A Report on the Present Functions and Operations of the National Bureau of Standards

Their Evaluation in Relation to Present National Needs and Recommendations for the Improvement and Strengthening of the Bureau

Excerpts from a report to the Secretary of Commerce

ON OCTOBER 15, the committee appointed to study the functions and operations of the National Bureau of Standards submitted its report and recommendations to the Secretary of Commerce. Because of its important implications in regard to all scientific organizations under the Federal Government, we print here the main recommendations, evaluations, and the summary of this report. The members of the committee were as follows: Mervin J. Kelly, Chairman (Bell Telephone Laboratories), appointed by the President of the National Academy of Sciences; John C. Green, Executive Secretary (Department of Commerce), appointed by the Secretary of Commerce at the request of the Committee; Lee A. DuBridge (California Institute of Technology), nominated by the American Institute of Physics; William L. Everitt (University of Illinois), nominated by the Institute of Radio Engineers; James W. Parker (Detroit Edison Company), nominated by the American Society of Mechanical Engineers; Kenneth S. Pitzer (University of California), nominated by the American Chemical Society; J. Barkley Rosser (Cornell University), nominated by the Policy Committee for Mathematics; Guy Suits (General Electric Company), nominated by the American Institute of Electrical Engineers; Clyde Williams (Battelle Memorial Institute), nominated by the American Institute of Mining and Metallurgical Engineers; and Abel Wolman (Johns Hopkins University), nominated by the American Society of Civil Engineers.

Functions and Authorities

The functions and activities of the National Bureau of Standards are undertaken in conformance with legislative provisions. The Organic Act (31 Stat. 1449), establishing the Bureau on March 3, 1901, was extensively amended in 1950 (64 Stat. 371, 5 U.S.C. 271–286) and now authorizes six broad functions: (1) the custody, maintenance and development of national standards of measurement and related measurement problems; (2) the determination of physical constants and properties of materials; (3) the testing and the development of methods for testing materials, mechanisms and structures; (4) cooperative activities relating to standard practices incorporated in codes and specifications; (5) advisory services to Government agencies on scientific and technical problems; and (6) the development of devices to serve special needs of the Government.

In the carrying out of these functions, the Act also provides authority for undertaking "specific activities" that are mainly for the purpose of giving the Bureau the necessary capabilities for the discharge of its responsibilities under its six broad functions. The most significant activities specified are:

(a) the development of methods of chemical analysis and synthesis of materials and the investigation of the properties of rare substances;

(b) the study of methods of producing and of measuring high and low temperatures; and the behavior of materials at high and at low temperatures;

(c) the investigation of radiation, radioactive substances and x-rays, their uses and means of protection of persons from their harmful effects;

(d) the study of the atomic and molecular structure of the chemical elements, with particular reference to the characteristics of the spectra emitted, the use of spectral observations in determining chemical composition of materials and the relation of molecular structure to the practical usefulness of materials;

(e) the broadcasting of radio signals of standard frequency;

(f) the investigation of the conditions which affect the transmission of radio waves from their source to a receiver;

(g) the study of new technical processes and methods of fabrication of materials in which the Government has a special interest; also the study of methods of measurement and technical processes used in the manufacture of optical glass and pottery, brick, tile, terra cotta, and other clay products;

(h) the determination of properties of building materials and structural elements and encouragement of their standardization and most effective use, including investigation of fire-resisting properties of building materials and conditions under which they may be most efficiently used and the standardization of types of appliances for fire prevention;

(i) metallurgical research, including study of alloy steels and light metal alloys; investigation of foundry practice, casting, rolling and forging; prevention of corrosion of metals and alloys; behavior of bearing

metals; and development of standards for metals and sands;

(j) the operation of a laboratory of applied mathematics;

(k) the prosecution of such research in engineering, mathematics and the physical sciences as may be necessary to obtain basic data pertinent to the functions specified herein; and

(l) the compilation and publication of general scientific and technical data resulting from the performance of the functions specified herein or from other sources when such data are of importance to scientific or manufacturing interests or to the general public and are not available elsewhere, including demonstration of the results of the Bureau's work by exhibits or otherwise as may be deemed most effective.

In our examination of the Bureau, we have taken the six authorized broad functions with the related specific activities as the charter for the programs of the Bureau.

We believe that the Organic Act of 1901 with the amendments of 1950 gives the Bureau adequate authority for the establishment of programs that should fully meet the present national needs; therefore, we are making no recommendations for further legislation.

The Bureau has made requests for legislation dealing with problems of operation such as working capital funds. The Committee has not concerned itself in sufficient detail with operating procedures to have a view on these requests. Its comment on legislation is directed only to that which defines the scope of Bureau programs.

Importance of the Bureau of Standards to National Welfare

The functions authorized for the Bureau of Standards are of great importance to national welfare. As our society becomes increasingly industrialized, these functions assume even greater importance and the work of the Bureau in meeting the obligations of its assigned functions becomes more highly scientific, broader in scope and more complex in organization.

In a society whose welfare is so dependent on applied science and technology as is our own, it is most important that the Government carry out those functions in support of science and technology that are uniquely in its province in the most effective manner possible and that a sufficiently high level of effort be maintained to insure an adequate coverage of the area of responsibility. It has placed broad and important functions in this area with the Bureau.

The first four of the six functions of the Bureau are wide in scope and of great importance to our nation's industrial health. The remaining two, while more restricted in scope, are properly placed with the Bureau; for with its organization of experts in science and technology and their special technical facilities, it is fitting that the Bureau provide advisory service on scientific and technical matters to other Government agencies and, where uniquely indicated, to develop special devices to serve their needs.

It is the Committee's considered judgment that our highly industrialized society requires a Bureau of Standards that is the finest that can be created. To the extent that the Bureau is weak or inadequate, our technologic society is handicapping itself. By the very nature of its functions the Bureau's work must not be "reasonably good," it must be superior. It is not sufficient to have fairly good standards of measurement; fairly good methods of testing materials, mechanisms or structures; or reasonably good determination of important physical constants. The standards, the measurements, the test procedures must be the very best, the most accurate, the most reliable that can possibly be achieved at any given time, limited only by the state of the art at the time. It is thus more than a play on words to say that the "standards" by which the Bureau is judged must be the very highest and best.

The scope of coverage of the first four broad functions must be adequate to meet the needs of our advancing technology. Physical constants, the properties of new materials, the development of methods for their testing and their early incorporation in codes and specifications are vitally important to our highly industrialized society. The Bureau's work on the "new" should as a minimum keep step with the pace of applications of the "new" by industry. For its full effectiveness it must not lag.

It is with these views of the functions of the Bureau and of their importance to national welfare that the Committee has approached its assigned task of evaluation.

Place of the Bureau of Standards in the Government

The Committee has received suggestions from a variety of sources that the Committee consider the place of the Bureau of Standards within the organizations of Government. It has been suggested that the Bureau might better perform its authorized functions if transferred elsewhere in the Government from the Department of Commerce and specific suggestions have been given as to places more appropriate to its functions. The Committee has given thoughtful consideration to these suggestions. We are convinced that in the present framework of Government organizations there is no place better suited to the Bureau of Standards than in the Department of Commerce.

Evaluation and Comments

Organization. The Committee's appraisal is contained in the section titled Organization of the Bureau. The appraisal is generally favorable. The recommendations for modification at the Associate Director level should increase the effectiveness of scientific and technical administration and make it possible for the Director to give needed added attention to his broader administrative and professional responsibilities.

Personnel. The Bureau of Standards has high standing among the scientific and engineering people of our country and its superior qualities are recognized in

other countries. This results from the high quality of the professional staff, their dedication to the Bureau and the integrity of their scientific and engineering work.

While this favorable situation now prevails, it is deteriorating and unless corrective steps are taken, the Bureau will not be adequately staffed with men of high professional competence and standing in the years to come. Much of the strength described above comes from the professional staff recruited before World War II. The enlarged opportunities for scientists and engineers in our country since that time, the relation of supply to demand, the siphoning of junior personnel from the basic programs to the military programs and the contraction in basic programs since 1950 have all made contribution to the inadequacies in the junior professional staff. These are the men that will make up the core of the professional staff of tomorrow. Time marches on and the staff recruited before 1940 will through the years disappear from the Bureau.

The separation of the weaponry programs from the Bureau will help this situation. However, unless the decrease in support of the basic programs of the Bureau that began with the Korean incident and is continuing through Fiscal 1954 is reversed and to an adequate extent, the Committee views the future professional personnel outlook of the Bureau with grave concern. The expansion of the Bureau's basic program is treated in later sections.

Space and Facilities. The crowding of the laboratories for the basic programs necessitated by the rapid expansion of the defense effort was discussed in the section on Programs of the Bureau. While the transfer of weaponry programs to the Department of Defense will not immediately aid in the correction of this crowding, the Committee recommends that in the plans for the Department of Defense operation of this work provision be made for returning to the Bureau some of the space now occupied by weapons developments so that it can be used in the basic programs area.

The laboratory facilities for basic programs work are inadequate. There have not been funds sufficient for replacement of obsolete facilities and the procurement of new facilities to meet the needs of present-day laboratory work in science and technology. The contrast in the qualities and amount of facilities for military development, which are of high quality, modern and generous in amount, with that of facilities in many areas of the basic programs is most striking. This situation can only be corrected by the provision of increased funds for implementing the Bureau's basic work. There is urgent need for increased funds in the years immediately ahead. The Committee recommends that the Director of the Bureau, in cooperation with the advisory committees that will be later proposed, make a critical review of the Bureau's laboratory facilities requirements and that funds be requested promptly on completion of the study to bring the Bureau's technical facilities up to levels of quality and quantity that insure effective and efficient laboratory work.

Programs: General. The work of the non-ordnance divisions of the Bureau is described in some detail in Section II. In general, the quality of the work is good and the professional staff is competent. Comment here will be limited to general topics and to specific areas where emphasis is desired.

The extent of coverage in the basic programs is, in general, not adequate to meet present national needs. This is due to lack of personnel, space and modern technical facilities. During the postwar years, 1945–1950, encouraging progress was made in building the basic program work to a level commensurate with national needs. However, the Committee does not believe that the work level of 1950 had reached the minimum justified by the needs of the nation in science, technology and industry for the services rendered by the Bureau. The shrinkage in support of basic programs that began in 1950, occasioned by the nation's emphasis on building military strength, made it necessary to decrease the work level by almost 20% as measured by man years of effort by 1953 and the funds provided for Fiscal 1954 will make necessary a further reduction of at least 10%. The Committee recommends a reversal of this trend and a building back to the work level of 1950 at the earliest possible time. This could be accomplished with efficiency in a two-year interval, if funds were available.

The Director of the Bureau, his supervisory staff and the advisory committees to be referred to later should make a realistic and critical study of the minimum additional support, beyond the 1950 level, needed by the Bureau to bring its strength into balance with the nation's needs. The Committee is convinced that a level well beyond that of 1950 is required but believes the level should be arrived at by a more extended study than that of this Committee.

The Committee recommends that the basic program effort be increased to the level of 1950 in two successive increments in Fiscal Years 1955 and 1956; also that the Bureau and the proposed advisory committees be prepared, in time for consideration in the 1957 Budget requests, to recommend the amount of further expansion in basic programs that is required to meet the nation's needs.

The ordnance programs, because of their classified nature, are not treated in Section II. Since much of this work and its personnel will be transferred to the Department of Defense, an evaluation is not essential. However, as stated in the section concerning the Organization of the Bureau, selected members of the Committee with consultant aid, have looked at this work and have found it in good order.

Testing and Specifications: The "testing" area of the basic programs merits special attention. Quality control; calibration; acceptance, qualification, regulatory and referee testing; standard samples and product tests are included in this general classification. The funds for this area in Fiscal 1953 amount to some $2 600,000: $960,000 coming from direct appropriations to the Bureau and $1,700,000 in transferred funds from other agencies. Approximately $330,000

for standard samples and testing for the public was received by the Treasury as miscellaneous receipts and is not available to the Bureau.

This area might be considered as one of the important end products in the Bureau's basic programs. It is made up of so large a number of specific items that they have not received individual examination by the Committee. The Committee is concerned that a larger amount of repetitive testing is now done in the Bureau than is necessary with the present state of development of technology in industry. In addition to adequate testing of products under Government control that can be done by an industry in supplying its products to the Government, there are available competent commercial laboratories whose principal activity is in testing and evaluating products.

The Committee recommends that the repetitive test operations of the Bureau be critically examined by the Bureau and the proposed advisory committees. Some of this work may be eliminated by substituting Government supervised acceptance tests in the plants of the suppliers or by using commercial laboratories where it is appropriate. The Bureau may be handling acceptance testing for some agencies that was highly proper when initiated but under changing conditions the Bureau's services may no longer be required by the agency. In the review, consideration should be given to any such situations.

The personnel and facilities of the test program area of the Bureau should be primarily employed in the development of specifications and testing and quality control procedures. The Bureau should exert a leadership for the maintenance of high quality in the products of Government purchase with the minimum of participation in repetitive tests.

Evaluation of Commercial Products: The Bureau makes evaluation tests on the commercial products of industry from time to time at the request of other agencies of the Government and has done so, we believe, throughout its history. This is a service that the Bureau must render. It has a competence for product evaluation over a very large area of industrial products. Such competence does not exist to a comparable extent anywhere else within Government. This competence must be made available to other departments.

While the volume of this work is extremely small in relation to the Bureau's total basic programs, it is the area that most frequently brings the Bureau to the attention of the general public. The current "Battery Additive" evaluation is typical of others that have sporadically occurred throughout the Bureau's history where its findings have been challenged and wide public attention directed to them.

The Committee recommends that policy and procedures of a non-technical nature, particularly with other agencies of Government, for handling commercial product tests be reviewed by the Secretary of Commerce and appropriate members of his staff with the Director of the Bureau of Standards. The Committee recommends that the policy and establishment of the non-technical procedures on commercial product tests be the responsibility of the Secretary of Commerce. The policy on the technical content of the problem should reside with the Director of the Bureau. We believe that the area of commercial product tests involves policies and actions of a non-technical nature on which the Director of the Bureau should not be required to make the decisions.

Standard Samples: Since 1905 the Bureau has been the source of "Standard Samples" of technical products of industry, such as alloys, rubber compounds and more recently radioactive elements. These samples have been analyzed by the most modern methods and with greatest possible accuracy. They are mainly used for calibration of analytical chemistry procedures by industry and others. Frequently they serve as standards in refereeing questions between buyer and seller.

This is a proper function for the Bureau and one that within its resources it has performed well. With the restricted funds of recent years and the rising cost of preparing the standard samples, the Bureau has made no progress in increasing the number of kinds of samples. It has actually not been able to maintain its earlier position. Substantially no development for bringing into being new standard samples has been possible for some years. Increased funds for maintenance of present standard sample supply and for the development of new standard samples are urgently needed. There is a charge for the standard samples that is small compared to their worth and this money goes into the Treasury and is not available for Bureau use.

Radio Propagation: The cooperative relationships of Division 14—Central Radio Propagation Laboratory—with other agencies of Government should be specially commended. The demands for new assignments in the radio spectrum for communication and broadcast of intelligence purposes have increased greatly since the close of the war. The most effective use of the radio spectrum can only be realized with full knowledge of the propagation characteristics of each of its sectors. An interdepartmental Government committee was formed after the war, advisory to the Bureau on its propagation studies and the propagation research and evaluation programs of Government, so essential to the most effective allocations of regions of the spectrum to the various uses, were centered in the Bureau.

The plan is in national interest and its adoption is to be commended. The Bureau's propagation work has been excellent. However, we view with concern the change with time in composition of this committee. Assignments to the committee from the other agencies were initially from technical policy levels of the organizations of the agencies concerned with the use of radio spectrum. These assignments have been increasingly given to members of those organizations well below the policy levels. The Committee believes that the radio propagation programs are of such importance that the personnel of the advisory committee should be drawn from as high a level in the technical organizations of the agencies of Government as is com-

patible with the other responsibilities of these men. There are values in economy and effectiveness in the concentration of the propagation research and studies in one agency of Government. The Bureau of Standards is uniquely indicated as that agency.

This area of Bureau responsibility has been well supported through the 1950–1953 period of decreasing support in other basic program areas. This difference is most probably due to the large and direct interest of the military in radio propagation and to the fact that, in general, such work is of direct value to both military and civilian communications. While perhaps not so evident, many other areas of the basic programs into which the Bureau has not entered because of lack of funds also have direct values for the military and the civilian economy.

The Committee is impressed by the effectiveness of the propagation work and takes it as an indication of the values that may well be expected from other areas in which Bureau activities are indicated as required, if the Bureau is to meet the obligations of its authorized functions, when the Bureau is provided with funds necessary to the performance of the work.

Applied Mathematics: The Bureau's work in applied mathematics should be specially commended. While it is limited in scope, it has been most effective in its areas of activity. The Bureau was one of the early laboratories in digital computer work—theoretical and instrumental. Digital computers are of increasing importance to the military and to business and industry. A laboratory of today, with the science and technology scope of the Bureau, must have a competent mathematical staff. Such a project as the digital computer gives body and objectivity to the work of the staff. Much of their time, however, should be employed in consultation and aid to other programs.

Advisory Committee to the Director

The conversion of new scientific knowledge into industrial products is proceeding at an ever-increasing tempo. In the formation of the programs of the basic area of the Bureau, balanced attention should be given to the new areas of science and technology where standards activities will be required. To aid the Director in forming the new programs and in the consideration of balance on programs in being, the Committee believes that a more intimate tie with the science and technology of the country is desirable. It therefore recommends that the Director of the Bureau, with cooperation from the eight scientific and technical professional organizations that supplied the members of this Committee, form small advisory groups for the different scientific and technical areas of the Bureau. We believe it desirable for the members of these groups to be appointed by the societies as advisors to the Director. This Committee will discuss with the Director its views concerning the formation of these groups. Should he decide to form them, the Committee will recommend to the societies that they cooperate with the Director in the selection of suitable candidates from their memberships.

In making its recommendation for the advisory committees to the Director, the Committee has given consideration to the Visiting Committee of the Bureau of Standards that is appointed by the Secretary of Commerce under statutory authorization. It sees no conflict between the activities of the Secretary's Visiting Committee and the advisory committees to the Director of the Bureau that it is recommending. In fact, the detailed knowledge of the Bureau's programs that these advisory groups will acquire in the performance of their duties can be of use to the Secretary's Visiting Committee.

This Committee recognizes that in its studies it has reviewed items that in previous years have received attention from the Secretary's statutory Visiting Committee. In the reports of that Committee which have come to its attention, it has not found any observations or recommendations there that are inconsistent with those of this report.

The Committee is not making a record of its observations on specific inadequacies in personnel in supervisory and professional positions or of unsatisfactory relationships between different members of supervision and between supervision and professional staff. No large organization is completely free of individuals inadequate for their assignment or of frictions between members of the organization. In the close contact between Bureau personnel and members of the Committee and their consultants such inadequacies and frictions were found. Their amount is not excessive and the management of the Bureau is, in general, aware of their presence. In many cases constructive action for improvement is in progress and in others consideration is being given of "what to do" to bring about improvement.

Catalog of Recommendations

The recommendations of the Committee for improvement and strengthening of the Bureau have been given in previous sections. The more significant ones are listed here:

1. Higher level of activity in the basic programs.
2. Modernization of facilities and increased space for basic programs.
3. Improvement of organization at the Associate Director level.
4. Transfer of weaponry projects to the Department of Defense.
5. Continued use of the Bureau by Department of Defense and Atomic Energy Commission for nonweaponry science and technical aid.
6. Continued and increased use of the Bureau by other agencies of Government in indicated areas of science and technology.
7. Decrease in repetitive test operations at the Bureau.
8. Division of primary responsibility for policy and procedure on commercial product tests between the Secretary of Commerce and the Director of the Bureau.
9. Increased support of standard samples program.

10. Advisory groups to the Director selected from membership in eight scientific and technical societies.

SUMMARY

From the Committee's extensive study of the Bureau's functions, its programs for discharging these functions, the facilities of the Bureau and its professional personnel, as well as from discussions with many scientists and engineers, it has reached some general conclusions. The major ones are listed:

1. The Bureau of Standards is of vital importance to national strength.

2. It is an organization with a splendid record and tradition, internationally recognized and respected.

3. It is, in general, staffed with professional men of competence, integrity and loyalty to the Bureau's functions and objectives.

4. With the increasing range and depth of technology, the need for the services of the Bureau of Standards becomes even more important and its functions more complex. The accurate determination of physical constants, the properties of materials, standards and standards practices and testing and evaluation procedures are all essential services for our industrial society.

5. Since the close of the war the technology of the nation has shot rapidly forward. The Bureau's basic programs expanded until 1950 but at a rate beneath that justified by the needs. Since 1950 the decrease in basic programs must be considered as tragic. The ground lost since 1950 should be regained in the next two fiscal years and the programs then expanded as detailed studies by the Director and his advisory committees find necessary.

6. Scientific and technical services to other agencies of Government are important responsibilities of the Bureau. In general, the Bureau has discharged these responsibilities well.

7. The Department of Defense and the Atomic Energy Commission have made broad and significant use of the Bureau. Their use of the Bureau in areas other than development of weapons is of value to the Bureau in its basic programs and should be encouraged.

8. The volume of weaponry development work has become large in comparison with all other activities of the Bureau. Its relative size and its effects on the other Bureau programs make its transfer from the Bureau desirable.

9. Other agencies of Government do not make as large use of the services of the Bureau as might well be expected. The Committee believes that an increase in the use of the Bureau by other agencies of Government should be encouraged.

10. If the recommendations of the Committee are followed, the Bureau should be in a positon to perform its authorized functions in balance at the minimum level for the nation's needs within a four-year period.

Excitatory Factors in Ventricular Tachycardia Resulting from Myocardial Ischemia. Potassium a Major Excitant[1]

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VENTRICULAR ECTOPIC ACTIVITY or the potentiality of ectopic activity following abrupt high ligation of the anterior descending artery of the dog occurs in three phases related to time elapsed since occlusion (*1, 2*). The first phase has a duration of about 10 min. During this period ectopic activity develops in almost all animals and precipitates ventricular fibrillation in 30–50% of them. In the animals in which ventricular fibrillation does not develop, ectopic activity passes through a maximum and declines to reach a level of only an occasional premature beat or ceases completely within 20 min or less after occlusion. First phase ectopic activity can be prevented by two-stage occlusion.

The second phase in the pattern of ectopic events is a period of little or no ectopic activity following the first phase, or following a two-stage occlusion bypass of the first phase. This period, during which there are only occasional ectopic complexes or none, has a duration as brief as 4.5 hr in some animals and as long as 7 or 8 hr in others, the majority being 5–6 hr.

The beginning of the third phase is indicated by the appearance of ectopic beats or a significant increase in their frequency if there were occasional ectopic complexes during the second phase. After the onset

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