NATIONAL BUREAU OF STANDARDS REPORT

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VISIT TO EUROPEAN FIRE RESEARCH LABORATORIES
MARCH 1970

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Measurement Services and the following technical divisions:

Applied Mathematics—Electricity—Metrology—Mechanics—Heat—Atomic and Molecular Physics—Radio Physics [2]—Radio Engineering [2]—Time and Frequency [2]—Astrophysics [2]—Cryogenics.[2]

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; develops, produces, and distributes standard reference materials; relates the physical and chemical properties of materials to their behavior and their interaction with their environments; and provides advisory and research services to other Government agencies. The Institute consists of an Office of Standard Reference Materials and the following divisions:

Analytical Chemistry—Polymers—Metallurgy—Inorganic Materials—Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations in the development of technological standards, and test methodologies; and provides advisory and research services for Federal, state, and local government agencies. The Institute consists of the following technical divisions and offices:

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THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center consists of the following divisions:

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THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System, and provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data—Clearinghouse for Federal Scientific and Technical Information [3]—Office of Technical Information and Publications—Library—Office of Public Information—Office of International Relations.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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VISIT TO EUROPEAN FIRE RESEARCH LABORATORIES MARCH 1970

by

I. A. Benjamin

U.S. DEPARTMENT OF COMMERCE

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1.0 GHENT

Prof. Herpol and Mr. Minne were hosts at their new facilities--in what was an old powerhouse building. All test facilities are propane gas fired.

1.1 Wall Furnace

This furnace has the burners programmed for the ISO curve. The propane burners use forced air with about a 2:1 ratio. Four burners are located on each side and fire against a baffle so that the specimen does not see the flames. The specimen can be loaded; and is about 2 m wide. Temperature is measured with an ISO pad and disc. The pad and disc are adhesively attached to the sample face with silicate. After the test the thermocouple disc is cleaned up and reused. Also a roving thermocouple on a long pole is used.

1.2 Floor Furnace

Approximately 2 x 6 m sample. Maintains 2 mm positive pressure at a distance of 100 mm below the roof. The exhaust is a down draft under floor into the old powerhouse chimney. The pressure in furnace is regulated by having a large compressor force cold air into the exhaust stack (blower capacity of 1500 m^3 at 500 mm press). No loading equipment at present but waiting for it to arrive.

1.3 EEC Project

Work on fire loading is being sponsored by EEC. Belgium is studying the rate of heat release of combustibles in filing cabinets. The tests are being conducted in a specially built 3 x 4 x 3 m high room. Four propane burners in the back wall of the room are used to follow the time-temperature curve. The exhaust is designed to maintain the room at zero pressure. The whole floor is supported on load cells; therefore the need to keep the room at zero pressure. The program has just started. In the first test a filing cabinet stacked with magazines with the doors open was used. In the next, the same fire load and cabinet were used but the doors were kept closed. Both the decrease in fuel input needed to maintain the curve and the weight loss from the load cells are being measured. Also, the O_2 content is being monitored and maintained at a given minimum value.

1.4 ISO Furnace

The furnace is in a circular steel shell. The bottom cone snaps into place with keyhole slots. The bottom is closed so that the only air entering passes over the cone, coming in at the level of the top of the cone. A 5 mm draft shield is on top and contains lugs to position the thermocouple. The sample holder is guided on both sides, 180° apart, and is on an oil dashpot. The holder is made of a bottom screen and two right angle portals of wire. Windings are of helical wire set in grooves in the tube and are evenly spaced. The tube is divided into four equal lengths. There are 5 turns in the two outside lengths and 10 in the two middle lengths. Windings are controlled by 3 separate auto-transformers.

1.5 Concrete Box

A small concrete box--about 1.5 m cube--was mounted off the floor. They are planning to light fires inside and have a window on the top side, to study pressures from fire and window breakage--no more definite information.

1.6 Miscellaneous

The British spread of flame test, BS 476, and the French box are also being used.

2.0 CITCM FURNACE AT METZ

2.1

This furnace, the largest of its kind has been jointly financed, 75% by the European Steel Industry and 25% by the European Steel Fabricators. Mr. Wahl; general director for CITCM, and administratively in charge of the operation travelled to Metz with me to visit the furnaces. They are located on the property of IRSID, the French steel industry research group. Mr. Arnault is in operational charge of the research program.

2.2

The furnace is 6 x 8 x 3 m high and has provision to expand to 6 m high at a later date. The furnace is fired by 6 oil burners at each end and 4 supplemental ones in the floor. Each burner is individually controlled from a master panel in the control room. The furnace can reach 1200 °C in 30 minutes and operate at 1.25 times the standard ISO time--temperature curve. The jacking system has 6 - 150 Ton, 200 mm extension jacks--in two outside rows; and 6 - 30 Ton, 800 mm extension jacks--two in each of three rows and in between the larger jacks in the

outside rows. The wall is of refractory brick, foam glass, and regular brick on the outside. The temperature controls for the furnace to follow the ISO or any other predetermined curve are located 10 cm from the specimen in several locations--probably giving a more severe fire than that obtained by controlling the temperature at the ceiling level. The furnace operates at 2 to 3 mm negative press, measured about 1 m from top of furnace. The manufacturer, a German company, claimed they could not give good control with positive pressure.

2.3

The projected program for this furnace is:

1. Study of the effect of continuity on beams with various end conditions at the outside supports. Possibly including some end restraint--though the furnace is not well adapted to handle this.

2. Study of portal frames.

3. Effect of composite construction.

4. Study of water controlled columns--maybe.

2.4

Both here and at CSTB there were a number of samples awaiting test which had been coated with intumescent paint. The paint is named Unithern, made by Spies, Hecher & Co. of Koln-Raderthal. The tests were generally designed for fire resistance in the 30 min. range.

2.5

Several studies have been run in their smaller furnace on burning 30 and 60 kg/m^2 wood fire loads with various window openings. In this work they have studied the effect of the fire on various weights of unprotected beams. The data showed a range for temperature failure from 10 to 21 minutes, depending on the beam size. They are also thinking of running the large furnace to duplicate the temperatures of some of the wood burnout tests.

3.0 POLICE LABORATORY--PARIS PREFECTURE OF POLICE

This laboratory does everything from routine analysis for the police to bomb and arson investigation and studies on air pollution. They are also active in fire research, in the areas of flame spread and smoke generation. Mr. Forrestier was our host, along with Mr. Callisti, one of his assistants.

3.1

The laboratory claims that by taking samples of concrete or carpeting from a fire they can test by gas chromatography if liquid fuel on the floor was present in the fire.

3.2

They have an XP-2 box which they have been using for smoke studies. They have modified it to have an opening about 3 to 4 cm high on the side and are planning to use a radiator in it to replace the burner.

3.3

They have built a prototype box--about 1/3 larger than the SDC. They hold a sample--about 15 cm cube--in a set of clamps and use 3 radiators (from 3 sides) to conduct a non-burning smoke test. They have a light and photocell as in the SDC. They also can sample gas.

3.4

They use the standard French flame of spread test--using the box.

Note: The same radiator is used in 3.2, 3.3, and 3.4; and is the one from the French standard flame of spread test--operated at 500 watt.

4.0 CSTB

Col. Cabret and his assistant, Mr. Bellisson, were my hosts for this trip to their laboratory outside Paris.

4.1

Their smoke test building is of greatest interest. It contains a burnout room, corridor and a tower seven stories in height. The corridor is level with ports for remote TV observation. The corridor, tower and burnout room all have dampers which can be remote controlled during the test. They can pressurize or exhaust any area during a test; or use natural venting. They are talking in terms of keeping the bottom 2/3 of the corridor smoke free for evacuation by means of exhausting the smoke and bringing in fresh air. This tower is part of a larger building in which they are also conducting high-rise plumbing studies.

4.2

They have developed a test for studying the fire hazard properties of cable insulation, following some fires in which bunched cables contributed significantly. About a 2 m length of cable is held vertically and a tube similar to the ISO tube is brought up around the cable.

There is a chimney on top of the tube with a slot in front with markers along the slot. The length that the flames travel up the chimney from the cable in the furnace is a measure of the cable insulation fire hazard.

4.3

They are experimenting with some new fabric tests. Their existing one has the fabric impaled on about an 8" x 10" frame, which is vertical, and an alcohol burner set underneath. The burnt area is measured for evaluation. The new test--in experimental stage--uses a similar fabric sample on a 45° slope and has an electric heater applied under the lower end.

4.4

They are using their own roof test. An inclined panel of about 3 m length is swept by 10 km/hour air. The surface is irradiated at the low end with 0.3 w/cm^2 and a 19 g burning brand is placed on the roof. They give two ratings--one an index for flame spread up the roof; and second a rating for time of resistance to burn through the brand.

4.5

An interesting study of flashover is being conducted simultaneously in full scale rooms and boxes 1/3 the room size. This study is directed to the study of the effect of ceiling linings and wall finishes on room flashover. The box is about 0.85 x 1 x 1.30 m and the room 3 times this size. In the box, cribs are being used to simulate furniture and cupboards. In the full scale a rough wood table, chairs and cabinet are being used. I watched a box test which had incombustible walls but a fiberboard ceiling. The fire grew in the corner crib till it hit the ceiling, spread across the ceiling and finally set the remaining cribs on fire from the roof town. According to their tests flashover seems to consistently occur about 800 °C.

4.6

The French have developed a new test for curtain walls since they have been getting plastic facades. They have built a 2-story high building about 3 m deep x 6 m height with a concrete floor separating the two stories. They put a full 2-story curtain wall in place and load the first floor with wood cribs to 50 kg/m^2 for fire load. They evaluate the construction based on flame travel on the outside wall and passage of fire to the floor above--one critical area being the junction between the floor and the curtain wall. They have run several tests and have reported some of these in the CIB symposium on "lightweight curtain walls".

4.7 Miscellaneous

CSTB philosophy, which I heard repeated later at TNO is that one test is not enough to judge material properties--either because not all materials will fit the one test; or because sometimes two different properties are important.

5.0 TNO

Dr. Van Elteren and Mr. Zorgman were my hosts for the visit to the laboratory which is outside of Delft.

5.1

The Dutch use a different box from the French for flame spread. One which is more of a heat release test. They use it in conjunction with the BS 476 Flame Spread Test since they feel that different properties are being measured and both are important. Samples are put into both sides of the box which has a radiant coil in the middle. One side is subject to ignition and the time to flashover is measured. By varying the radiant energy they get a curve of flashover time versus radiant energy level. A class "A" material will not flash in 15 minutes @ 0.4 cal/cm^2 sec. They have 4 classes of materials. Dr. Lie, when he was at the station, correlated this test with studies in a box which had a fire load of 20 kg/m^2 and set the criteria from the box test. (As an interesting note, they had a fire in an elevator shaft lined with Galbestos which has a flame spread of <25 in ASTM E84, does well in the BS 476 test but poorly in their box--justifying their use of two separate criteria).

5.2

They have built a fire box of about 1-1/2 x 1-1/2 x 2 m high in which they study steel frame models in fire. The model I saw was a two-way portal frame, unprotected, of uniform 1/8" x 1/4" bar stock, which had been subject to load and fire.

5.3

All the furnaces are gas fired. They have:

- A 2 x 4 m floor deck, in which they were running a marine deck test, fire with two rows of burners
- A 2 x 3-1/2 m vertical furnace, fired from each side
- A 1-1/2 x 8 m beam furnace, recently extended, with 4 burners on one side and 5 burners on the other. They are studying prestressed beams.

5.4

They have done some work on corridor ceilings but did not get good results so they are going to repeat. Are using a room with 20 kg/m^2 floor load opening onto a 10 m long corridor with asbestos cement walls with a small built-in opening from the room to the corridor. In their tests the ceiling charred but did not flash.

5.5

They have been running corner tests to study flame spread on walls. With a sample 1.2 x 7.0 m high they use either one for a wall test or two for a corner test. They measure the height of fire spread up the wall from the crib. Either one or three cribs is used. The cribs are 10 x 10 x 20 cm, with 1 x 2 cm sticks, with about 4 cm gap.

5.6

They set up a study for the TNO ship research center on detectors in machinery spaces. Both the Cerebus type and a local made ion detector have been installed in a working freighter. They ran several test fires in the ship to check out the equipment. The detectors are on board the ship, have not given a problem of false alarms, and are being checked each time the ship comes into port.

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