The house of measurement

The Government's standards lab is mostly service-oriented, but there's room for basic scientific research as well

by Edward Gross

It is taken for granted that a light bulb made by Westinghouse will fit a socket made by G.E., that the advertized density of motor oil will be the same anywhere in the country, that a gallon of gasoline measured from a pump in Denver will have the same volume as a gallon from a pump in Miami, that the hands of clocks in Los Angeles, Chicago and New York will all move at the same speed.

All of these assumptions depend in part on standards, whether they are standards of performance, quality or measurement. Technology in its present state could not exist if it didn't have these standards, which it uses as templates. The 20 billion measurements made daily in this country would to a large extent be meaningless without them.

At the turn of the century, the growing industrial might of the nation made it apparent that without standards chaos would reign. To satisfy this national need, Congress created the National Bureau of Standards in 1901.

The development of standards rests on the art and science of measurement. And measurement is the stock and trade of the NBS, located 20 miles from Washington, D.C., at Gaithersburg, Md.

By knowing just four quantities—mass, length, time and temperature—virtually all other measurement standards can ultimately be derived. These four quantities can be used to define the units for velocity, pressure, force, acceleration, electric current or light and sound intensity and many other physical factors.

Housed in a vault at the NBS is the standard for mass, the kilogram. It is a copy of the platinum-iridium cylinder that resides at Sèvres, France, at the International Bureau of Weights and Measures and represents one kilogram for the entire world.

The NBS duplicate kilo is a little lonelier these days. It used to have a companion: a platinum bar whose length defined the meter. But the bar was replaced as a standard in 1960 by the number of wavelengths of orange-red light emitted by a krypton lamp. And now the lamp is being pursued by the laser beam (SN: 1/25, p. 96).

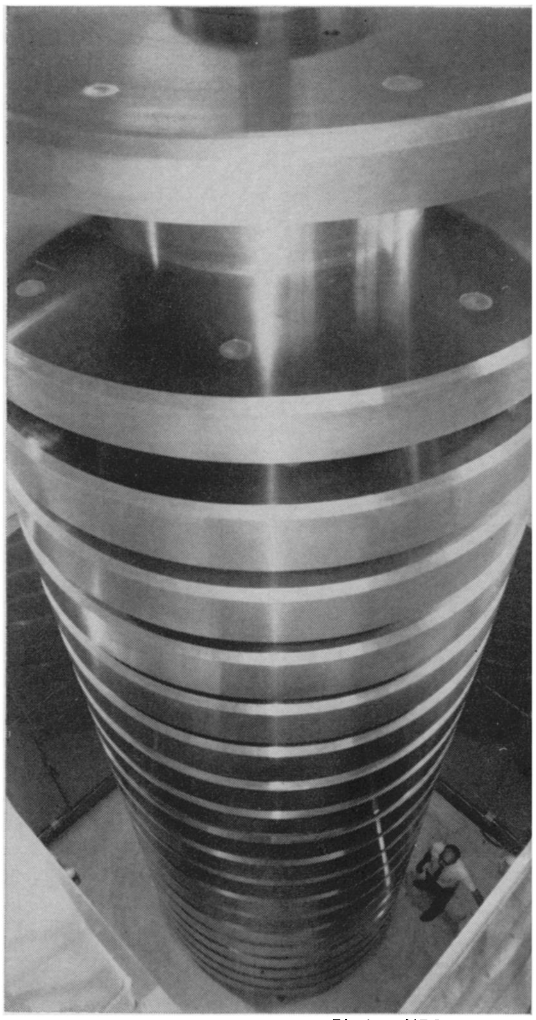
Also obsolete is the first atomic clock, devised in 1949. It was intended to provide a standard for time, although it was never adopted as such. It defined the second by the consistent number of vibrations of the ammonia molecule. But its accuracy of one part in 10 billion (an error of one second every 300 years) was not good enough, so NBS scientists came up with a clock based on the number of oscillations of a cesium atom (correct to about one part in a trillion). They now have their eye on an even more accurate timepiece, using the hydrogen maser. It promises to be 100 times as accurate as the cesium atomic clock. For the immediate future, however, improvements in the cesium clock will dominate.

Before a thermometer can be calibrated in degrees, an origin or zero point must be found. A low pressure apparatus that keeps the three phases of water (ice, liquid and vapor) in equilibrium does this job. This point defines zero degrees C., 32 degrees F. and 273 degrees Kelvin.

Of more direct consequence than measurement standards is the NBS work with engineering standards. These are used to gauge the performance of seat belts, auto tires, building materials, the accuracy of scales, the quality of rubber, plastic and paper, and the flammability of carpets and drapes. Of industry's 15,000 standards, only 500 originate from the NBS. The rest are established by organizations such as the American Society for Testing Materials, the Society of Automotive Engineers and the United States of America Standards Institute.

Of the standards put out by the NBS, the only mandatory ones pertain to the flammability of fabrics and the unlocking of refrigerator doors from the inside, and even in these cases the Secretary of Commerce must do the enforcing. NBS has no such powers.

As would be expected, NBS does a good deal of routine testing especially



Photos: NBS

Record-making deadweight: One million pounds for calibrating forces.

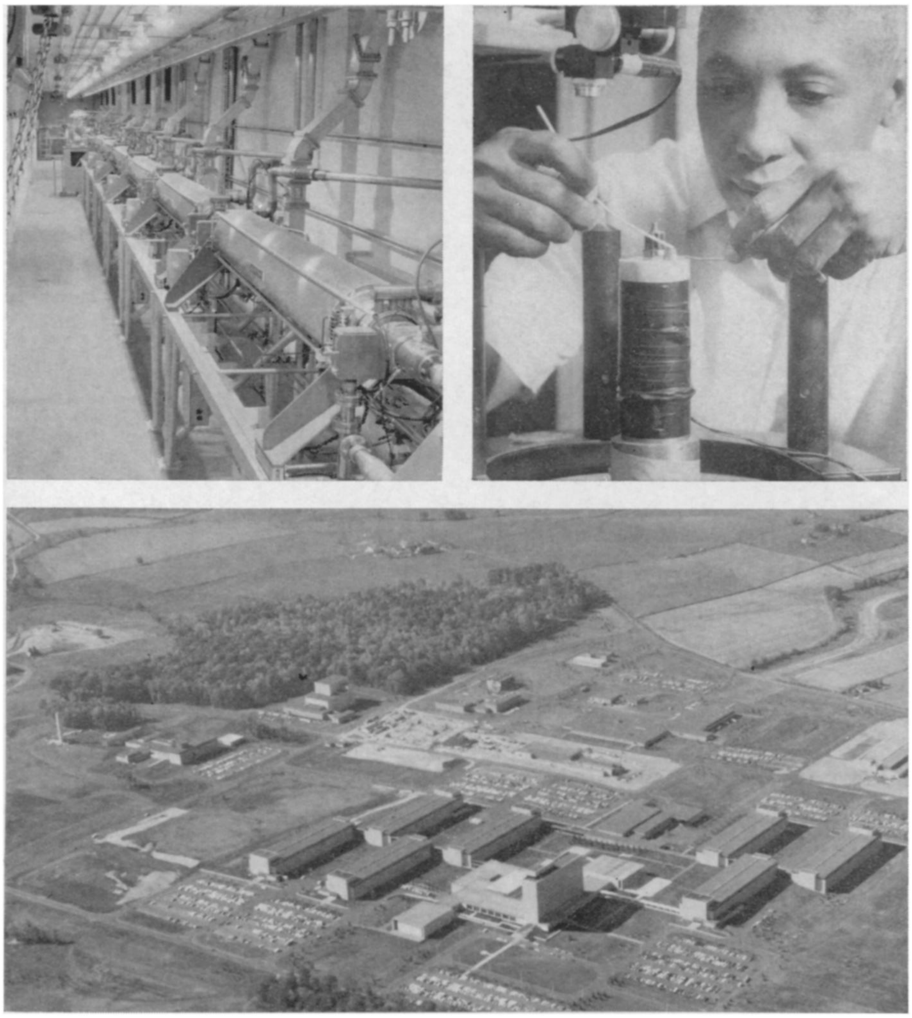
on Government purchases. The products tested range from tires, to cement and to hearing aids for the Veterans Administration. But the test results are not for public consumption (SN: 5/24, p. 508).

The NBS does relatively little product testing. The function to which the bureau has been restricted, by policy, is to provide the methodology: the technology, for making measurements from which standards can be derived. From its role, the bureau could be fancifully called the DNA molecule of measurement. In this molecule are all the keys that determine what the system will be like and how it will work, all the way down to the man with a caliper on an assembly line.

When the NBS tests for industry, it does so on a generic, not a name-brand, basis. It is not looking to compare brand A against brand B. The same holds true for the testing it does for Government.

Says Dr. Howard E. Sorrows, acting director of the Institute for Applied Technology:

"While we provide essential data and



Equipment at bucolic Gaithersburg, Md., site ranges from NBS's 150-MeV electron linac to an accelerometer, calibrated by physicist Earle Jones.

methods of measurements for many other agencies of Government at the Federal, state and local level on which many of the decisions of our society are made, we do not make their decisions. In our type of work it is essential that we maintain a third-party position. This permits complete objectivity and technical contributions limited solely by our resources and abilities."

As Paul Kratz, program evaluator for information services, puts it, "We offer measurement techniques and calibration methods and knowledge in general on a large number of important materials. We are not directly concerned with the many uses to which these materials will be put."

This was not always the case, and the NBS has made a lot of enemies in its 68 years. Its findings have angered the building, gas, paint, gasoline and tire reclamation industries as well as the Congress. Its own parent, the Commerce Department, has opposed it. Fearing a loss of Congressional support, the department has suppressed negative reports, among the most celebrated being one criticizing the performance of dental fillings and a notorious one in the 1950's involving a battery additive AD-X2.

The additive's manufacturer claimed that it rejuvenated dying car batteries. The bureau tested it at the request of the Post Office, found it had no special merits and announced the findings, naming the product. The manufacturer got its distributors to write their Congressmen, and the result was that NBS director Dr. Allen V. Astin was fired by Commerce Secretary Sinclair Weeks. Subsequent investigations substantiated the NBS conclusion, and when the dust settled Dr. Astin was reinstated. Dr. Astin is retiring this year.

The NBS is now so cautious it refrains from taking sides, even when it really cares. It is a known advocate of the metric system, a position it has maintained since its inception. Although the movement appears to be winning converts, entrenched groups such as textile manufacturers and heavy industry, who would lose mightily in an immediate conversion, as well as business-oriented Congressmen, oppose the system (SN: 7/20, p. 53). Last year Congress told the Commerce Department to conduct a study of the impact of increasing metric usage on this nation's economy. Although Congress refused to finance it, the study, without fanfare, is under way anyhow at NBS.

Money—or the lack of it—is one of the bureau's main problems. Appropriations for NBS now run near the $37 million level for its three institutes (Basic Standards, Materials Research and Applied Technology) and other facilities, including a Denver, Colo., branch. And the Government agencies it does work for pay their own way. But there are many projects, such as a center for data on fire hazards and the study of the metric system, that the NBS is prevented from carrying out at an appropriate and proper level by the shortage of funds.

Research is a natural concomitant of standards work. It is difficult, for example, to set a meaningful standard about the flammability of a new product or material without conducting experiments on its physical and chemical properties and even its atomic structure.

And for years—until recently—the bureau had the reputation for housing one of the finest-pure-physics laboratories in the world.

If this is no longer so, it is the doing of a former Assistant Secretary of Commerce for science and technology—J. Herbert Hollomon, who now is president of the University of Oklahoma.

Behind the declaration that, "Those people up there used to think they were there to do physics," Hollomon decided that what they were actually there for was to serve industry with needed technical assistance. And he supervised the reorganization of NBS into its present institutional structure to do that.

Whether science or service oriented, the areas to which NBS scientists have contributed over the years is impressive. They include aircraft and naval navigation, infrared detection devices, photography, metal protection, telescope construction, cosmic-ray studies, the U.S. war efforts (proximity fuzes and the Manhattan Project), medicine and dentistry, building construction, high-temperature furnaces, radio communication, rocketry and computers.

The work of the NBS has had a social impact as well, as seen in the recent Phoenix (housing) Project experience (SN: 10/12, p. 372). Radical methods and materials for this Detroit low-income housing program did not conform to the city's building code regulations. Detroit was considering scrapping the idea, but first turned the plans over to the NBS for testing. The city agreed to abide by the NBS findings on the tests. The NBS gave the technology a clean bill of health, and the city issued a permit. ◇