required (1) a suitable place in which to work, (2) an equipment of apparatus, tools, and machines, and (3) facilities and appliances for providing the proper conditions for experimental work. Two buildings have been planned, one of which, the Mechanical Laboratory, is now under construction, and the plans for the other are completed. The latter, which is called the Physical Laboratory, will provide for that part of the experimental work which ought to be kept free from mechanical and magnetic disturbances, and to this end will contain scarcely any machinery. It will also contain the offices for administration, the library, and a well-equipped chemical laboratory. The Mechanical Laboratory contains the mechanical plant, instrument shop, and laboratories for the heavier kinds of experimental work, where considerable power or large currents are required. These two buildings are to be connected by a spacious tunnel, through which air ducts, steam, gas, and water pipes, and electric circuits are carried from the Mechanical to the Physical Laboratory. The facilities and appliances for bringing an experiment under the proper conditions are more difficult to secure than the apparatus itself. In general, laboratory rooms should be well lighted and ventilated, and their temperature should be under control. The windows should be double, in order that the space near the windows (often the most valuable space in the laboratory) may be warmer in cold weather and cooler in warm weather, and freer from drafts of air than would be the case with single windows. It should be possible quickly and conveniently to darken many if not all the rooms. The temperature of the laboratory should be automatically controlled by thermostats, so that any temperature (within certain limits) which may be required by any particular experiment or investigation may be maintained both day and night, if necessary, for any desired period. The humidity of the air should be low, so that moisture developed in the room either by respiration or evaporation may be absorbed by the air and carried away instead of depositing on the walls and furniture of the room and apparatus. These last considerations, the control of the temperature and humidity of the air, are vital. Many kinds of work can ordinarily be done only in the winter months, because summer temperatures and summer humidity can not be controlled. This involves not only long delays, but often a large amount of extra labor. This is perhaps most often the case in electrical work, but in many other instances it is equally important. Apparatus, tools, and machines often suffer by rusting in summer, in spite of the fact that the attendant means to be careful. Hence in a laboratory where work is to be carried on during the entire year, and where a large quantity of valuable apparatus and instruments of precision are in use, and where, in addition, valuable apparatus is to be received from outside for testing, the necessity of controlling the humidity as well as the temperature of the room is evident.

The buildings will be heated by the double-duct system—hot air from one duct is mixed with cooler tempered air from a second duct in such proportions as to hold the temperature of the room constant, the proportions of the hot and tempered air being regulated by a pair of dampers, the latter being automatically controlled by means of a thermostat. Each room of a building, therefore, has its own supply flue, regulating dampers, and thermostat. The latter may be set at any desired temperature within the range of the apparatus. If in hot weather the hot-air duct carries air taken from out of doors, say at 90° F., and the tempered-air duct carries artificially cooled air, say at 60°; a mixture of the two may give a room temperature of 75°, when the temperature would otherwise be 80° or 85°. The thermostat will adjust automatically the proportions of cooled and uncooled air so as to hold this temperature constant, thus preventing the usual gradual increase of temperature as the day progresses. By a readjustment of the thermostat any other constant temperature can be secured, provided it is within the range of the system.

The laboratory facilities will include gas, compressed air, vacuum, hot and cold air, and ice, cold brine, liquid carbon dioxide, and liquid air will be provided for the production of low temperatures. Gas and electric furnaces will be available for high temperatures. The electrical equipment will include the dynamos, motors, storage batteries, transformers, and other apparatus necessary for the production of the range of current and voltage required for experimental and testing purposes.

The Mechanical Laboratory is approximately 41 meters (135 feet) long by 16 meters (51 feet) wide and is three stories high. A large extension of the first floor increases its area by nearly 50 per cent. This floor will include a boiler room large enough to eontain the boilers, pumps, tanks, and other aeeessories necessary for the present equipment and a reasonable amount of expansion, a large engine and dynamo room, a large room for the refrigerating and liquid-air plants, a large storage-battery room, also rooms for the heating and ventilating apparatus, gas plant, eoal supply, and storage. The seeond floor will include an instrument shop, woodworking shop, and several laboratories for electrieal work requiring heavy currents. The rooms of the third floor will be used for eleetrieal work and other testing.

The Physieal Laboratory is approximately 52 meters (172 feet) long, 17 meters (53 feet) wide, and four stories high, with an attie eontaining eonsiderable available storage spaee. The building will be of extra heavy eonstruetion, will be well lighted, and the first two floors reserved entirely for experimental purposes. A eorridor will extend the entire length of the first floor and the exterior of the building will be so designed that if in the future additional buildings should be needed they may be plaeed one on the east and the other on the west, and conneeted to it by an arcade opening into the corridor of the first floor.

A basement is exeavated only under the eentral portion of the building and under the corridor, the laboratory rooms at either end having eonerete floors, upon whieh piers may be built as they are found neeessary. All of the rooms of the first and seeond floors will be praetieally constant-temperature rooms, with automatie temperature control. They will have double windows, provided with light-tight shutters for darkening the rooms when neeessary. The laboratories of this building are provided with all of the usual laboratory facilities; ample ducts and spaces are provided for placing wires or piping that may be needed in the future.

This building will eontain laboratories for testing and investigations in the following subjeets: weights and measures, including length, mass, and capacity; eleetrieity, including standards of resistance, electromotive force, and induetion. The space allotted to the subjeet of eleetrieity will also include laboratories for general research and investigations in conneetion with electrical standards, measuring instruments, constants, and the eleetrieal properties of materials. The subject of thermometry will be amply provided for and will include the testing of all kinds of mercurial thermometers and the instruments for measuring temperatures above and below the range of mercurial thermometers as well as facilities for investigations in this field. The third floor of the building will be devoted to the Library, Museum, supply rooms, and administration. The fourth floor will be fitted up as a Chemical Laboratory.

In addition to the heating and ventilating system in this building, there is a separate exhaust system connected to each laboratory, toilet room, storage-battery room, hoods of the chemical laboratory, etc. These exhaust flues will be provided with a fan sufficiently strong to secure a positive draft for carrying off all noxious fumes or vapors that may be generated in these rooms. Much attention has been given to the permanent laboratory equipment, such as plumbing, working tables, cases, etc.

WEIGHTS AND MEASURES.

The work of the past year has involved the verification of a large number of standards of length, mass, and capacity for the Government and for chemists, engineers, State and city sealers, manufacturers, and merchants. In addition to the work done for the public, considerable attention was given to the improvements of comparers, balances, and other apparatus used in the work of this character, the object being to design apparatus which will permit of the work being done with the required accuracy and the maximum speed. This of course applies only to the routine comparisons, which have to be made in large quantities for nominal fees.

Verifications of the highest scientific accuracy will be always more or less laborious and require more time, but even here both labor and time are greatly reduced if the proper equipment is provided. The verification of the weights and measures, including hydrometers, polariscopic apparatus, and other appliances used in everyday transactions, is one of fundamental importance to the Government and to the people at large. The rapid development of our industries has resulted in new demands upon the Government, to which it would not have been subjected formerly. There is hardly a field in which competition does not exist, and in consequence the Bureau is called upon to settle questions of standards that would scarcely have arisen a few years ago. Another cause contributing to the increased demands along these lines is the necessity for greater accuracy. What would have been considered sufficiently accurate a few years ago will no longer satisfy engineers, manufacturers, merchants, or the public.

Among the more urgent matters demanding attention are the following:

1. The verification and stamping of chemical glassware, such as flasks, burettes, and graduates. Large quantities of graduated glassware are used by chemists, who are at present obliged either to test it themselves or purchase German ware, which has been examined and stamped by the German bureau of weights and measures. This causes great inconvenience to our chemists, and, moreover, makes it difficult for American manufacturers to compete with German makers of high-grade measuring apparatus, whose product bears an official stamp indicating the accuracy of its graduations. Preliminary plans to meet the demands of chemists and manufacturers have been prepared, and it is expected that by the end of the next fiscal year the Bureau will be in a position to test this ware in small quantities.

2. The design and construction of a model set of weights and measures that shall be adapted to the needs of State, county, and city sealers. The sets of weights and measures furnished to the States in accordance with the acts of 1836 and 1866, while doubtless good enough for the dates of the design, do not meet present requirements. The Bureau is continually called upon by State and city authorities for information as to where suitable sets of standards may be procured, and the preparation of such a model set, together with regulations for their use, are matters that are daily becoming more urgent.

3. The present chaotic condition of the question of hydrometers is also one demanding immediate attention. Numerous hydrometers for special purposes are in use, none of which are based upon an authoritative table of densities corresponding to the indications of the instrument. In consequence much confusion exists among manufacturers and merchants, and even officers of the Government, as to the meaning of the graduations of these instruments, and the aid of the Bureau is frequently invoked.

THERMOMETRY.

The work in thermometry has hitherto been confined to the testing of mercurial thermometers within the range from about $-20°$ C. ($-4°$ F.) to about 50° C. (122° F.). Work within this narrow range no longer satisfies the requirements of scientific work or the demands of technical processes. Many of the processes of manufacturers are dependent for their successful operation on an accurate knowledge of the temperature, such, for example, as annealing, hardening, tempering, galvanizing, distillation, smelting, etc., temperatures of hot blast and furnace gases, of furnaces and ovens used in the various industries, such as the manufacture of steel products, glass, porcelains, and other ceramic materials, etc. In many operations comparatively slight variations of temperature produce wide differences in the character of the resulting products. This has led to an increasing demand for thermometers and pyrometers that will register high temperatures. Manufacturers abroad have been quicker to realize the great importance of an accurate knowledge of the temperature in many lines of work, although these questions are now beginning to receive due attention in this country.

The lack of proper attention to this question is undoubtedly due to the absence of suitable standards of temperature, for the indications of the various pyrometers found on the market yield widely different results and consequently lead to confusion and loss of confidence, and this in a great measure not due to inferiority in construction of American instruments, but is inevitable, as the manufacturers could not obtain uniform standards, so that each maker was compelled to establish his own scale of temperature as best he could with the facilities at hand. The result has been that American manufacturers have been compelled to go abroad for reliable standards which are certified by foreign testing bureaus.

To meet these requirements specifications have been drawn up and the necessary apparatus purchased or constructed that will in the near future enable the Bureau to undertake the testing of all kinds of temperature-measuring instruments up to about 1,500° C. (2,700° F.).

The liquefaction of air and other gases on a large scale has opened up a new and important field of research on the properties of matter at extremely low temperatures and occasioned a demand for thermometers whose scale extends considerably below that of the mercury thermometer. The Bureau is preparing to meet these requirements, and will very soon be able to certify such thermometers for temperatures as low as —190° C (—310° F.).

Many inquiries have been addressed to the Bureau by various manufacturers with reference to the testing of clinical thermometers, and the necessary preliminary work is now well under way. Many thousands of these thermometers are tested and certified each year by foreign testing bureaus, and the high standard of requirements set by those bureaus has done much toward improving the accuracy and reliability of thermometers of this type.

ELECTRICAL STANDARDS.

A laboratory has been fitted up for the verification of standards of resistance and electromotive force, in terms of which all electrical measurements will be directly or indirectly expressed. A large number of resistance standards, ranging from 0.0001 to 100,000 ohms, have been secured and suitable comparing apparatus has been acquired, so that the Bureau is already equipped for the measurement of resistance standards submitted for verification in terms of those belonging to the Bureau to the highest order of accuracy.

The international unit of resistance, legalized by act of Congress in the United States, was defined by the International Electrical Congress in terms of the resistance of a column of mercury of specific dimensions at a specified temperature, and it was assumed that the various governments represented would take up without delay the construction of new mercurial standards. While the use of secondary standards for ordinary purposes suffices, it is most important that the Bureau should undertake the construction of primary mercurial standards at the earliest possible moment, not only to place the resistance measurements on a firmer basis, but also to determine, in conjunction with the laboratories of other governments, the accuracy with which such standards may be reproduced from their definitions, and to construct a number of secondary mercurial standards, as such standards after aging are not subject to as large variations as wire standards.

Facilities are now provided for the verification of resistance boxes, ratio coils, potentiometers, and other classes of apparatus, and facilities are to be provided for the calibration of low-resistance standards of high carrying capacity, for the determination of specific conductivity, and insulation resistance.

A considerable portion of the time during the past year was spent in planning the work to be undertaken and in the design of special apparatus.

During the past year a considerable number of resistance standards have been verified for manufacturers, scientific institutions, and the Government.

STANDARDS OF ELECTRO-MOTIVE FORCE.

Accurate measurements of electro-motive force are as fundamental as the accurate measurement of resistance. A number of Clark standard cells, legalized by Congress as the standard of electro-motive force in the United States, have been constructed from chemically pure materials obtained from a number of different sources, and also from the same materials subjected to further purification. Although the agreement of the individual cells with each other is within two parts in 10,000, a further supply of materials for new cells has been purchased. This material will be analyzed and subjected to further purification in order that the standards of electro-motive force may meet every requirement.

The main source of the variation of the electro-motive force of the Clark cell seems to be due to the differences in one of the ingredients used, and investigations should be directed to ascertain under what conditions this material can be obtained with uniform electro-motive properties.

When the unit of electro-motive force was defined by the International Congress, the best determinations of the value of the Clark cell in terms of that unit corresponded to the relation 1 volt = 1000/1434 electro-motive force of the Clark standard cell at 15° C. Subsequent work has indicated that the volt thus defined is too small by almost one part in a thousand. A different unit has therefore been adopted by Germany. Moreover, another type of standard cell, the Weston, has been found to possess some advantages over the Clark cell. A number of these cells have already been set up and, in view of the possibility of its adoption as the official standard of reference, others are to be constructed and compared with each other and with the Clark standard cells.

Although the measurement of electric currents will be based upon standards of resistance and electro-motive force, the Bureau should undertake the redetermination of the electro-chemical equivalent of silver, upon which the legal definition of the unit of current is based, since the value adopted is not consistent with the definition of the two other fundamental electrical units—the ohm and the volt.

THE VERIFICATION OF AMMETERS AND VOLTMETERS.

One of the temporary laboratories has been fitted up for the calibration of voltmeters and ammeters, and while the range is at present limited to 150 volts and 50 amperes, apparatus will soon be installed for increasing these ranges to 2,000 volts and 1,500 amperes. The necessary galvanometers, resistance standards, resistance boxes, regulating rheostats, and other accessory apparatus have been provided. A comparative study of the different makes of American instruments will be made after the working standards of the Bureau have been calibrated. Facilities will also be provided for the measurement of ammeter shunts of high carrying capacity. A number of requests for work of this kind have already been made. With facilities for the measurement of high voltages and heavy currents, the Bureau will also be prepared for the verification of direct current watt-meters and supply meters; and this work will be undertaken for the public as soon as an adequate force is provided.

It is desirable that a portable apparatus be designed which will permit electric light and power companies so disposed to have their switch-boards and other apparatus tested in place.

ALTERNATING-CURRENT LABORATORY.

An alternating-current laboratory is being fitted up at 235 New Jersey avenue SE. A storage battery for furnishing direct current for experimental work and for power has been installed. Orders have been placed for specially designed single-phase and multi-phase alternators, to be direct connected to independent direct-current motors. Especial attention will be given to the comparative study of the methods for determining wave form, which in many practical cases departs so widely from the simplest type.

The determination of electrostatic capacity and the investigation of dielectric-hysteresis will also be given special attention, as will also the verification of standards of self and mutual inductance.

For the verification of alternating-current ammeters and wattmeters a set of Kelvin ampere balances, as well as considerable other apparatus, has been purchased, and a low-voltage storage battery of large capacity will be installed for supplying heavy currents. Facilities will be provided for the verification of alternating-current voltmeters from the lowest to the highest ranges. Instruments of various types have been ordered, and will be calibrated by the aid of a high-voltage test battery, 1,000 cells of which are to be immediately installed. One of the first problems will be to make a comparative study of various types of alternating-current instruments to determine the limits of error to which they are liable and the influence of the frequency and wave form on their indications. Provision will be made for the calibration of direct-reading wattmeters, as well as the commercial types of supply meters. Before this can be done for the public it will be necessary to make a careful study of several different types of alternating-current meters. Only a limited range of work can, however, be attempted in the temporary laboratory, for lack of space and assistance.

MAGNETIC WORK.

Owing to the insufficiency of the force, no work along this important line could be undertaken. Facilities will, however, be provided without delay for the determination of the magnetic properties of materials, a knowledge of which is so important to manufacturers of electrical apparatus, and for the verification of magnetic balances and other apparatus for the determination of such properties.

Investigations as to the influence of treatment and chemical composition on the magnetic properties of iron and steel would undoubtedly be of great value to manufacturers, and will be taken up as soon as time permits.

PHOTOMETRY.

The importance of accurate standards for photometric measurements is recognized by the Bureau. It will therefore endeavor to place at the disposal of the lighting interests and the general public as soon as possible means for verifying such standards.

The Hefner amyl-acetate lamp, notwithstanding its numerous and evident defects, its reddish color, the influence of flame height, temperature, humidity, etc., upon its intensity, has been generally adopted as the primary standard. Only in the hands of a skilled observer are the results satisfactory, and the numerous corrections which must be applied render its use out of the question in industrial photometry. This has resulted in the adoption of properly treated incandescent lamps as secondary and as working standards, the luminous intensity depending only upon the voltage applied. Variations in the intensity with use are eliminated by using the secondary standards only for checking the working standards. The most urgent demand will therefore be met by providing facilities for the verification of such lamps.

One of the rooms in the temporary laboratory has already been fitted up as a photometric laboratory, with the latest type of comparing apparatus. Several Hefner lamps have been purchased, and orders have been placed for the necessary electrical apparatus, voltmeters, ammeters, wattmeters, resistance standards, and a precision photometer. A battery of sixty-six 200-ampere-hour cells has been installed for furnishing the necessary power, and regulating rheostats have been constructed.

One of the sources of error in photometric measurements is due to the difference between the color of the Hefner standard and that of the modern sources of artificial illumination with which it is compared, and an extended series of measurements by different observers, skilled in photometry, is to be arranged to study this source of error and to eliminate errors arising from the improper use of the Hefner standard.

While the most urgent demand is for properly verified standards of candle power, it is highly important that the Bureau should make a comparative study of the different methods which have been proposed for the determination of the "mean spherical intensity," upon which the economic value of a lamp when used for general illumination depends.

The defects of the Hefner standard make it important to investigate further the different methods which have been proposed for the realization of a better primary photometric standard. Thus the "acetylene-in-oxygen" lamp and the Nernst glower should be investigated, but the most promising direction is that along which the Physikalisch-Technische Reichsanstalt has been working for a number of years, that is, in the study of the radiation from the inside of a hollow body, the walls of which are maintained at a uniform temperature. The intensity of the radiation emanating from the interior depends only upon the temperature of the walls, and while the methods for the measurement of the high temperatures involved in photometric standards are not yet sufficiently precise, it is probable that the temperature can be defined in terms of the radiation emanating from a body at a lower and, therefore, more accurately measurable temperature. Work along this line should be undertaken in conjunction with the other high temperature researches. Provision will be made for the spectrophotometric analysis of the light emitted by lamps, as this furnishes the best means of defining its quality.

Recent improvements in the construction of arc lamps, the commercial advent of the Nernst glow lamp, the mercury arc, and the general introduction of the Welsbach incandescent gas lamps, make it important for the Bureau to provide for the investigation of questions concerning their performance.

THE WORK OF THE OFFICE.

The office work includes correspondence, preparation of certificates, purchases, accounts, records, library and archives, care of apparatus and supplies, editorial work, and publication.

A steadily increasing correspondence has developed in connection with the business and technical work of the Bureau. Requests for information on the part of the general public and Government bureaus have been numerous. Information concerning standards and standardization should be fully available for the use of all interests concerned.

The card system has been applied in the business of the Bureau, the main advantages being the ease of quick reference, convenience of classification and rearrangement, facility of removal of useless matter, and the unlimited expansibility. The vertical system for filing correspondence has been adopted, and the numerical, alphabetical, and subject index combined in a simple manner, to secure the merits of each, especially facilitating subject reference. Each letter, order, or other paper received or sent is numbered, and a record kept of source, destination, subject, to whom referred, and file number. The alphabetical card index affords a complete and quick reference to any paper received by or sent from the Bureau

The accounting of the Bureau involves the receipt and record of fees for standardizing weights, measures, and measuring instruments, the record of appropriations and balances; the checking, record, and forwarding of vouchers for settlement; preparation of statements for Auditor, warrants, checking of disbursement records, and the annual accounting of appropriations and fees.

APPROPRIATIONS, 1901-2.

Toward the erection of a suitable laboratory, cost not to exceed $325,000	$100,000
Site, National Bureau of Standards	25,000
Salaries, National Bureau of Standards, 1902	27,140
Equipment of Laboratory, National Bureau of Standards, 1902	10,000
General Expenses, National Bureau of Standards, 1902	5,000
Total	167,140

EXPENDITURES, 1901-2.

Appropriation.	Disbursements.	Unfilled orders.	Total.
Laboratory	$119.20		$119.20
Site	25,000.00		25,000.00
Salaries, National Bureau of Standards, 1902	21,959.76		21,959.76
Equipment of Laboratory, National Bureau of Standards, 1902	1,718.46	$8,212.13	9,930.59
General Expenses, National Bureau of Standards, 1902	3,281.55	1,636.46	4,918.01
Total	52,078.97	9,848.59	61,927.56

PRINTING AND PUBLICATIONS.

The work of the year included the preparation of the necessary printed matter, such as stationery, printed forms, and record books for the work in the office and laboratories. The planning of these forms involved the determination of the routine to be adopted in the various branches of the work. During the year an official seal was designed and engraved by the Bureau of Engraving and Printing, more than thirty blank forms were prepared, and a number of record books designed for special purposes.

THE LIBRARY.

During the year the Bureau received about 700 volumes, 150 of which were from Government departments and from private sources. The appropriation permitted the purchase of only a few of the books and journals imperatively needed for the scientific work, and at the present time new lists of necessary reference books have been laid aside for lack of funds. An adequate reference library is a fundamental requisite in a scientific and research laboratory. A librarian is urgently needed to take charge of the books, to prepare a subject catalogue, attend to the work of compiling needed bibliography, and to prepare journals and pamphlets for binding. Such a librarian would be of great assistance to the technical work of the Bureau in the preparation of technical bibliographies of scientific subjects for immediate use in the practical work of the Bureau.

NUMBER AND VALUE OF TESTS COMPLETED DURING FISCAL YEAR ENDED JUNE 30, 1902.

Nature of test.	For Government.		For public.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Length	35	$79.15	123	$155.30	158	$234.45
Weight	109	102.50	99	53.00	208	155.50
Capacity	251	171.00	9	12.50	260	183.50
Temperature	75	128.00	22	6.25	97	134.25
Electrical			7	25.00	7	25.00
Sundry	273	583.70	52		325	583.70
Total	743	1,064.35	312	252.05	1,055	1,316.40

The amount received from the public is made up as follows:

Value of tests completed for the public during fiscal year 1901–2			$252.05
Received by United States Coast and Geodetic Survey prior to the organization of the Bureau	$0.50		
Received during fiscal year 1901–2	256.40		
Received during fiscal year 1902–3 for tests completed 1901–2	22.50		
		$279.40	
Received during fiscal year 1901–2 for tests not completed in that year		27.35	
			252.05

Respectfully,

S. W. Stratton,
Director.

The Secretary of the Treasury.