6898

NATIONAL BUREAU OF STANDARDS REPORT

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EUROPEAN VISIT
FIRE RESEARCH 1960

by

A. F. Robertson

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT 1002-12-10120

July 15, 1960

NBS REPORT 6898

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IMPORTANT NOTICE

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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ABSTRACT

On the occasion of a meeting of the CIB and EPA groups on Fire Research, a visit was made by the writer to Britain, Germany and France, where groups active in the field of fire research were visited. A brief summary is presented of discussions with various members of the technical staff of some organizations active in the field of fire research.

CIB Meeting

The fourth meeting of this group was held in Charles House of DSIR in London on May 30 and 31, and at the Joint Fire Research Station on 1 June. The first day was spent in discussing the model enclosure fire tests and planning further studies. Some discussion of this will be presented below. The list of delegates, agenda, and the many papers presented are enclosed as appendix A & B.

Enclosure Fires Tests

Dr. Thomas presented table I as a hurriedly prepared summary of the experimental data so far available. It will be observed that for any spacing and vent area combination studied, variations in fire load had little effect on average combustion rate. However, there were significant variations in combustion rates between countries and these were large enough to require study before progressing further.

Table 1
Fuel Combustion Rates[a]
Model Enclosure Fire Test Data From Various Countries

Fire Load Spacing	1/1				1/3			
Window Area	1/4		1		1/4		1	
Fire Load	20	30	20	30	20	30	20	30
Data from UK	.13	.18	.32	.43	.28	.22	.41	.38
Data from USA	.28	.26	.49	.47	.29	.31	.48	.52
Data from Germany	.18	.18	.38	.43	.23	.25	.53	.46
Data from Holland	.26	.21	.25[b]	.41	.27	.28	.55	.55
Data from Australia	.15	.16	.42	.49	.21	.31	.73[b]	.44
Average rate	.20	.20	.40	.45	.26	.27	.49	.47

[a] These burning rates are the mean rates between the 90% and 20% fuel remainder times.

[b] These points not included in determining average.

Table II

Variations in Performing Model Tests

Variable	Details	Countries Involved
1. Crib Stocking	Not Glued Glued Nailed	Germany, Canada[1], Netherlands UK, USA, Canada Netherlands (first layer)
2. Enclosure Drying	Dried before test Not " " "	UK, USA Germany, Canada, Netherlands
3. Box Material	Asbestos wood Asbestos Mill board	UK, Canada, Germany USA, Netherlands
4. Floor Baffle	No baffle used Baffle at box floor	UK, Canada, Germany USA, Netherlands
5. Fuel Material	No detailed data available, but assumed variable	

[1]Only data for glued specimens submitted to CIB.

A survey was therefore made during the meeting concerning procedure details used in the various countries. The results are tabulated in table II. It was assumed that the variations in burning rate shown in table I were at least partially a result of the procedural variations. It was decided that UK, USA, and the Netherlands would perform further tests to study the effect of fuel type and box material before proceeding further. It was further decided that in all future tests the cribs would be glued, the crib would be suspended at least one box height above any horizontal baffle, and boxes would be dried before each test or at least once each test day. It was further agreed that wood from four or five countries, perhaps USA, UK, Netherlands, Germany, and Australia, sufficient for two tests of the 1-2-1 fully open model using 20 kg/m^2 fire load and 1:3 spacing would be shipped to UK, USA, and Netherlands. I offered to provide glue for use during these further tests.

Russian Model Work

Mr. Milivonov presented a discussion of work currently under way in Russia on the behavior of fires in rooms or models of them. He stated that when these tests were completed and a report was available, this would be forwarded. He summarized his work as follows:[1]

They had used wooden sticks of 5 x 5 x 80 cm size with a moisture content of 14% as fuel. These, when stacked in crib form, were found to burn in quite similar fashion to furniture, corresponding to a fire load of 50 kg/m^2.

Attempts were made to change only one variable at a time. The tests were conducted with enclosures having floor areas of 9 and 5 m^2 and windows of 1 and 5 m^2 area. It was found that the fire duration D in hours could be expressed as

$$D = q/\lambda \qquad (1)$$

where q is the fire load kg/m^2 and λ is the rate of fuel consumption kg/m^2 hr.

[1] The following abstract was recorded from Mr. Rogowski's translation of portions of a Russian mimeographed report. This was available to Mr. Rogowski during 2 or 3 hours of the meeting prior to presentation.

For a range of window sizes of 1, 1.5 and $2m^2$ a factor φ was defined as

$$\varphi = \frac{0.16 \text{ Floor Area}}{\text{F Window Area}} \qquad (2)$$

The type of fuel used was stated to have no effect on fire duration.

An adjusted fire duration was then defined as

$$\mathcal{D} = \varphi D = \frac{0.16 \text{ Floor Area}}{\text{F window Area}} \left(\frac{q_1}{\lambda_1} + \frac{q_2}{\lambda_2} \ldots \right)$$

where the subscripts refer to different fuel types. It was found that the following factors influenced the fire behavior:

1. Quantity of combustible fuel
2. Air supply conditions
3. The rate of burning (?)

The following rules were suggested as applicable to the use of models for study of large fires:

1. The two structures must be geometrically similar.
2. The height of ventilation openings must follow the law

$$h_m^{1.5} = Ce \; h_{o\delta}^{1.5} \qquad (3)$$

where h_m is the height of model opening
$h_{o\delta}$ " " " " prototype opening
Ce " " scale ratio

3. The same fire loading must be used or $q_m = Ce \; q_{o\delta}$
4. The fire duration is then given by

$$D_m = Ce \; D_{o\delta} \qquad (4)$$

A study was conducted on a room of 1850 x 1350 mm floor dimensions and 1500 mm height with an opening of 1000 mm height and 500 mm width. The results were compared with a prototype of twice this scale size and the data were in close agreement.

Mr. Lawson pointed out that the relationship shown in equation (3) of the Russian presentation was quite consistent with the findings of the Japanese as well as recent British work. These showed that similar fuel consuption rates would exist in two models when the factor $A\sqrt{h}$ was maintained constant. In this factor A is the area of the window or other opening while h is the height of the opening.

The Russian delegate promised that further information on their work would be made available as it developed.

Remainder of CIB Meeting

The previous discussions of studies of model techniques consumed about one and one-half days. The afternoon of Tuesday 31 May and the following morning were spent in brief discussions of the other papers prepared for this meeting and included in appendix B. These included:

1. Fire Resistance:

   Discussions of effects of restraint on floor constructions, the current British plan to loosen-up on unexposed surface temperature rise (insulation requirement) as limiting performance, and discussions of deflection behavior as limiting load carrying ability.

2. Repairability of Buildings Damaged by Fire:

   The Japanese have done some interesting work on this subject and find that the strength of concrete beams exposed to fire can be significantly recovered after prolonged exposure to high moisture conditions.

3. Curtain Wall Fire Behavior:

The Swedish delegate presented a resumé of a paper describing tests for study of the fire spread up the front of wooden buildings.

4. Movement of Smoke in Buildings:

I was impressed with studies made in both France and the Netherlands on the movement of smoke in buildings. This appeared to be good work in which the buildings involved were not damaged.

After dinner at Borehamwood, the CIB meeting was closed with a visit during the afternoon to the Joint Fire Research Station. We visited the Experimental Fires Laboratory which is now in constant use, and saw from the outside their new office and laboratory buildings, which are to be dedicated in the fall.

Joint Fire Research Station

Fire Extinguishment

I visited Mr. Hird to discuss their work on extinguishment. Most of this recent work has been related to study of foam compatible powders. The test method they have devised makes use of a 3 ft diam tray in which gasoline of 2 - 3 in. depth is burned. The critical rate of foam application to balance the rate of drop-out is determined. The powder to be tested is then added to the fuel in quantity of one pound in the gasoline tray and the rate of foam application is again determined. They find that in general the following application rates are required:

0.025	gal	foam	liquid/ft	min	--	no powder
0.5	"	"	"	"	"	dry powder with 1-1/2% stearate
0.25	"	"	"	"	"	Purple K
< 0.050	"	"	"	"	"	Potassium Sulphate plus 2% stearate
< 0.050	"	"	"	"	"	Sodium chloride with stearate

They observed that stearate did not appear to be objectionable for many salts other than bicarbonate. They find, however, that results vary with the type of foam liquid used. The results of use of this test method are not the same as those using the NRL compatibility test.

Mr. Hird indicated that they were just now in process of finishing a powder applicator with which rate could be controlled at will. He was interested in our unit and requested drawings of it. They have done some tests on very large oil fires with two fighters. The results he showed me seemed to indicate that they were able to control the fire with very low application rates. He was dissatisfied with our suggestion that the minimum application rate was a function of fire area. He considered it should more properly be a function of unit width of fire being fought.

I visited Mr. Stark who is working under Dr. Rasbash on the proposed inerting system for control of building fires. This experimental unit consists of a jet engine with after-burner and water-cooled exhaust such that the exhaust gases are at about 100°C with only about 5% oxygen. The whole rig is mounted on a truck which could be moved up to any building. They plan to study its effectiveness in controlling fires in their Models Laboratory. They have so far run just one or two tests but others will be studied shortly. In using this unit, they attempt to avoid turbulence with gases in the room to be flooded with the objective of smothering the fire promptly by "plug flow".

Growth of Fires

I talked to Dr. Thomas about his current work, the discussion closely related to three papers. The first involving an analysis of flame height was initiated as a result of observations made of the burning behavior of fabrics. He has been able to show a correlation between δ/L, the flame height to lateral dimension of the fuel bed, and R'^2/L^5 the ratio of the absolute rate of fuel consumption to fifth power of lateral fuel dimension. He has been able to show a correlation of this type over a very wide range of fuel types including fabrics, crib fires and oil tub fires. He was pleased to see that our crib results seemed to agree with his.

Another paper involved further discussion of self-ignition phenomena. I gathered that this provided a discussion of the observed effect that the results of Mitchel's tests seem to show two different reactions are taking place, one in which the self heating may be quite pronounced but as a result of which the reactant is quickly depleted. This phase does not seem to have been detected by the adiabatic furnace. This equipment seems to be sensitive only to the second or longer term reaction which appears to be less subject to fuel depletion.

A third paper involves a theoretical study of the burning of wood on the assumption that flow of oxygen to the wood reaction zone was not of importance. He was interested to find that the problem was quite amenable to treatment by techniques similar to those developed in the study of self-ignition. He computed the rate of char formation in several ways but found that it was quite sensitive to the heat of reaction. He believes the Japanese value of this is probably too low.

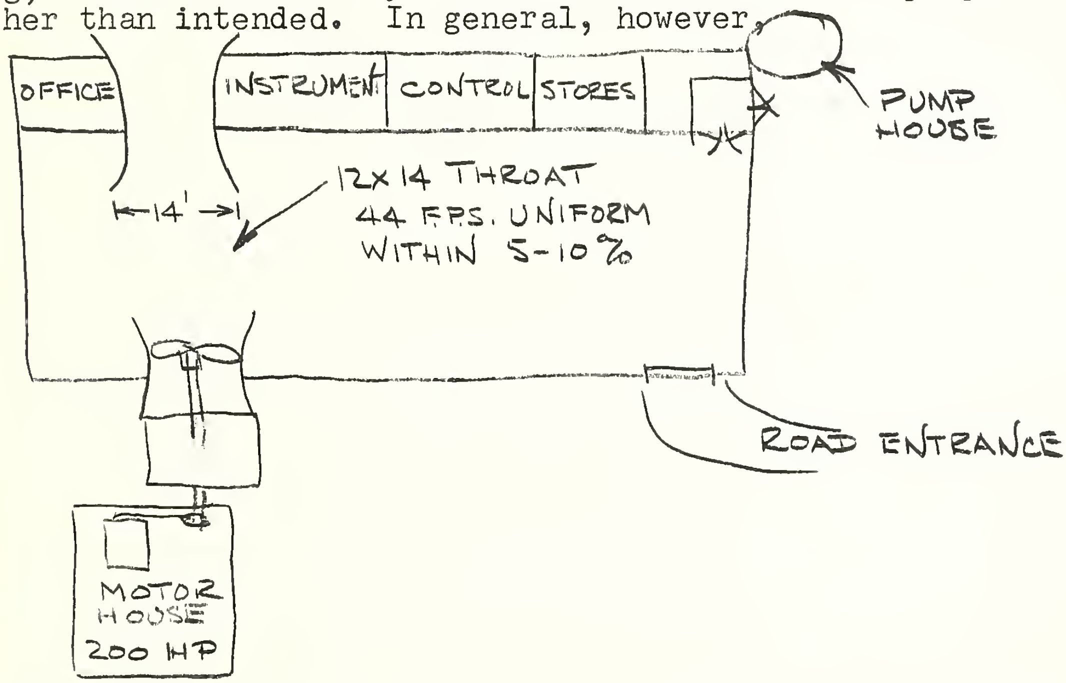
We discussed work he had under way on models. He was planning to continue some work on the arrangement of fuel when burned in rooms. One experiment he reported involved the placing of fiberboard slabs in a vertical position, perpendicular to the window. He found that the rate of burning remained constant regardless of whether all slabs were equally spaced or pairs of slabs were stacked closely together. We also discussed the need for baffles around the openings of the model rooms tests. He would plan to explore this as well as ignition sensitivity and let us know the results. I agreed that we would perform additional model tests using the box material they would forward and each of at least three fuel types.

Models Laboratory

I visited Mr. Stark who apparently is in charge of operational use of this laboratory. We discussed the various features related to it. In general, he felt that they would have been better off to use a separate building for a wind tunnel. The arrangement they had, prevented its use unless the building was tightly closed up. (This doesn't happen often in England!). This has a tendency to interfere with other work underway. When I was there, they were performing experiments on

1. A factory building model for roof vent studies
2. Oil pan fires for foam compatibility studies
3. Small wind tunnel tests of kerosine heaters
4. Arrangements were being made for tests of the jet engine inerter.

These would all have to be interrupted if the wind tunnel was in operation. He also questioned the need for the moving roof. He was not certain on its ultimate need, but pointed out that with it open, there were frequently undesirable drafts produced in the room. He thought that the use of fans might work just as well. Although they have three laboratories located along one side of the building, these were already overcrowded and used for purposes other than intended. In general, however,



he considered the lab a very useful one and was happy with it. The windows were very useful for illumination, but it would be preferable to have them to the north. Heating was a problem, and he suggested that it would be preferable to use pipes in the floor rather than the radiators they have at about 15 ft level. Forced convection heaters were objectionable because of the drafts they create.

Fire Endurance Tests

I discussed test methods in general with Messrs. Ashton and Malhotra. They indicated that in the new building code for Scotland, integrity would be required for an hour or more, but the insulation requirement, unexposed temperature rise, would be waived for periods in excess of 15 min.

In general, they were inclined to agree with us on the desirability of a rate of deflection for determination of the time of load failure of floor and beam specimens during fire test. They were uncertain of the need for both deflection and rate of deflection requirements. They indicated that they might incorporate a requirement of this type when the British Standard is revised.

They have made no progress on drying specimens or measurement of their condition. A new group of specimens now being made for column tests is to be dried 6 months prior to test. This study involves steel columns with various types and thickness of concrete aggregate protection. These are required in connection with a code change permitting the concrete to carry a maximum of one half the column load.

Mr. Malhotra mentioned an interesting test in which he had run an experimental fire test in one of their huts for determination of flashover time. It was found that this time, when sprayed asbestos fiber was used on the walls, was very similar to that observed when fiberboard was used as an interior finish.

They were interested in problems associated with foamed polystyrene. They have given it a class 3 or 4 rating (spread of flame) because it ignites and burns with match ignition. It melts and shrinks back without burning in their spread of flame test.

Japanese Work

I spent a morning in talks with Dr. Kowagoe, who is currently working at the Joint Fire Research Station. He furnished a chart, Appendix C, outlining the organizations in Japan which work on unwanted fires. We also discussed numerous things of general interest. These included:

1. Discussion of Dr. Yokoi's work on flames above burning fires. Kowagoe questioned the conclusion that the convection column above a number of dispersed fires was similar to that above a large pan fire of the same diameter.

2. In making temperature measurements during fires in Japan they use protected thermocouples of 1.0 mm wire diam for measuring temperatures within rooms. However, for measurements in flames above burning material they use 0.65 mm diam wire thermocouples which are bare.

3. Their hot wire anenometer can be used in gases at temperatures up to 100°C.

4. Professor Harada, Tokyo Technical University, Ookayama Meguro-ku Tokyo has made very careful measurements of strength, expansion, thermal diffusivity etc., as a function of temperature for concretes and other materials. Information should be available from him.

5. In Japan, the building code calls for a 3 ft spandrel wall with 1 hour endurance between windows of a building or the use of a balcony which extends about 1.6 ft out above the window.

6. Yokoi's work has shown that the use of wide windows results in the flame issuing from them closely following the wall above the window. This is not observed for narrower windows. He has estimated the following spandrel heights required between windows for a fire load of 50 kg/m^2.

Window		Spandrel
Width	Height	Height
1	3	121 cm
4	3	226

These figures are taken from his thesis which is currently being translated.

7. Dr. Kowagoe does not know of any measurements being made on vapor behavior as it leaves the surface of a burning liquid.

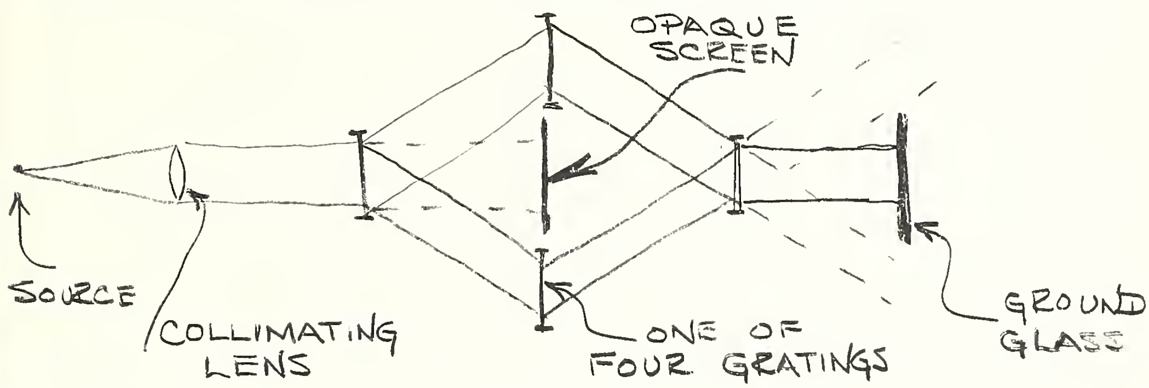
8. He described a number of experiments on the strength recovery of reinforced concrete construction after fire exposure. The results obtained were for both lightweight and dense concretes. They show that a major recovery in strength from the loss resulting from fire exposure is obtained after one year's exposure to the weather. The results of the study are expected to be published in the fall.

Radiometers

I spoke briefly to Mr. Wright about radiometers with which he is concerned. He indicated that a calibration curve was forwarded with the unit they sent us. They can furnish a duplicate if we tell them the identification number. They use a copper slug as their radiation standard. They find that the unit they forwarded works well unless the body temperature changes significantly. They have a water-cooled version for work where the radiometer is exposed for long periods.

Imperial College

I visited Dr. Burgoyne, who furnished a list of graduate workers in the Chemical Engineering Department. I had talks with only four of these men. The only thing of special interest, I observed, was the use of an interferrometer constructed with the use of diffraction gratings.



This makes an excellent "poor man's" interferrometer. I believe this instrument was described in Scientific Instruments about a year ago by Dr. Weinberg.

I also talked to both Dr. Burgoyne and Dr. Cullis about Mr. Creitz's work on flame ionization. Both were very interested and Dr. Cullis agreed to comment on the next paper if we would furnish it shortly. He plans to be at the Combustion Symposium in California and has an invitation from Dr. Howard to talk at NBS the day after Labor Day. He will try to visit us then.

Institute für Baustoffkunde
und Materialprüfung

I visited Mr. P. Bornermann at this institute of the Technische Hochschule Braunschweig Germany. The director, Dr. Kordina, was out of town. This laboratory is located in woods about 8 miles from town. It was built in 1939 as a research center for study of explosive damage to buildings. They have about seven furnaces for floor and wall tests taking specimens of about 2 x 3 m size. One floor furnace may take specimens as large as 4 x 6 m, but most of their tests are performed on the smaller specimens. They do have reinforced concrete restraining frames, but most tests seem to be performed without their use. The furnaces are very simple, just cubicles with openings for portable oil burners to be inserted. Dead weight loading is used. The furnaces are lined with lightweight cellular concrete.

The specimens are constructed outdoors and dried under small portable roof covers for at least 3 months prior to test. Most of their work is done for industry for approval purposes, but some research is also under way. Unexposed surface temperatures are measured by soldering a TC to a small copper sheet about 3/4 x 1-1/2 in. size which is fastened to the specimen. This is covered with a small square of asbestos paper about 3/16-in. thick by 2-in. square. They will be interested to compare their results with use of our pads.

They are cooperating in the model fire experiments and are using a local spruce as a fuel. The sticks were not nailed or glued, but were conditioned prior to test.

I was interested in visiting with Mr. Schultz, who is doing building acoustic studies work at this same organization. They have three types, reverberation, transmission, and wall panel conduction tests. The latter method attempts to assess the conduction through walls as well as transmission through the panel itself. They also have made extensive field measurements of acoustic behavior in actual buildings. He was interested in any information which was available on sound control in apartment and housing projects.

Bundesanstalt für Materialprüfung (BAM)
(Federal Institute for Testing Materials)

The visit to this organization was planned primarily because the British had reported that this was the really outstanding organization in Germany, in the Fire Protection field. The organization, together with a sister organization in Braunschweig, the Physikalische-Technishe Bundesanstalt form, together, an organization quite similar in scope of activities to the National Bureau of Standards. The BAM, concentrating on Engineering and Chemical problems, while the Braunschweig group carries on Physical and Technical activities.

An organization chart is included as appendix D.

A. Fire Resistance

The visit was started with Dr. Seekamp, who is in charge of Section 2.2 Protection. They are in process of constructing a new laboratory and office building for division 2, Non-Metallic Building Materials. Since space is limited, the existing building is being removed. The new laboratory for fire test work is being built on the ground floor and basement. It will be 11 x 45 m in size and will contain a wall furnace 3 x 3 m, a floor furnace 4 x 3 m, and a column furnace 2 x 2 x 3 m in size, the whole area to be conditioned at 20°C and 65% rh.

We saw the last tests to be run in their present furnaces. The floor construction under test was 2 x 3 m in size and involved a dense reinforced concrete construction with fiber-board ceiling. They currently have 4 or 5 furnaces of this size. There was also a wall furnace for specimens about 2 x 2 m. The two column furnaces were quite similar to that at NBS. They were interested in the problem of spalling and attributed it to moisture in the concrete. They condition specimens for three months prior to test.

We discussed the model room experiments briefly. They also are using spruce as a fuel. Their sticks were stacked just prior to burning. A photograph was given me of their experimental setup.

B. Heat Transfer

The next visit was with Chemmerer, who has charge of the heat transfer work under Dr. Seekamp. Their hot plate apparatus was about one meter square with a central test area about 20 in. square. They commented on the need for large specimens because of the non-uniformity of building materials. They were currently in process of initiating a round robin series of tests and were interested in the fact that NBS could furnish materials of measured conductivity.

They showed me heat flow meters that they had purchased from TNO Netherlands. They claimed that they had excellent experience with these units, specially the small one of about 1 cm diameter. They were also enthusiastic about the probe method of conductance measurement developed by TNO. They were ordering one of these instruments for use in Berlin.

They showed me calorimetric equipment on the roof which was being used to study the effectiveness of venetian blinds as sun shades. They commented that the ASHV & RE in our country does similar work.

C. Combustion

Dr. Zehr spent quite a while showing me some of the work done in his section on combustion of gases, dusts, and solids. Most of the work has apparently been concerned with dusts and solids.

Several more or less conventional test methods were shown for tests on dusts. These included:

1. An electrically heated hot plate on which dust layers were placed and the temperature at which smouldering combustion would occur was observed.

2. A vertical tube furnace of small diameter (1-1/2 in.) and of metal construction was being used for ignition temperature determinations of dusts. In using this apparatus N_2 or CO_2 was passed by specimen during warm-up period.

3. A horizontal tube furnace into which dusts could be blown to determine possibility of ignition.

4. A large enclosed hood with Bunsen pilot flame into which one gram samples of dusts were injected. Evaluation of the burning behavior was based on photographic records of the flame produced.

It was mentioned that they had observed self-ignition of metallic dusts after prolonged grinding in an airtight ball mill when this was opened. They also described experiments in which they had been able to produce steady flames in dust air mixtures and even made flame speed measurements on them. In producing such flames, they had found Lycopodium powder very easy to handle. Their equipment made use of a motor driven helical screw which fed the dust into an air stream.

They have done extensive experimental work on study of self-ignition of materials. Fiberglass was one such material studied. They made a cylindrical roll of the material about 8-in. diameter and perhaps 18 in. long. This was heated in an oven at various temperatures until self-ignition was observed. It was mentioned that foamed rubber after cleaning with chlorinated hydrocarbon was observed to ignite at relatively low temperatures, 100 - 150°C.

They showed me improved forms of the Mackey apparatus which they apparently find useful in studies of some materials.

It was mentioned that polyvinylchloride plastics, when pyrolized at relatively low temperatures, left a char residue which was very subject to self-ignition at temperatures close to 160°C.

They demonstrated the ignition of steel wool with a flint lighter and a 4-1/2 v dry cell battery.

D. Measuring Instruments

Several unusual mechanical measuring methods were demonstrated. The most interesting of these was a small dial indicator type of gage length measuring device. With its use, distances between two steel balls mounted on the specimen being studied could be reproduced to a precision of ± 0.001 mm or ± 0.000,04 in. It could be used over any gage lengths up to about 6 in. This instrument appeared to be a very useful device, NBS should have some. Another device under development was a strain sensitive disc of anodized aluminum. This was proposed as a more uniform material than the strain sensitive paints. In use, the disc would be cemented to the structure under study and the type of cracking produced in the anodized surface serves as an indication of the strain developed. Another instrument shown, provided for high speed photographs of strain produced as a result of impact on a plastic model. These photographs were produced by a multiple spark and lens fixed film camera technique.

Numerous electrical measuring devices were under development. These included:

1. A bonded strain gage dynanometer and thrust measuring cell.

2. Development of a device for measuring changes in shape of the internal diameter of a hole formed in a structural member.

3. Equipment for measurement of dynamic stress strain behavior of materials.

4. Strain gages of long gage length for use in reinforced concrete.

5. Use of a rectangular ring to develop more uniform strains for tests of strain sensitive elements.

Vibration Test Methods

Vibration studies were being performed under the direction of Mr. Amerdick. In general, such studies are, where possible, performed by setting up symetrical vibrating systems. This reduces the loads transmitted through the testing machine to the foundation. They work close to the resonant frequency of the system and control amplitude by varying the frequency of the exciting oscillation. An electrical contactor is used to measure amplitude of oscillation. They showed me a test stand for study of vibration fatigue failure of high tension electrical cables.

A new instrument in process of development involved an electronic method for direct measurement of the damping coefficient of a vibrating material as a function of stress.

I was impressed with the productivity and energy of this organization, which being in Berlin, must work under considerable difficulty.

CSTB Paris

I visited the Centre Scientifique et Technique du Batiment (CSTB) to review recent progress and discuss technical work with Colonel Fackler.

One thing of special interest involves their work on experimental room fires. The rooms used are built of brick and concrete and are of about 3 x 4 m size. Windows of area equal to one sixth the floor area have been used. These rooms are referred to as LEPIR or Laboratorie Expérimental Pour Incindies Réels. The experiments so far have been performed with bare masonry unpainted interior walls. Mockup furniture is used, and windows are simulated. The latter are removed when the glass first cracks. The studies conducted are designed to explore the effects of furniture material and arrangement on time to flashover. The fires are ignited with 1/2 kg of rag waste and 1/2 l oil. They are extinguished almost immediately after flashover with a water spray using the minimum amount necessary to control and extinguish the fire. About 5 days drying period is allowed between the experimental burn tests.

It was stated that with one typical furniture arrangement, the time to flashover was found to be within 10 percent of 20-1/2 minutes for a group of four identical tests. In performing the tests, it had been found necessary to conduct them as far as possible, in such a manner that winds would not influence the results.

Some concern was expressed about the use of foamed plastics in buildings. Some experiments had been conducted in room burn tests in which polystrene was mounted as the ceiling surface finish and hardboard as a wall finish, and the hardboard ignited. In these tests the polystrene drew back from the heated gas column above the fire and was never ignited. A question was raised about the possibility of electric spark ignition of such foamed insulation.

Two fire tests were run during my visit to the laboratories at Champs sur Marne. One of these was a precast beam and poured concrete floor slab unit with plastered ceiling. The other was a reinforced concrete protected steel column. The floor construction was reported as one of a series typical of current construction techniques. The test was in their new floor furnace. The specimen was supported on two ends and loaded with dead weights. No restraining frame was used and the elaborate hydraulic loading equipment was just set aside. The furnace differs from any other in that the fuel oil is burned in two separate combustion chambers and the hot gasses used to heat the specimen. Automatic control equipment was used to program the time-temperature curve. They have been making good use of this equipment and have performed perhaps 15 - 20 tests in the last year with it. The column test was one of a series in which cover thickness was varied. The column was loaded and performed very well, no visible cracks developed until load failure was approached. The aggregate after test appeared to be of a calcareous type.

I was impressed with the progress being made at CSTB, in spite of the still apparent shortage of technical staff.

Appendix A

Delegates Attending

FOURTH MEETING OF C.I.B./C.T.F., LONDON.

30 MAY TO 1ST JUNE, 1960

AUSTRIA

Oberstadtbaurat Dr. techn. Leopold Rister,
Wiener Staditschen Pruf-und Versuchsanstalt.

CANADA

Mr. G. W. Shorter,
Head of Fire Section, Division of Building Research,
National Research Council.

FRANCE

Colonel J. Fackler (CHAIRMAN OF C.I.B./C.T.F.)
Centre Scientifique et Technique du Batiment.

Monsieur Roland Traverse.

Capitaine Clement (Paris Fire Brigade).

Monsieur Bellisson. (CSTB)

GERMANY

Dr. H. Seekamp,
Bundesanstalt für Materialprüfung,
Berlin-Dahlem.

Dipl. Ing. Bornemann
Institut für Baustoffkunde und Materialprüfung
Technisch Hochschule, Braunschweig.

Dr. Westhoff.

Appendix A (Continued)

HOLLAND

Dr. C. W. van Hoogstraten,
Director of the Institute for Fire Prevention,
(Brandveiligheidsinstituut T.N.O.).

Dr. T. T. Lie,
(Brandveiligheidsinstituut T.N.O.).

Ir. F. J. van Sante,
Stichting Ratiobouw.

ITALY

Dr. Salvatore Cuomo,
Del Centro Studi ed Esperienze dei Servizi Antincendi
Rome.

JAPAN

Mr. Kunio Kawagoe, (at present working at J.F.R.O.)
Building Research Institute,
Ministry of Construction,
Tokyo.

SWEDEN

Lektor P. A. Johannesson,
Swedish State Committee for Building Research,
(Statens Nämnd för Byggnadsforskning).

U.S.A.

Dr. A. F. Robertson
Chief, Fire Protection Section
National Bureau of Standards

Appendix A (Concluded)

U.S.S.R.

Two representatives from:
Academy of Building and Architecture,
Moscow.
(i) Mr. A. F. Milovanov

UNITED KINGDOM

Mr. D. I. Lawson, Director,	Joint Fire Research Organization
Mr. R. G. Silversides, Asst. Director.	
Dr. F. E. T. Kingman.	
Mr. J. F. Fry (SECRETARY TO C.I.B./C.T.F.)	
Mr. L. A. Ashton.	
Mr. G. Langdon-Thomas.	
Mr. H. L. Malhotra.	
Dr. P. H. Thomas	
Mr. R. W. Pickard.	

Interpreters

Mrs. C. Marett
Mrs. N. Taylor

Appendix B

PAPERS REQUIRED FOR C.I.B./C.T.F. MEETING

30TH MAY TO 1ST JUNE, 1960.

SESSION 1

30TH MAY 10.00 - 12.30

<u>Papers submitted for discussion</u>

CIB/CTF 60/18 (UK)	- Report of Preliminary Eight Tests of Co-operative C.I.B. Programme on Models

SESSION 2

30TH MAY 15.00 - 17.30

<u>Papers submitted for discussion</u>

CIB/CTF 60/9 (J)	- An Experimental Fire in a Room with a Large Opening
CIB/CTF 60/10 (UK)	- Studies of Fires in Buildings Using Models. Part I - Experiments in Ignition and Fires in Rooms
CIB/CTF 60/11 (UK)	- Studies of Fires in Buildings Using Models. Part II - Some Theoretical and Practical Considerations
CIB/CTF 60/16 (UK)	- Some General Questions in the Study of Fires in Rooms
CIB/CTF 60/17 (UK)	- Proposals for Next Stage of C.I.B. Programme on Fires in Rooms

Appendix B (Continued)

Other relevant papers

CIB/FRWP 59/22 (UK)	- The Burning of Fires in Rooms: Part I - Small scale tests with cribs and high ventilation
CIB/FRWP 59/25 (UK)	- The Temperature & Duration of Fires: Part II - Analysis of some full scale tests
CIB/CTF 60/4 (UK)	- The Temperature and Duration of Fires: Part I - Some experiments with models with restricted ventilation

SESSION 3

31ST MAY 10.00 - 12.30

Papers submitted for discussion

CIB/FRWP 59/20 (N)	- The Determination of the Fire-Resistance of a Floor, Consisting of Prefabricated Hollow Beams of Reinforced Concrete
CIB/FRWP 59/24 (I)	- Sulla resistenza al fuoco dell strutture e sui relativi metodi di prova
CIB/CTF 60/7 (C)	- Restraint and Temperature Studies on Wall of Clay Brick Exposed to Fire
CIB/CTF 60/8 (J)	- Fire Resistance Test of Pre-stressed Concrete Beam
CIB/CTF 60/19 (UK)	- The Use in Building Codes of the Insulation Requirement of Fire Resistance Tests

Appendix B (Continued)

CIB/CTF 60/20 (UK)	- Deflection as a Criterion of Failure for Beams and Floors
CIB/CTF 60/25 (USA)	- Proposed Criteria for Defining Load Failure of Beams, Floors, and Roof Constructions During Fire Tests
CIB/CTF 60/27 (UK)	- First Programme of Tests on Effect of Restraint on Fire Resistance of Floors
CIB/CTF 60/28 (UK)	- Correlation of Floor Tests
CIB/CTF 60/32 (F)	- Première série de planchers - Résumé des résultats obtenus

<u>Other relevant papers</u>

CIB/FRWP 59/18 (I)	-
CIB/FRWP 59/21 (J)	- Essai de la Résistance au feu de poutre en béton précontraint
CIB/CTF 60/1 (J)	- Les Réctifications et les Explications supplementaires pour le rapport ((Essai de la résistance au feu de poutre en béton précontraint))

SESSION 4

31ST MAY 14.00 - 16.30

<u>Papers submitted for discussion</u>

CIB/CTF 60/21 (UK)	- Repairability of Buildings Damaged by Fire
CIB/CTF 60/22 (UK)	- Fire Requirements for Curtain Walls and Their Behavior in Fires

Appendix B (Continued)

CIB/CTF 60/24 (S)	- Fire Tests with Light, Non-Bearing External Walls
CIB/CTF 60/29 (J)	- Diagnosis of Bearing Power Reinforced Concrete Buildings Damaged

SESSION 5

1ST JUNE 10.00 - 12.30

Papers submitted for discussion

CIB/CTF 60/23 (UK)	- Movement of Smoke and Toxic Gases in Fires in Buildings
CIB/CTF 60/26 (USA)	- Fuel Potential Test Method
CIB/CTF 60/30 (I)	- Sulla resistenza dei pilastri di acciaio alle elevate temperature

SUPPLEMENTARY LIST OF PAPERS REQUIRED FOR

C.I.B/C.T.F. MEETING

30TH MAY to 1ST JUNE, 1960.

SESSION 2

30TH MAY 15.00 - 17.30

Papers submitted for discussion

CIB/CTF 60/34 (N)	- The influence of heat supply dimensions and ventilation on the flashover time in enclosures with internal linings

Appendix B (Continued)

CIB/CTF 60/40 (N)	- Report on studies of Fires Using Models, derived from received C.I.B. papers

SESSION 3

31ST MAY 10.00 - 12.30

Papers submitted for discussion

CIB/CTF 60/33 (N)	- Determination of the equilibrium state of the moisture content of building materials by measuring the electrical resistance
CIB/CTF 60/37 (F)	- Note concernant les echauffements admissibles pour les faces non exposées des éléments
CIB/CTF 60/39 (UK)	- The first programme of tests on effect of restraint on fire resistance of floors Part II
CIB/CTF 60/42 (N)	- Survey of floor tests

SESSION 4

31ST MAY 14.00 - 16.30

Papers submitted for discussion

CIB/CTF 60/35 (F)	- Note sur la prévention du feu dans les immeubles d'habitation en France
CIB/CTF 60/36 (F)	- Arrêté no ... du ... concernant la protection des bâtiments d'habitation contre l'incendie, la sécurité et la sauvegarde des personnes en cas d'incendie. Project - Confidential

Appendix B (Concluded)

CIB/CTF 60/38 (F)	- Les murs-rideaux et le danger d'incendie contribution a l'établissement d'un programme d'essais

SESSION 5

1ST JUNE 10.00 - 12.30

CIB/CTF 60/41 (N)	- Note on some tests about the spread of smoke through a building
CIB/CTF 60/43 (F)	- Note sur les dangers occasionnes en cas d'incendie par les fumées et les gaz brûlants du point de vue de la sécurité humaine

Appendix C

Japanese Organizations Active in Fire Protection Work

	Organization	Sub-organization	Section
Federal	Prime Minister's Office	Fire Defense Headquarters	Fire Research Institute (5)
Federal	Ministry of Construction	Building Research Institute	5th Div. Yokoi Fire Research Section 6
Federal	University of Trade & Indus.	Industrial Laboratory	Fire Research Section (2)
Federal	Ministry of Agriculture	Forest Experimental Institute	Fire Research Section 1
Federal	Ministry of Transportation	Marine Construction	(2)
Federal	Ministry of Transportation	Railroad Institute	
Federal	Tokyo Metropolitan Gov't.	Tokyo Metropolitan Fire Board	Fire Section Kimbara * 3
Federal	Tokyo Metropolitan Gov't.	Material Testing Laboratory	Fire Section * (1)
	Tokyo University	Drs. Kimbara, Hamada, Uchida * , etc.	
	Tokyo Technical University	Dr. Harada	
	Tokaka University	Dr. Fujita *	
	FOC of Japan (Insurance)	Calamity Research Committee	Fire; Wind; Earthquake; Tidal wave; Etc.

*Organizations having fire endurance furnaces.

Encircled number indicates number of technical staff employed.

Committees include:
1. Fire Prevention Soc., Dr. Uchida, Chairman, Dr. Homada, Sec. with about 1000 members.
2. Fire Research Committee, Dr. Kimbara, Chairman, an academic group with perhaps 18 members.

Appendix D

Technical Organization of BAM
With Names of Staff Members Visited

Division 1		Metals & Construction	Dr. Martin
Section 1.1		Metalurgy	
1.2		Structural Properties of Metals	
	1.22	Vibration Test Methods	
1.3		Chemical Properties	
1.4		Corrosion	
Division 2		Non-Metalic Building Materials	
Section 2.1		Mineral Building Materials	
2.2		Concrete	
	2.23	Test Methods	Mr. Jung
2.3		Protection	Dr. Seekamp
	2.31	Fire Protection	Mr. Becker
	2.32	Insulation and Heat Conduction	Mr. Caemerer
	2.33	Acoustics	
2.4		Protection of Wood (Degredation)	
Division 3		Organic Materials	
Section 3.1		Paints and Rubber Plastics	
3.2		Textiles Leather	
3.3		Paper and Cellulose	
3.4		Coal and Petroleum	
Division 4		Technical Gases and Explosives	Dr. Zehr
Section 4.1		Acetylene	
4.2		Other Gases	Dr. Kaesche
4.3		Explosives	
4.4		Thermal Processes	
4.5		Welding	
Division 5		Special Problems	
5.1		Non-Destructive Testing	Dr. Voupel
5.2		Measuring Techniques	Dr. Emschermann
	5.21	Mechanical Methods	Mr. Fencht
	5.22	Electrical Methods	Dr. Rohrbach
5.3		Rheology of Materials	
5.4		Electro-Chemical Problems	
5.5		Color	
Division 0		Administrative Services Library	Mr. Grantz

Appendix E

Publications Received Relating to Fire Research and Acoustics

Fire Endurance

1. Dr. H. Seekamp, and P. Boué, Die Verwendung befongefüllter Stahlstützen mit geschlossenem Querschnitt. (The Use of Concrete-Filled Steel Columns with Closed Cross Section), Der Bau und die Bauindustrie, 6, 4 (1957).

2. Dr. Horst Seekamp, Bandversuche mit stark bewehrten Stahlbetonsäulen, (Fire Tests with Heavy Concrete-Protected Steel Columns), Deutscher Ausschuss für Stahlbeton, 132, 17, (1959).

3. Annon., Die Normung von ein-und Zweiflügligen Türen für Fahrschachtzugänge von Augzügen, (The Standardization of Single and Double Wing Doors Used in Elevator Shaft Entrances), Die Bauwirtschaft, 4, 26 January (1957).

Flammability

1. Dr. H. Seekamp, J. Prüfung von Schutzmitteln zur Erschwerung der Entflammbarkeit des Holzes (Feuerschutzmittel), (Testing of Treatments for Reducing the Flammability of Wood), Handbuch Der Werkstoffprüfung, 99-107, (1957).

2. Franz Zeplichal, Wolfgang Wegener, and Hermann Peters, Entzündlichkeit und Brennbarkeit von organischen Schaumstoffen, (Inflammability and Combustibility of Organic Foam Plastics, Materialprüf, 1, 297-302, (1959).

3. W. Wolgast, Prüfverfahren auf Schwerentflammbarkeit für brennbare Stoffe, (Testing Techniques of Combustible Materials other than Wood Which Have Low Flammability), Zeitschrift Brandschutz, 2, 1-4, (1959).

4. Dr. H. Seekamp, Die Zukunft der Feuerschutzmittel, (The Future of Fire Retardants), VFDB-Zeitschrift - Forschung und Technik im Brandschutz, 4, (1957).

5. Annon., Das Verhalten brennbarer, unbehandelter Wand-und Deckenbekleidungen im Feuer, (The Behavior of Combustible Wall and Ceiling Coverings Exposed to Fire), Bauwelt, 23, (1959).

Appendix E (Continued)

Combustion of Dusts

1. J. Zehr, Die physikalische Kennzeichnung der Staubeigenschaften (The Physical Identification of the Properties of Dust) VDI-Verichte, 19, 19-24, (1957).

2. Dr. B. Kaesche-Krischer, Untersuchungen an vorgemischten, laminaren Staub/Luft-Flammen), (Investigation of pre-mixed laminar dust and air flames), Staub 19, 200-203, (1959).

3. H. Selle, Die chemischen und physikalischen Grundlagen der Verbrennungsvorgange von Staüben, (The Chemical and Physical Principles of the Combustion Processes of Dust), VDI-Berichte 19, 25-36, (1957).

4. H. Selle, Die Grundzüge der Experimentalverfahren zur Beurteilung brennbarer Industriestäube, (Principle of the Experimental Processes Used in the Evaluation of Combustible Dusts), VDI-Berichte 19, 37-48, (1957).

5. H. Selle, and J. Zehr, Experimentaluntersuchungen von Staubverbrennungsvorgängen und ihre Betrachtung vom reaktionsthermodynamischen Standpunkt, (Experimental Investigation of Dust Combustion Processes from the Viewpoint of Thermodynamic Aspects of Reactions), VDI-Berichte 19, 73-87, (1957).

6. J. Zehr, Untersuchungen über die Verbrennungsintensität von Holzstaub/Luft-Gemischen bei variierendem Sauerstoffgehalt der Luft), (Investigation of the Combustion Intensity of Wood Dust and Air Mixtures with Varying Oxygen Content), Staub 18 (1958).

7. J. Zehr, Explosive Eigenschaften von Staub/Luft-Gemischen, (Explosive Properties of Dust and Air Mixtures), VFDB-Zeitschrift - Forschung und Technik im Brandschutz - 3, (1957).

Appendix E (Concluded)

Gas Explosives

1. J. Zehr, Anleitung zu den Berechnungen über die Zündgrenzwerte und die maximalen Explosionsdrücke, (Guide to the Computation of Ignition Limit Values and of Maximum Explosion Pressures), VDI-Berichte, 19, 63-68, (1957).

2. Von Hermann Selle, Deflagrations-und Detonationserscheinungen beim Zerfall von Methylnitrit, (Deflagration and Detonation Phenomena in the Decomposition of Methylnitrite), Zeitschrift Für Elektrochemie, 61, No. 5, 672-678, (1957).

Acoustics

1. Dr. Th. Kristen, and Dr. H. W. Müller, Schallabstrahlung von Bauteilen bei erhöhter Druckbelastung, (Sound Reflection of Building Components at Elevated Acoustic Pressures), Die Schalltechnik, 24, 1-4, (1957).

2. H. Neumann, Zur Frage der Trittschalldammung, der Wärmedämmung und des Feuerschutzes bei Asphalt-Fuβbodenbelägen im Hochbau, (On Impact Alternation and Fire Protection of Asphalt Floor Coverings Used in Building Construction), Zeitschrift - Bitumen, 5, 1-6, (1953).

3. R. Palazy, Verbesserung des Trittschallschutzes durch Schwimmende Estriche bei ein-und zweischaligne Deckenkonstruktionen, (Improvement of Impact Sound Protection by Means of Floating Coverings Used in Single or Double Shell Roofing Design), Parkett, 6, 75-78 (1958).

4. Dr. Th. Kristen, and R. Palazy, Schallschutz von Wohnungstrennwänden aus Kalksandsteinen, (Sandproffing of Dividing Walls Made of Sand-Lime Bricks), Baupraxis, 5, 197-202, (1958).

USCOMM-NBS-DC

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer. Concreting Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

- Office of Basic Instrumentation.
- Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Research. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation Obstacles Engineering. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Ultra High Frequency and Super High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.

NBS