

NIST: RESPONDING TO BASIC NEEDS, RESPONDING TO SPECIAL NEEDS

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ABSTRACT

The National Institute of Standards and Technology (NIST) was established by an Act of Congress in 1901 as the National Bureau of Standards (NBS). It was charged with serving the Nation's science and industry by establishing and maintaining the fundamental standards of science and related instrumentation and measurement methods and by providing calibration services and determinations of the properties and physical constants of materials. Work done by NBS in radio, aircraft, optical glass manufacture, and to facilitate industrial standardization established a pattern for NBS/NIST of mobilizing its scientific talent in response to national needs in times of crisis or challenge.

INTRODUCTION

The National Bureau of Standards (NBS), now the National Institute of Standards and Technology (NIST), was established by an Act of Congress in 1901, about midway through an American historical period that the historian Robert H. Wiebe characterized by its "search for order." At the beginning of this period, the emergent political economy of industrial capitalism experienced several

profound depressions in cyclical succession. Consequently, it searched for stabilization mechanisms. Industrial consolidations and finance capitalism were both reactions to disruptive competition and inefficiencies in the supply chain, but they created their own disruptions. The growth of Federal regulatory mechanisms – what Republican-turned-Progressive Theodore Roosevelt termed the "new nationalism" – was, in turn, a quest for order that responded to these dislocations.[1]

In part, the establishment of NBS was another "Progressive Era" consumer-focused reform akin to the enactment of the *Pure Food and Drug Act* in 1906 (34 Stat. L., 771). Despite the efforts since 1836 of the Office of Weights and Measures in the U.S. Coast and Geodetic Survey to distribute standards of length, mass, and capacity to the states and customhouses, standardization largely had not filtered down to the level of the commercial transaction. The new national standardizing bureau set about to remedy this situation. Between 1909-1911, the Bureau conducted a study of trade weights and measures. Its inspectors reached every state but Arkansas and Oklahoma. During this investigation,



Figure 1. Aerial view of the Bureau of Standards, 1919.

8630 scales were tested, and 42 % were found to be incorrect; 20 % of the weights and 33 percent of the dry and liquid measures tested were incorrect.

As a result of publicity from this investigation, 25 states revised legislation or enacted weights and measures legislation for the first time, some of it based on a model law drafted by the Bureau.

Following a Bureau recommendation and using its Constitutional authority to "fix the Standard of Weights and Measures," Congress enacted the first mandatory Federal measurement standard for general commercial use on March 4, 1915. The *Standard Barrel Act* (38 Stat. L., 1186) defined the standard barrel and its subdivisions for fruits, vegetables, and dry commodities and made it a misdemeanor to sell at less than this capacity.[2]

ECONOMY AND STANDARDS

But more than from concern for the consumer or even for bolstering consumer confidence, the establishment of the Bureau resulted from the recognition that the growth of the new industrial economy ultimately depended on the progress of science and the accuracy of scientific determinations. Testimony before Congress concerning the Bill to establish the Bureau was permeated with complaints by scientists in American universities and industrial laboratories, who had to purchase precision instruments from European manufacturers as well as send instruments overseas for calibrations. Many European nations had established national standardizing laboratories in the latter part of the nineteenth century. These national laboratories supported the manufacture of precision instrumentation in their respective countries and, thus, underpinned their scientific enterprises. American scientists considered it imperative that the United States follow the European lead.[3]

In this "the Age of Electricity," there was a particular need for standardization in the area of electrical measurements. In 1884, a national conference of electricians and scientists at the Franklin Institute in Philadelphia called for the establishment of a national standardizing laboratory to certify instruments used for electrical and other measurements. By 1884, commercialization of the

telephone and the electric light was underway.[4] By 1901, the Buffalo Pan-American Exposition, in celebration of the first hydroelectric power station at Niagara Falls, dazzled visitors with a 121 meter electric tower that was beaded with 40,000 incandescent lamps and capped by a statue of the goddess of light. An 18 meter model of the falls poured from its side. [5]

In 1901, calls for the establishment of a National Bureau of Standards found receptive ears in Congress. The new American laboratory was charged with serving the Nation's science and industry by establishing and maintaining the fundamental standards of science and related instrumentation and measurement methods and by providing calibration services and determinations of the properties and physical constants of materials.

Samuel W. Stratton, a physics professor from the University of Chicago, was appointed director of the new agency. He assembled top-notch practitioners to join his scientific staff. Beginning with 8 staff members in a few cramped offices, Stratton left the Bureau in 1922 with a staff of nearly 1000 and a modern group of laboratory buildings in a campus-like setting, perhaps the first such research park in the Nation. The Bureau settled on 3 hectares in a then undeveloped, outlying part of Northwest Washington, D.C., where central city levels of vibration and electrical disturbances would not interfere with the performance of precision measurements (figure 1).[6] After World War II, many industrial laboratories similarly moved to isolated research parks in exurban areas but for different reasons (figure 2).



Figure 2. In 1910, the International Committee for Investigating the Voltmeter met at the Bureau of Standards in Washington, carrying out a series of intercomparisons that led to a new value for the international volt. Samuel W. Stratton stood sixth from the left.

WARTIME GROWTH

NBS was able to grow as it did in large part due to the emergency need for military research and development during World War I. Its scientific, technical, and administrative staff grew from 517 in 1917 to 1,117 a year later.[7] WWI established a pattern for NBS/NIST of mobilizing its scientific

talent in response to national needs in times of crisis or challenge. In the case of the First World War, the pressing national need for industrial standardization dovetailed with part of the mission of the young agency. The War effected a confluence of economic channels that made industrial standardization a necessity. It intensified the consolidation of national markets that had proceeded steadily in the last few decades of the nineteenth century and in the first years of the twentieth.

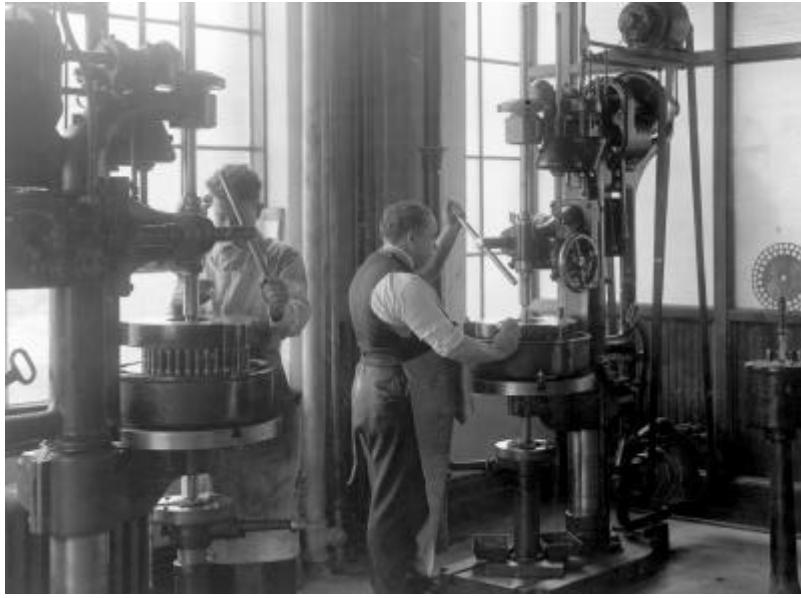


Figure 3. Precision gage blocks, manufactured at the Bureau in 1919, were lapped to exact nominal length.



Figure 4. These large masses of optical glass were manufactured at the Bureau in 1919.

The *Urgent Deficiency Act* of June 15, 1917 (40 Stat. L., 216), appropriated funds to “provide by cooperation of the Bureau of Standards, the War Department, the Navy Department, and the Council of National Defense, for the standardization and testing of the standard gauges, screw threads, and standards required in manufacturing throughout the United States, and to calibrate and test such standard gauges, screw threads, and standards, including necessary equipment....”[8] Thus directed, the Bureau assisted the military by testing gages. About 60,000 plug, ring, snap, profile, spline, screw thread, and other gages were tested.

The Bureau provided the Ordnance Department of the Army with a number of 70 inch (177.8 centimeter) standard bars to be used for standardization in manufacturing at the weapons arsenals. Using these uniform standards, the arsenals could achieve interchangeability of the parts needed for large rifles, which had to be manufactured at several locations and assembled at another. Likewise, the Bureau began to manufacture gage blocks, the production of which had previously been the province of just one company in Europe. The process used by the Bureau for the manufacture of gage blocks was eventually spun off to the private sector (figure 3).[9]

Along with gage block manufacture, the Bureau introduced another important new industry to the American economy during World War I: optical glass manufacture. High-quality optical glass had never been made before in the United States. In 1914, after war in Europe disrupted the

supply from Germany, the Bureau began the successful experimental manufacture of this item (figure 4). After President Wilson declared war in 1917, the need for optical glass for binoculars and field glasses was so pressing that citizens were called upon to loan these instruments to the Government. The Bureau began to provide manufacturers with the knowledge of process and materials that it had gained in two years of research. With the agency's guidance, a whole new industry rose up to meet the demand.[10]

Problems in connection with the military use of radio received great attention. Appropriations were made to render the Bureau's radio laboratory more efficient. The Bureau's radio laboratory achieved several important technological advances during the War, including the development of a system of submarine radio transmission. At the same time, the Naval radio research laboratory, the Naval aircraft radio experimental laboratory, the research laboratory of the Signal Corps, and the radio laboratory of the Intelligence Division of the Army took up residence at the Bureau, where they could be provisioned with instrument testing and measurement services.[11]

The Bureau recognized the airplane's potential to decide the War's outcome, and aeronautic research became a major concern. Bureau scientists constructed an altitude chamber in which to test airplane engines under realistic conditions of air pressure and temperature. Tests were made on the full range of aeronautic instruments, becoming the technical basis for Army and Navy specifications.[12] Bureau staff also made studies of materials used in airplane construction and studies of aviation fuels, carburetors, radiators, ignition systems, and lubricating oils.[13]

CONTINUED RESPONSIVENESS

After the Armistice, the impetus that the War gave to industrial standardization did not disappear, and most industrial sectors --manufacturers and technical societies alike-- formed documentary standardization committees on which the Bureau of Standards was represented. The Bureau returned to mission activities that had been suspended during the War, but continued to respond to new challenges posed by the economic situation in the 1920s. The housing shortage in the wake of World War I and obstacles to home buying were taken up by a Division of Building and Housing in the Bureau, which saw standardization of construction materials and building codes as ways of bringing down high housing costs. Municipal zoning ordinances, which were thought to

encourage home building by stabilizing residential property values, were also promoted through the drafting of standard enabling legislation.[14]

In the years since World War I, NBS/NIST has responded expertly to a variety of special national needs of a technical nature while continuing to serve the basic need of American science and industry for measurement standards and calibrations and for information on the properties of materials. The pattern was repeated in World War II, in the aftermath of the shock of Sputnik, in the energy crisis of the 1970s, and in the late 1980s and early 1990s when the United States felt challenged by global economic competition.

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