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"THE BUREAU OF STANDARDS"

by

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The Bureau of Standards was organized by Congressional Act about 25 years ago. The Director at the present time is, as you know, Dr. Burgess. Under his supervision the work is divided into two groups - the Commercial Standards Group and the Research and Testing Group

The Commercial Standards Group is under the direction of Mr. Hudson, Asst Director, Commercial Standards, and that work will be explained to you in some subsequent lectures I shall, therefore, not go into that phase of it but will confine my remarks in general to the work of the Research and Testing Group.

We have altogether at the Bureau of Standards about 850 employees, some 550 of which might properly be classed as technical employees. The activities of the Bureau might be classified something like this - as far as the Research and Testing Group is concerned

First we have one of the fundamental duties of the Bureau - the maintenance of our standards. That refers not only to the fundamental standards of length, mass and time, the electrical standards, standards which determine the temperature scale, but the working standards which are based upon these fundamental standards The first division of the work as a whole I should characterize as the maintenance operation, development of methods relating to our standards.

The second function is research which, of course, is also fundamentally connected with the work of the standards themselves - research in industrial problems or research for other branches of the Govt.

Third, would be the testing, which is carried out for other branches of the government and for industry

Just a word regarding the relation of the Bureau of Standards to other Government organizations. First, the work of the Federal Specifications Board. That Board is set up under the Chief Coordinator and its object is to provide specifications covering materials, products, etc , that are needed by more than one Department of the Government in those cases it is deemed desirable to setup a specification which will serve as a basis for the purchase of such material and that specification then becomes mandatory upon all the Government departments which have occasion to purchase material of this character Since it is a mandatory requirement it becomes important to see that the specifications shall be as acceptable as possible to all concerned The specification is set up by a technical committee coming under the Federal Specifications Board They seek first to bring what technical information they can bearing on the problem in hand, the Bureau of Standards may come in, the technical branches of the Army and Navy do come in, and certain other departments if they have men who are qualified and interested in this work.

The specification, after being set up, is sent to the various departments for scrutiny and if they have any criticismsto make they come back to the Federal Specifications Board and are referred to the committee. After it has been reviewed and is satisfactory in the minds of the Federal Specifications Board members it is put into effect These specifications number something like four or five hundred at the present time and they have been developed in the past four or five years In my opinion, they range from mediocre to excellent and the excellence of the specifications

depends upon the amount of technical information that we can bring to bear upon the subject in formulating the specification There is no trouble in drawing up a good specification if we all know the facts about it We can then specify what is essential and leave out what is non-essential If we put into the specification such words as "the material shall be satisfactory for the purpose intended", then the indefiniteness of the whole thing is such that it does not form a specification at all The purpose of the Federal Specifications Board is to try to formulate specifications which will be effective in Government purchases and the Government is one of the greatest purchasers of the country. These specifications go further however, because there is a distinct feeling throughout the country that a material which is acceptable to the Government must be a pretty good material and consequently those specifications are going to be used very widely. In fact the commercial standard about which you will hear in one of the subsequent lectures is a standard based in part upon these Government specifications That is one contact of the Bureau of Standards with the problems that are before you - namely, an attempt to supply, insofar as we can, the technical information which will tend to make a specification a really discriminating specification, containing all the essential features and eliminating the non-essentials.

The Director of the Bureau is chairman of the Federal Specifications Board. He is also chairman of the National Screw Thread Commission, which is another organization actively associated with this work. The function of this commission is to standardize the machine screw threads which are used in the Army and Navy manufacturing establishments and, insofar as possible, in the products purchased by the Army & Navy That organization has made a distinct advance in standardization in this field. The recom-

mendations of the National Screw Thread Commission are being adopted by many technical organizations Colonel Peck is vice-Chairman of the Commission It is made up of two commissioned officers of the Army, two officers of the Navy, and two representatives of the American Society of Mechanical Engineers, & two representatives of the American Society of Automotive Engineers, which are selected on the recommendation of the Secretary of Commerce. There is, outside of the Government, a great agency which is supposed to be - in a very broad way - national in character It is called the American Standards Association It used to be called the American Engineering Standards Committee That organization has for its primary purpose the selecting of those specifications which have proved themselves in industry and giving, by this stamp of approval, an elevation to the rank of a national standard - not a federal standard, but a national standard The American Standards Association has set up a rather elaborate machinery to examine these existing specifications and this machinery moves slowly and ponderously, but thoroughly The American Society of Mechanical Engineers would recommend to the American Standards Assn a certain specification which they believe is ready to be made The Assn then sets up a technical committee for the examination of this standard and notifies members of other societies, not only the technical people but also the producers and consumers It gets them together to find out whether this particular standard meets the requirements of every phase of industry. The producer, consumer and technical men determine whether the specification is being properly applied to the product in question After they get through with the process the specification receives the approval of the Association The Bureau of Standards and other branches of the Government sit in as member bodies of this association and of course we help them from the

standpoint of technical information as much as we can, but our interests in the field of specifications at the present time are directed more particularly to the work of the Federal Specifications Board.

That gives you a crude picture of our relations to industry in connection with standardization. From the standpoint of research and industry I would like to tell you about the procedure.

We have authority to invite technical men to work at the Bureau They become our guests This is what we term our research associate plan and when industry has a problem upon which it would like to have further investigation carried out and deems it desirable to have the Bureau of Standards assist in and direct the investigation, the proposition is put up to the Bureau. The industry agrees to provide a certain amount of money, this money to go for the payment of salaries for these research associates They are technical men selected by the Bureau and the industry jointly and for the time during which they are employed they have the privileges and standing of bureau employees. Their work is under the supervision of the particular section of the Bureau in which they are employed and the results when completed may be published as a technical paper from the Bureau of Standards. It is the understanding also in all this research associate work that such results as may be obtained will be available to the public and in general this type of cooperation occurs with trade associations or with technical societies rather than with individuals To illustrate the point I will tell you of a research associate project which has just been arranged for. The Industrial Utilities Commission in Chicago is having a great deal of trouble with the breakdown of their underground cables when they are used for high voltage tranmission of say 110,000 volts. They had occasion recently to take up a cable that had

been in service two years. This cable, they found, had already passed through 70% of its useful life. These cables are paper insulated, and impregnated with some kind of solid oil like petrolatum, and apparently under the action of this high voltage some kind of change takes place and the insulation rapidly goes out So this organization has come to the Bureau and has offered to set up a fund of $10,000. for technical and fundamental investigation upon the nature of conductance in insul tors. All insulators do conduct a very little. What is the nature of this conductance, the character of the ionic changes? ~~Xxxxxxxxxx~~ This problem will be attacked first without any reference to the vital problem of avoiding the rapid deterioration of these cables. It will be attacked by preparing just as pure liquids as we can and studying the electrical properties of those liquids and then gradually lead up to the practical solution , if that is possible The method of attack will be illustrated by the fact that the ordinary mineral oil is a great mixture of compounds. Which of these is responsible for this trouble we can only determine by first determining the properties of the pure liquids themselves. That gives you an idea of the problems before us.

Slide 1.

This is a view of the Bureau of Standards, industrial building, commercial building, metallurgical building, etc.

Slide 2.

Here is a picture of the meter bar The marks are down here

Slide 3.

Another phase of the length measurements consists of the calibration of geodetic tapes First the meter is compared with a standard 5-meter bar and in turn that 5-meter bar is carried along under the tape and examined from point to point by means of microscopes traversing the length of the bar For

work requiring less precision we have a place where one tape can be compared with another of known length. We have temperature control is this room. The air is stirred to keep the room at a uniform temperature.

Slide 4.

This represents another feature of the length measurements, namely the comparison by optical means of two standards The degree of precision is about 1 to 2 parts in a million

Slide 5.

This is the kilogram Here is its prototype

Slide 6.

Here is a method which is used in very precise weighing, this balance being operated at a distance in order to keep the heat of the observer's body away from the balance. Very precise weighing can be done in this way. In this balance it is possible to take the weight off by operating one of these levers. The weight is lifted off and put over on the platform and another lever exchanges the weights

Slide 7.

This is another slide of our weighing process, in which track scales are being calibrated in the field The Government owns three of these cars.

Slide 8.

This is the time end of the length, mass and time fundamental standards. We develop a good deal of apparatus for the measurement of short time intervals

Slide 9.

We come to the electrical standard This is a standard of resist-

ance. The situation is this Our real practical standards are the electromotive forces of the Weston cell and the resistance of certain wire standards. Those were determined on the basis of work which has been done in the past years and the present basis consists of a mercury ohm. This is a very difficult set-up so that the comparisons are made once. They are trying to carry it in terms of electrical resistance Instead of using an electromotive force the current was defined as the amount of silver that would be electroplated by one ampere in one second of time.

I spoke of our research on units and one thing I had in mind was the desirability of going over to the absolute system. It is possible to define these units in absolute terms which are tied up with length, mass and time, and that program is one which we have in mind

Slide 10

This deals with the maintenance of the standard of electromotive force.

Slide 11.

Here is another phase of the work of the electrical division, namely the radio beacon which has been developed for the Aeronautics branch to guide our planes over commercial airways. This beacon sends out two waves at about 90 degrees to each other. The present system is that one of these waves sends out a frequency of 65 cycles per second and the other 85 cycles per second On the platform is a radio receiving set but in place of the earpieces we have a visual indicator which contains two reeds. One is tuned to vibrate at 65 cycles and the other at 85 cycles. If the airplane is on its course, which is midway between these two, these reeds receive impulses of equal intensity and they vibrate with equal amplitude. If it gets off the course to the right then the right reed vibrates more than

the left The process becomes very easy. The pilot simply changes his course until the two reeds are vibrating with equal intensity. For instance, suppose he were flying from Belfonte, Pa. to College Park He has a beacon which is directed at College Park, so he flies from that beacon, keeping his reeds vibrating with equal amplitude After he has flown 150 miles he is outside of the Belfonte range but he knows his general course and he flies into a rather broad V until he picks up College Park.

Q. Suppose another plane takes off in another direction. Will it take care of that?

A. Yes, that beacon can be modulated so that it will You can fly in four different courses and the beacon will take care of it

Slide 13.

This shows the testing of clinical thermometers. They are tested in units of 50 each. The consumer getting the thermometer containing the certificate reads that "this thermometer has been tested and complies with the tolerances permitted for clinical thermometers."

Slide 14.

This is the dynamometer laboratory which is a part of the Division of Heat and Power and shows an engine under test.

Slide 15.

This is a very interesting thing. In order to get the performance of an aircraft engine in the air it should, of course, be tested under conditions of temperature and pressure corresponding to any particular altitude If an engine is to be operated at an altitude of 20,000 feet test should be carried out at pressure of something like 15" of mercury and at temperature of perhaps minus 30 degrees Centigrade.

We have here a big concrete chamber in which the engine can be

mounted and pressure and temperature reduced to correspond to any altitude conditions This door swings around and the pressure of the air is so great as to keep it shut tight The engine is connected to the dynamometer outside and its behavior studied We can also study superchargers. The engines for altitude flights are connected with superchargers and you may really work under conditions under which the supercharger will have to work.

The U. S. Govt. was the first to go into this study of engines under reduced temperatures and pressures.

Slide 16.

Here is another phase of automotive work. This car is so equipped that we can study the various things that come into road operation. Here is a means of determining the direction and velocity of the wind and the effect of that velocity upon the power required by the car This provides a record of the number of variables

Slide 17.

We come to a class of tests that are very difficult to stardardize. This work deals particularly with the effectiveness of fire resisting materials This shows a fire in our test building.

Slide 18.

This shows the contents of that building. It is set up as an office building - wooden desks, books, wooden file cases, safes, etc. We are interested in this case to know how the contents of those safes are going to withstand the fire.

Slide 19.

This is what is left of the room and here are the two safes Their contents were carefully examined

Slide 20

This is probably the most comprehensive study of safes that was ever made There were 40 in this building We secured permission to burn this building It was a four-story building and the safes were put on each of the floors along with a certain amount of combustible material. This fire department gathered about and at 6 o'clock one Sunday morning it was started off The results of that experiment will be available very soon.

Slide 21.

This shows one of the methods of measuring candle power of a lamp.

Slide 22.

This is along the line of investigation of the effectiveness of elevator car door interlocks To be effective it should prevent the car from leaving the landing when the door is open and should prevent opening the door when the car is not at the landing. The Bureau has been carrying out a series of tests of various interlocking devises for the Supervising Architects office and others

Slide 23.

Here is one of our big testing machines. It has a capacity of 2,300,000 pounds of compression. You see a long girder that is under test.

Slide 24

Here is the same machine with a different kind of load. It is an airship girder for the Navy which is being subjected to both a compressional and a transverse load.

Slide 25.

This machine has a capacity of 5,000 tons - 10 million pounds

The object under test is a part of the Delaware-Camden bridge The problem was the effectiveness of wide-web girders - whether they would buckle.

Slide 26

This is one of our wind tunnels which was built outdoors where we can get more satisfactory conditions.

Slide 27 shows the entrance to the above tunnel

Slide 28.

Here is another problem of aero-dynamics - the wind resistance of chimneys. In this case we built a wooden framework covered with sheet steel

Slide 29

This is some work on the fatigue of metals, - a scheme for getting very high vibrations - 2 or 3 hundred cycles per second

Slide 30.

The compressed air comes out this and this end of the specimen is free to vibrate back and forth. The result of the air coming out is a reduction in pressure Consequently the specimen is pulled over that way and is brought up against a corresponding nozzle on that side. It is possible to get stresses amounting to 25,000 pounds per square inch at very high speeds

Slide 31

In the case of ferrous metals, if we put a specimen through ten million vibrations and it does not fail we have reason to believe that it will stand that particular stress indefinitely However, these light alloys such as duralumin will stand 30,000 pounds per sq. in up to 200,000 cycles but when you go up to one million cycles they begin to fail at stresses of 25,000 pounds per square inch The endurance of these alloys depends upon how long they are going to be subjected to this particular vibration and that complicates the problem greatly. You can see how time-consuming that is.

Slide 32.

This illustrates another activity of the Bureau - the experimental paper mill. One of the recent accomplishments in that field has been the improvement of the currency paper which is now used by the Government The life of that paper has been materially prolonged

Slide 33

This is an experimental spinning mill We have been working on some special airplane fabrics and fabrics for use in parachutes

Slide 34 - A rolling mill of the Metallurgical Division

Slide 35 - A forging hammer in the same laboratory

Slide 36.

We are coming to a very different subject - the manufacture of optical glass. As you know, when we went into the World War we were ~~practically~~ without a source of optical glass. It had practically all come from Germany and Belgium so it was necessary for the U. S to see what it could do. One of the most important things about the manufacture of optical glass is to get a suitable pot, because if the pot is made of material which pollutes the molten glass then you have spoiled your work at the very start. This illustrates some of the pots which are used in the manufacture of molten glass The Bureau succeeded in making a very satisfactory pot

Slide 37.

This shows a pot of optical glass after it comes out of the furnace and cools down It fractures in this way

Slide 38

An illustration of a piece of fine optical glass The wood is behind a thickness of 3" of optical glass.

Slide 39.

If, instead of wanting your glass to break up you want it to

remain as a great slab, then you have another problem. We had occasion recently to undertake the manufacture of a 70" mirror for a telescope out in Ohio We were to make a slab of glass 10" thick and 70" in diameter. The first attempt failed The slab broke because the pot was too strong for the glass and when contraction began the glass cracked. Finally a pot was made up of very, very soft porous brick. Here is the furnace discharging the molten glass into that pot After that pot was filled then came the questi of cooling it, if possible, in such a way that it would not crack Previous laboratory study had shown how the expansion of the glass changed with the temperature as it was cooling down and indicated that there were certain critical places where the changes were relatively rapid and consequently, for certain temperature ranges it was extremely important that the glass be brought through them with extreme slowness. The material after being run into the pot was covered up and provided with heating devices so that the temperature could be carefully watched and when the temperature had fallen into this critical region it was regulated, so that the change of temperature during a day was only a fraction of a degree Six months were consumed in cooling this piece of glass Finally it was taken out The bricks were taken off and this shows the beautiful slab of glass The next problem was to cut a hole through the center That was successfully accomplished with a special type of boring material, going very slowly, using copper tubing and carborundum. Now the glass is in Pittsburgh being figured for that particular telescope

Q. Does the Bureau of Standards attempt any money-making schemes besides the sale of optical glass?

A. The Navy Dept, buys from four to five thousand dollars worth of glass from the Bureau by means of transfer The Bureau sells nothing. That is not quite correct, either. We have a series of standard commercial

samples which are samples of known purity. They have been carefully analyzed according to certain practices and these samples are sent out in great numbers About $12,000 worth a year are sold The Government appropriates $10,000 The difference goes back into the Treasury

Q. How was the mirror financed?

A. That was primarily a question of working out that technique Nothing like that has ever been done on that scale in this country The Bureau consented to undertake it for the experience it would gain.

Q. Does the testing of tapes go back to Miscellaneous Receipts?

A. Yes. That is an arrangement I should like to see modified We could do much more for industry if we could use the fees received from industry, but every test that is made for industry is so much taken out of the general receipts of the bureau Therefore we limit our commercial testing to things for which their laboratories are not equipped We feel that we should do the work on the big testing machines because there is no other place to do it. The testing for the Government and commercial testing amounts to $1,500,000. per year

Q. What is the annual appropriation?

A. About $2,300,000.

Q. What is the relation of the National Research Council to the Bureau of Standards?

A Our relation with that is a good deal like our relation with the American Standards Assn Our people take part in the work of the Committees but we have no formal relations

Q. Dr. Burgess is a member?

A. He is chairman as an individual.

Q Is the National Academy of Science financed by the Government?

A. It is financed by some donations that were made years ago, so

they have an income from that and from their fees They have a charter under the Government and in that charter it was stated that the overnment had the right to call upon them for advice upon any problem they desire

Q. How is the American Standards Assn supported

A. By contribution from member bodies They set up such an elaborate procedure that it is very slow getting a standard through and enthusiasm has waned a little However, they have recently undergone some reorganization which led to this change of name and they hope to speed things up

Q. I have noticed that you test automobile tires and brick walls Do you do that for the Government or for individuals?

A. The brick wall was an investigation to determine the strength of brick walls - the bearing load as modified by the character of the brick, the kind of mortar, the workmanship, and the method of construction. It was financed jointly by the Common Brick Manufacturers Assn and the Bureau In this connection I might say that while the research associates have their salaries paid by outside concerns, the incidental expenses of these investigations are carried by the Bureau and it assumes responsibility for the results

In connection with the automobile tire work, that testing is limited to other branches of the Govt.

Q. Does the Bureau make tests of nationally advertised products on their own initiative?

A. You refer to Chase & Slenck They give the wrong impression We would undertake that only if all the products in that particular field could be brought in and only under special circumstances We are at present working on a locking screw thread which was initiated by the Rau Thread Co They have an interesting new locking bolt and they asked the Government

to undertake an investigation of the properties of that bolt They were not quite sure what the exact tension of the thread should be Our reply in that case was that if they were willing to have included in that study an investigation of other locking devices as well the problem could be put up as an investigation of locking devices in general.

Q. You made reference to certifying thermometers.

A. Suppose I illustrate that. A man sends in his flask, for example, which has a ring on the neck of it and he asks to have the volume determined at a specified temperature. The Bureau then would issue a certificate that the volume of this flask at 20° Centigrade was 994.64 cubic centimeters That certificate goes out.

Q. He then uses that as a sales talk?

A. That is where we have to look out We have to look out for the man who sends us one instrument which tests very well and then says "this is a sample of the precision of our instruments as shown by Bureau of Standards' test" He can say that is a certificate covering that particular instrument, but that is all.

Q. Some of the States require tests

A. Massachusetts does. Their requirements are a little different from others and our tests would not meet their laws.

Q What is the position of the B. of S. on the bill of Senator Copeland stating that all thermometers shall bear the stamp of the B. of S ?

A. It is my feeling that that matter could have been handled more advantageously by setting up a suitable specification for clinical thermometers by equipping laboratories in the various manufacturing plants where those thermometers could be tested in accordance with these specifications and giving the Bureau general supervision over these laboratories to see that

these specifications were lived up to. It does not seem necessary to have them all tested The thermometers for the Veterans Bureau are tested. It is possible to buy in the market clinical thermometers which bear Bureau of Standards certificates.

Question as to conflict between B. of S and Amer Stand Comm deleted