NATIONAL BUREAU OF STANDARDS REPORT

10 338

9TH MEETING OF C.I.B. COMMISSION W.14
PARIS, FRANCE
AND
VISIT TO FIRE RESEARCH STATION
BOREHAM WOOD, ENGLAND

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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ABSTRACT

A Summary is presented of the proceedings at the 9th meeting of the Working Group on Fire of the Conseil International du Batiment (CIB/CTF) held at the Centre Scientifique et Technique du Batiment, Paris, 1 to 5 June 1970. The activities and progress of working groups on Fire Endurance, Smoke and Gases, and Fires in Single Compartments are reported.

Also included is a summary of discussions with several members of the British Fire Research Station, on topics of particular interest to the current work of the Fire Research Section, NBS.

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1. GENERAL INFORMATION

The previous (8th) meeting of CIB Commission W.14 - Working Group on Fire - met two years earlier in Boreham Wood, England, and details of that meeting are given in NBS Report No. 9953. The 9th meeting was convened on 1 June 1970 at the offices of the Centre Scientifique et Technique du Batiment (CSTB), the French counterpart to the Building Research Division, NBS.

Representatives of 13 countries participated at the meeting. A list of delegates is included as Appendix A, and the program arranged as Appendix B. Since the previous meeting, a total of 87 technical papers and reports were circulated to the delegates (See Appendix C).

The formal meeting started with a welcome from our hosts, Mr. Blachère, President of CSTB and President of CIB, and Col. A. Cabret, Chief of the Fire Section of CSTB, who had arranged a get-together cocktail for delegates the previous evening.

Mr. Blachere noted that the duties of CIB were in performing research and exchanging information, whereas I.S.O. was responsible for developing standards and standard test methods. He emphasized the importance of cooperation in fire studies, and noted that a Liaison Committee - consisting of (7 or 8) International Civil Engineering representatives - is undertaking the sponsorship of a Colloquium on Fire Control and Safety in Structures. To prepare for this colloquium, a limited number of representatives of C.I.B. and the Liaison Committee, will meet at CSTB at the end of June.

Col. Cabret was elected Chairman of Commission W.14 and presided during the week's meeting. After acceptance of the official report of the 8th Meeting, three discussion groups were formed. As in previous meetings, delegates were free to join one of the three following groups to discuss progress:

Group 1 - Fire Endurance

Group 2 - Spread of Smoke and Toxic Gases

Group 3 - Fires in Single Compartments

Informal discussions within groups continued through the day and a short report was presented to the reassembled delegates the next morning. The following information is based upon notes by the authors taken during the Group discussions and the summary report as presented by the Secretaries of the three groups: Group 1 - Mr. Malhotra, Fire Research Station; Group 2 - Mr. Tourette, CSTB; Group 3 - Dr. Thomas, Fire Research Station.

2. REPORT OF GROUPS

2.1 Group 1 - Fire Endurance

There were three main topics covered in the discussions of Group 1:

A. Correlation of Furnaces

Report No. 70/6 (D) "Correlation Tests on Furnaces for Separating Elements", was discussed by the German delegate. The data presented in this report was apparently derived from the same tests described in preliminary fashion at the last meeting of Commission W.14 about 18 months earlier. There was a wide scatter of data from the six furnaces (four fuel oil, one coal gas, one propane). Where the same type instrument (made by a single laboratory) was used, the variability among laboratories ranged in one case from 58 to 81 minutes; and in another case from 62 to >90 minutes. Due to lack of correlation, a more refined approach was proposed.

Dr. van Keulen of the TNO heat transfer laboratory had been consulted on the problem and proposed a refractory plate heat flow meter which was intended to measure total, and total less the radiative component of flux. The use of this device was proposed in a second document passed out at the meeting. It was proposed that heat meters of this design be used for another interlaboratory comparison of wall panel furnaces.

Preliminary tests at TNO with this device have proved promising. The design of the panel will be available in about six months and manufactured for use by other laboratories. Cost approximately £ 100 to £ 150 ($240 to $360) but may be less. Panel is 20 mm thick and consists of Silmanite porcelain refractory with one surface half coated with gold, the remainder being uncoated (grey). Thermocouples will be located in holes drilled in the panel located at its center and on both surfaces. Each participating laboratory will obtain an identical instrument from TNO. Mr. Witteveen plans to prepare detailed test procedures and instructions. This exercise may result in correction factors to be applied to certain furnaces, and in a more detailed test specification.

Mr. Bellisson stated that additional information was needed on the conductivity and volumetric heat capacity of the panel. Also, on the distribution of heat on the exposed surface (i.e. uniformity of the thermal conditions).

Mr. Bellisson suggested consideration of his water cooled heat flux meter. He pointed out that this could be located in various parts of a wall panel. There was objection to this on the grounds that it was too complex for the usual laboratory technician. It also failed to provide means for defining the radiative component of the flux and since it was essentially a fixed temperature device it did not come close to simulating the behavior of a typical fire test specimen. This criticism seemed unduly harsh but was the basis for its rejection for the proposed study.

We pointed out that the proposed study was likely to lead to further evidence of real differences of exposure severity between furnaces and provide little evidence of ways in which furnace design could be modified to achieve more uniform results. We suggested that it would be preferable before proceeding further if one laboratory could perform a study with a small scale furnace designed for operation under a wide variety of furnace characteristics. Such studies were encouraged by the group although not at the expense of delaying further comparison studies. It was suggested that the various labs furnish Dr. van Keulen with information on the data collected through use of such small furnaces so that he could include it in his analysis. It was suggested that such information should include fuel, refractory thermal characteristics and dimensions, furnace dimensions, exhaust connection, number of tests and experimental data. This proposal was not mentioned in the final report of the group. We indicated an interest in participating in the studies proposed.

During discussion of this work with the group as a whole Dr. Thomas suggested that furnace sensitivity be measured by performing tests at various exposure levels, say 10% above and 10% below standard conditions, and measuring the difference in fire endurance. This should help to provide a basis for relating fire performance in one laboratory to that observed in another. Col. Cabret noted that total agreement between different furnaces could not be expected. Prof. Herpol pointed out that since the performance of structures was different in different furnaces, then the test criteria (temperature-time curve) must be inadequate. Mr. Bellisson noted that it was possible to vary the air/fuel ratio (e.g. 10% excess air or 60% excess air) and thus affect the partition of convection vs radiation energy (even with the same temperature-time history). Mr. Malhotra listed the important factors as geometry of furnace, flue arrangement, flames (luminous or non luminous), location of thermocouples, nature of specimen.

Belgium and Sweden agreed to join in the test program bringing the total to 11 or 12 countries.

B. Analysis of Fire Endurance

Little time was available for detailed discussion of this subject. This together with the fact that neither Mr. Keough nor Gordon Shorter were present to discuss the papers prevented effective discussion of the following documents:

70/15 (Canada) "Elevated-Temperature Tensile and Creep Properties of Some Structual and Prestressing Steels"

69/20 (Australia) "Steel Properties for Fire Resistance"

69/21 (Australia) "Prediction of a Creep Equation of State from Isothermal Tests"

It was generally agreed that work directed towards analytic prediction of fire behavior of structures should be the ultimate objective and any work usefully directed toward this end would be most desirable.

During discussion of this topic in the full session a proposal was made by UK that Commission W.14 might wish to sponsor a symposium on the subject of fire endurance predictive methods. We supported this proposal but the Chairman apparently was not cooperative and the matter was allowed to drop.

C. Effect of Specimen Age

Document 70/25 (UK) was discussed by Mr. Malhotra. It seems that the British had run fire endurance tests on reinforced concrete columns which had aged for 9 months. These showed fire endurance of 55 minutes with no appearance of spalling. Similar specimens, but with somewhat less cover for the steel, showed severe spalling when tested after 5 years of indoor storage. The fire endurance of these was just over 20 minutes. These latter specimens had been stored in a horizontal position and there was evidence of fine cracks on their surface. The reason for the large difference in behavior was not clear. The British would appreciate advice or suggestions. They plan to conduct further study on the subject.

2.2 Group 2 - Smoke and Gases

This group reviewed and discussed several papers dealing with smoke and gases.

CIB/CTF 69/18 (UK); FR Note 769 - "A Study and Toxic Evaluation of the Products from the Thermal Decomposition of PVC in Air and Nitrogen".

Products of Decomposition were measured as a function of temperature (constant furnace temperature). Products were cooled to -160°C then heated and supplied to a gas chromatograph and mass spectrometer. During the early stages (<5 min), HCl is given off when PVC decomposes in air or N_2. Weight loss is rapid at start, then negligible after ~5 min. Over 75 products were identified, the same ones in air and in N_2. At an elevated temperature (450°C), there are fewer products, indicating the oxidation of some initial products. At 300°C the hydrocarbon component consists almost entirely of benzene; at higher temperatures, aromatics. A toxicity factor based on 1g in 1m^3 was used (described by Sumi). The most toxic gas is HCl.

Mr. Tourette noted that above 100 ppm, it is impossible to breathe HCl. Below 100 ppm, irritation was the more important factor (compared to obscuration).

Mr. Becker indicated that animal experiments are the only way to evaluate toxicity since the cumulative effect is important. Experiments were conducted with rats exposed for 1/2 hour. See CIB/CTF 68/44 (D), a German report on toxicity previously distributed. English translation may be available in about one month. See also Fire International Vol. 3. Also Modern Plastics, Oct. 1969, p. 94.

Mr. Bowes pointed out that information on the effects of irritation on human subjects was available in a paper by Shern, ASTM STP422. In U.K. teams of individuals are exposed to low concentrations of irritants (auto exhaust fumes), but not to combustion gases, to examine the subjective effect. Blink rate of the eyes is used as a measure of irritant level.

Mr. Tourette noted, from FR Note 776 that any phosgene produced decomposes rapidly and is very difficult to detect and measure.

A discussion of the gas measurements in BSS 18 followed, particularly in reference to use and accuracy of Draeger tubes. Mr. Gross suggested the need to check calibration of colorimetric tubes to establish the precision of a particular batch.

Mr. Bowes stated that in his studies, colorimetric tubes were used for CO but their accuracy was not checked.

Mr. Yuill noted that in fatal U.S.A. airplane accidents dense smoke prevented occupants from reaching exits; in buildings, smoke blocking of exits is also considered important. He pointed out that we have no direct medical evidence of effect of smoke on lungs, although there is a feeling that lung blockage may be due to the absorption of gases on smoke particles.

Dr. Robertson remarked that limited visibility resulting from smoke density may not matter if irritation prevents a person from opening his eyes.

Col. Cabret concluded that different aspects of smoke are being studied in almost all countries: Visibility, Irritancy, Corrosiveness. We must try to dissociate the different effects and study each separately.

Mr. Lawson emphasized the need for medical data from autopsies to determine whether visibility or toxicity is indeed the more important. In Great Britain, J.F.R.O. has no power to determine the cause of death in fire (this is a function of coroners appointed by Home Office). He said that a CIB recommendation could be useful in indicating the importance of this aspect to the Home Office.

A statement was formulated to the effect that C.I.B. Comm W.14 noted the lack of information on cause of death generally attributable to "smoke". It was resolved that member countries should request further information from their Governments, and that CIB W.14 would draw up a questionaire to assist in determing the actual cause of death in cases involving smoke inhalation and asphyxiation.

2.3 Group 3 - Fires in Single Compartments

With regard to the cooperative tests from the first phase (Fully-Developed Fires), Thomas and Heselden have prepared a report (Internal Note No. 374) on the more than 300 experiments performed by nine laboratories. The actual distribution of test conditions is given in Table 1 (based on FR Note 319). The Thomas and Heselden report will serve as the first draft of a proposed CIB paper. The report includes a statistical (multiple regression) analysis of the data, some conclusions on the effects of the variables, and suggestions for the presentation of the results. The complete data have been made available to NBS and TNO on punched paper tape. Comments on the report are requested by the end of the year.

Some of the main conclusions of the report were:

(1) Data separation was necessary for the 1/4 open vs full open ventilation conditions, although in some cases the data could be combined.

(2) Effect of stick thickness was very small and could be neglected.

(3) Effect of scale was generally small provided the proper parameters were chosen for scale factors (e.g. floor area, or preferably ratio of total surface area/window area).

(4) Effect of fire load was confounded possibly by the obstruction of air supply by the crib in the 1/4 open compartments.

(5) Effect of Compartment Wall material - doubling the thermal conductance, decreased the rate of burning by 17%.

(6) The parameter $\frac{R}{A_w \sqrt{H}}$ is not a constant of approx. 6 kg/min $m^{5/2}$ as generally considered for ventilation - limited burning, but probably comes about because previous results were based on tests in which the parameter $\frac{A_t}{A_w \sqrt{H}} > 20\ m^{-1/2}$.

The parameters chosen by Thomas and Heselden for their data presentation - which are both empirical and based on a "heat balance theory" model - include a mixture of dependent and independent variables. We believe that presentations based on a separation of dependent and independent variables would be more meaningful, even if "universal" correlation are not possible.

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Table 1

Summary of Tests Performed in C.I.B. Cooperative Program

First Phase - Fully Developed Fires

Fuel Load	Fuel Thickness	Fuel Spacing	121									211									221									441								
		Scale	1/2			1			1 1/2			1/2			1			1 1/2			1/2			1			1 1/2			1/2			1			1 1/2		
		Ventilation	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1	1/4	1/2	1
		1/3																																				
	1	1																																				
		3	1	1	1	1		1				1	1	1	1		1	1		1	1	1	1	1		1												
		1/3	1	1	1	1		-				1	1	1	1		1	1		1	1	1	1	1		1												
20	2	1	1	1	1	10	1	10				2	2	2	12	1	12	1		1	2	2	2	9	1	9				1	1	2				1	1	1
		3	1	1	1	1		1				1	1	1	1		1	1		1	1	1	1	1		1												
		1/3																																				
	4	1	1	1	1	1		1				1	1	1	1		1	1		1	1	1	1	1		1												
		3																																				
		1/3																																				
	1	1																																				
		3				1		1									1	1		1				1		1												
		1/3				1		1							1		1	1		1				1		1												
30	2	1				2	1	2							3	1	3	1		1				3	1	3				1	1	1				1		1
		3				1		1										1		1				1		1												
		1/3																																				
	4	1				1		1							1		1	1		1				1		1												
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40	2	1				10	1	10							11	2	12	1		1				8	1	9										1	1	1
		3				1		1								2	1	1		1				1		1												
		1/3																																				
	4	1				1		1							1		1	1		1				1		1												
		3																																				

Thomas recommended the establishment of a CIB study group to evaluate the results and conclusions in terms suitable for the design and application to real structures. (e.g. actual walls are thermally different and are thicker than the 1 cm thick asbestos used in the model compartments; this would have a considerable effect upon heat transmission and fire endurance). There was some concern that different regulations could evolve from different countries if the same data were analyzed separately. However, the time required for a study group to evaluate the results would delay the report for a considerable period. These are partial notes of the extended discussion which followed:

With regard to the proper procedure for preparing a C.I.B. publication, Mr. Fry agreed to contact the CIB Secretary-General and the Governing Board. Mr. Witteveen pointed out the need to establish the link between real fires and I.S.O. furnace tests, and urged that maximum use be made of the model test results and of analysis along the lines suggested by Miss Law. Mr. Van Elteren felt that the application to design should continue as a cooperative effort. However, Mr. Lawson cautioned that care should be excercised so as not to extend into the administrative area, and this was endorsed by Col. Cabret.

There was no general agreement on the formation of a Study Group and several delegations felt that it might be better to forward the data report to the appropriate fire authorities in their respective countries, where individual judgements could be made on the application of the results to design, to codes and to regulations.

With regard to the cooperative tests from the second phase (Growth to "Flashover"), there are eight participating laboratories, and seven sets of summary data have been submitted. Based upon a partial analysis of four sets of data only, and which may be modified later, the following conclusions were noted with regard to the time for flames to cover the tops of all cribs (See Internal Note 375):

(1) the stick spacing, the fuel height and the location of the ignition source had the largest effects

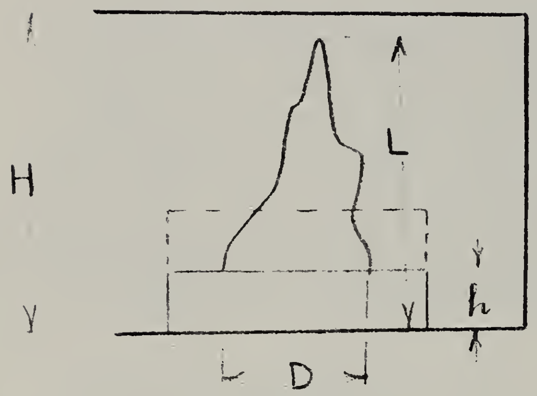
(2) the lining (combustible vs noncombustible) had a relatively small effect (18%)

(3) the shape of the compartment (in relation to the window) had a negligible effect

(4) the effect of scale (based on FML data on two meter scale) could be rationalized in terms of flame properties and the heights of the fuel and of the box. Scaling correlation is satisfactory in early stages where flames are small or only reach ceiling; and in later stage, provided there is no combustible wall lining, $t_3 \propto \frac{H^{3/2}}{h}$. It is unsatisfactory

in later stage where combustible wall lining is present. Here, t_3 may vary as $\left(\frac{H^{3/2}}{h}\right)^{1/2}$. (H = box height, h = fuel height).

(5) there were a number of significant interactions.



$$\frac{L}{D} \propto \left(\frac{R^2}{D^5}\right)^{1/3}$$

$$t_f \propto \frac{H^{3/2}}{h}$$

No additional research was recommended until all the data could be analyzed, sometime later this year.

3. DISCUSSION OF SELECTED PAPERS

Paper No. 69/6 (UK) "The Assessment of Smoke Production by Building Materials in Fires. 2. Test Method Based on Smoke Accumulation in a Compartment", FR Note 749, was presented by Mr. Bowes. He stated that the basic considerations were: (1) Smoke was cool and well-mixed, situated at a considerable distance from the fire source. (2) Simple measurement of optical density. (3) Range of exposure conditions - Flaming & Smoldering. Using the JFRO Fire Propagation Test (9 in square specimen) located in a large room, $\frac{V}{A}$ is eight times greater than for the NBS chamber. There was reasonable agreement with NBS results on wood fiber board and the scaling effect was reasonably well established. Realistic values of "visibility" resulted, ranging from 1 meter for glass-reinforced polyester to 17 meters. Repeatability was satisfactory on the order of ± 20% in six tests.

Paper No. 70/7 (USA) "Hazards of Smoke and Toxic Gases Produced in Urban Fires" was presented by Mr. Yuill, Southwest Research Institute.

Paper No. 70/26 (CA) "Smoke Produced by Burning Materials in Oxygen-Deficient Atmospheres" was presented by Mr. Keough. This work was prompted by Kawagoe's presentation on the "Smoke Load" concept at the previous meeting. The effect of specimen orientation when exposed to 3.5 w/cm^2 radiation and electric pilot ("typical fire condition") and reduced oxygen concentrations was studied. Mr. Keough stated that the smoke load concept will be very difficult to apply since the quantity of smoke produced varies considerably and is hard to measure. The values of specific optical density (at 21% O_2) for some materials were in the thousands, a point which needs to be resolved. There apparently is no data on D_s vs time from these tests, but there is a relation between O_2 content and critical radiation intensity for ignition. Privately, NBS agreed to send its smoke round robin materials to Keough (Australia) and Zorgman (TNO) for data comparison.

Paper No. 70/34 (USA) "Generation of Lethal Environments in Building Fires" was presented by Mr. Friedman. This is the first progress report on work sponsored by the Environmental Control Administration,HEW. Initial work has been done on study of combustion products from liquid pool fires in enclosures with varying ventilation openings.

Paper No. 70/20 (USA) "Fire Test of an Exterior Exposed Steel Spandrel Girder" by L. G. Seigel was presented by Dr. Robertson. Col. Cabret remarked that heat flow into compartments adjacent to the burning room was also important. Dr. Thomas noted that the size of flames leaving a burning compartment depends on the type and distribution of fuel. In tests at J.F.R.O.,7 psf in the form of wood cribs produced no external flames, whereas the same quantity of fuel as fiberboard wall linings produced considerable exterior flaming. Mr. Keough stated that the paper did not take into account (1) prevailing winds, or (2) variation in the length of the flame shield. Depending on the design of the flame shield, vortex air patterns could cause flames to impinge closer rather than further away from the building.

Paper No. 70/19 (USA) "Design of Liquid-Filled Structural Members for Fire Resistance" by L. G. Seigel was presented by Dr. Robertson. Col. Cabret noted that in three or more buildings in Europe (two in France, one in German), water-filled columns are used. More buildings are under construction (Rouen, Marsaille). He considers the technique unsuitable for horizontal members (beams) due to possible steam accumulation. Mr. Yuill stated that there are six buildings between six and 60 stories in height, now under construction in the U.S. with water-filled columns. Mr. Lawson noted the possibility of columns being drained, in the same way that sprinkler systems are sometimes drained, by error or accident, and not re-filled after service. This differs from fixed (i.e. solid) insulation which can be expected to remain. Mr. Malhotra stated that to be effective, water circulation must be maintained. Based on JFRO tests, it appears that the accumulation of steam, with insufficient outlet area, could cause excessive heating and ultimate collapse. Mr. Keough remarked that tests were carried out in 1968 in Australia on three cylindrical columns. To prevent development of steam pockets, he stated that it was important to top feed, rather than bottom feed.

Paper No. 70/24 (UK) F. R. Memo No. 2 "Criteria of Failure in Fire Resistance Tests" was presented by Mr. Malhotra. He noted the distinction to be drawn between stability and integrity for the three usual types of structural elements:

(1) Load-bearing; nonseparating

(2) Load-bearing; separating

(3) Non load-bearing; separating

Mr. Becker stated that Germany uses a single stability criterion for non load-bearing walls; after test, a two Kg-m horizontal force is applied to conventional walls, a 400 Kg-m force for fire walls. For load-bearing walls, this is only one of several criteria. Mr. Shorter remarked that Canada is studying the effects of (1) size of openings on the fire performance of load bearing structural elements (e.g. openings for air conditioning ducts in floor and ceiling systems) and (2) piercing of structural elements by plastic pipe. When complete, this information will be relayed to C.I.B.. Col. Cabret noted that the criteria are quite similar in different countries, even though the philosophies may vary. Flammability, escape time, extinction time (fire brigade action), are all factors which affect the approach to national fire codes and regulations. France uses separate fire resistance ratings in terms of three well-defined categories: (a) stability, (b) integrity , and (c) insulation; whereas in U.K. and USA, there is a single fire resistance rating, which is based on any one of three criteria. Dr. Robertson noted that the separation of integrity and insulation is applied only to marine construction in the U.S..

Paper No. 69/2 (I) No presentation; no discussion.

Paper No. 70/31 (U.S.A.) "Fire Load, Fire Severity and Fire Endurance" was presented by Dr. Robertson. Mr. Heselden noted that in Fig. 7, the relation was good because the R vs L correlation was very good. The data applies to one shape compartment, one crib construction only and does not make use of rate of burning. It should be compared with CIB cooperative data.

Col. Cabret wondered whether the U.S.A. will reconsider its analysis in light of the CIB cooperative test program results using models.

Paper No. 70/12 (F) was submitted, but not discussed. This paper comprises a list of fire endurance tests conducted by CSTB.

Paper No. 60/5 (UK) was presented by Dr. Thomas.

Distance across which fire can spread from one piece of furniture to another is SMALL: however, tall items will produce tall flames which may spread out along ceiling surfaces and radiate to other items. In reply to a question as to whether these can be applied to poorly ventilated compartments (inasmuch as ventilation is relatively unimportant in fires in early stages; as confirmed by 2nd phase of CIB cooperative model tests), Thomas suggested that caution be exercised in applying the conclusions to other than well-ventilated conditions.

Col. Cabret asked to what extent have radiation measurements been made in compartments in U.S.? And measurements of the separation of radiation and convection.

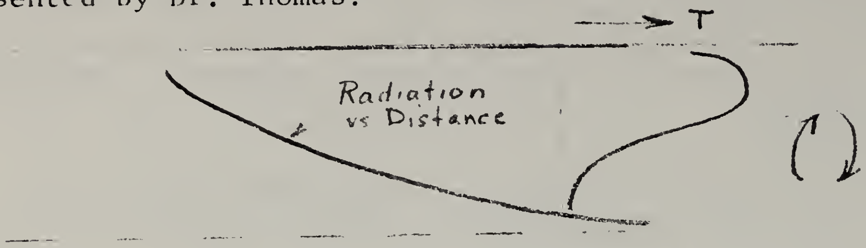
Dr. Roberston replied that IITRI has made measurements, starting with furnished full-scale actual buildings in Chicago, but their approach was similar to that of U.K., i.e. simulating the effect of the atomic blast.

Mr. Yuill remarked that in a study for NBS Flammable Fabrics Section, it took 1 - 1 1/2 hrs. for flames to involve furnishings from a burning cigarette.

Paper No. 70/30 (USA) "Interlaboratory Comparison of the Potential Heat Test Method" was presented by D. Gross.

Col. Cabret noted that France uses a calorimetric method in their regulations, but it is based on the higher heat of combustion, rather than (the more appropriate) differential technique. Prof. Herpol indicated that ISO TC 92 considered such a test, but after much study and tests, abandoned it in fovor of a furnace test. Col. Cabret observed that it was possible to separate the question of defining noncombustibility and the quantitative measure of heat. There was additional discussion revolving around the meaning and the definition of "combustibility" and "noncombustibility".

Paper No. 68/39 (UK) "Spread under (Incombustible) Ceilings" was presented by Dr. Thomas.



mixing of hot and cold represents work against gravity

There are three factors (interactions complex)

1) Presence of ceiling - controls radiation in early stages

2) Thermal Properties of Ceiling -- effects secondary radiation from ceiling

3) Flammability of Ceiling - only affects feedback and surface spread.

Mr. Lawson stated that it was not necessary to specify a "noncombustible" ceiling in a corridor; one with "low flammability" is sufficient, and the thermal conductivity of such materials would be important.

Dr. Thomas gave an implication of the results: Vertical screens will be effective in restricting flames along ceiling, whereas noncombustible separations will be almost useless because of the extreme length of flames.

Paper No. 68/49 (UK) "Effect of Source of Ignition" was presented by Dr. Thomas. Statistics - Fires confined to room of origin.

Mr. Lawson noted that rubbish burning fires were due primarily to combustible packaging, and this has overtaken smoking as the No. 1 cause of large industrial fires in the U.K.. Some thought is being given to nonflammable packaging materials. There is a great need for improved fire statistics and a recommendation by CIB could help to increase governmental support.

Mr. Yuill remarked that in the U.S.A., some cities provide good statistics; most cities do a poor job. NFPA has a current program for encouraging the collection of statistics.

4. FINAL DISCUSSIONS

The final reports of the three Groups formed the basis for the summary decisions listed in Appendix D.

In the discussion following the Group 1 report, Mr. Lawson and Mr. Malhotra suggested that a valuable symposium topic would be: "Analytical methods to calculate the fire resistance of frame constructions using available data on material properties and computer programs". The Chairman felt that this could be considered as one point of discussion at the forthcoming Planning Session of CIB at the end of June.

After the presentation and final discussion of the three Group reports, Mr. Lawson suggested as a theme for the next meeting: "The Measuring and Importance of Combustibility". The Chairman noted that a more general theme could encompass other important factors such as flammability, definition of stability, and full-scale fire research.

With regard to the distribution of documents, no changes were made.

Mr. Fry, the Coordinator, was encouraged to attend the CIB Planning Session and to relay information to the member countries.

Under New Business, Mr. Lawson described a proposed British test furnace 10 x 5 x 3 m with provision for unique lateral restraints and moments; to be used for evaluation of frame structures. Life 25 years. Cost £1.8 M. He requested some expression of need for such a facility by Commission W 14. He felt that analytical methods for prediction of fire performance of structures will become dominant in approximately 15 years.

Col. Cabret noted that PCA in U.S. and C.I.T.C.M. in Metz have facilities somewhat like that proposed and research has and will be carried out in these test furnaces. More information was needed on the British proposal.

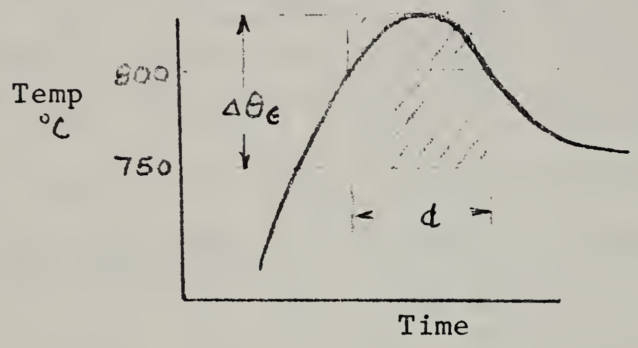
Dr. Robertson said that he supported the resolution and may wish to make use of the facilities in the future.

Mr. Lawson suggested the wording of a possible resolution which was considered agreeable to the various delegations: "Commission W 14, CIB, consider that it is necessary to have information on the fire performance of framed structures with various degrees of lateral and moment restraint. It is noted with interest that the U.K. are considering the construction of a furnace in which these forces and moments can be applied, and that this will extend facilities in other parts of the world. Commission W 14 can foresee that this furnace will yield information important to the design of composite structures in the future."

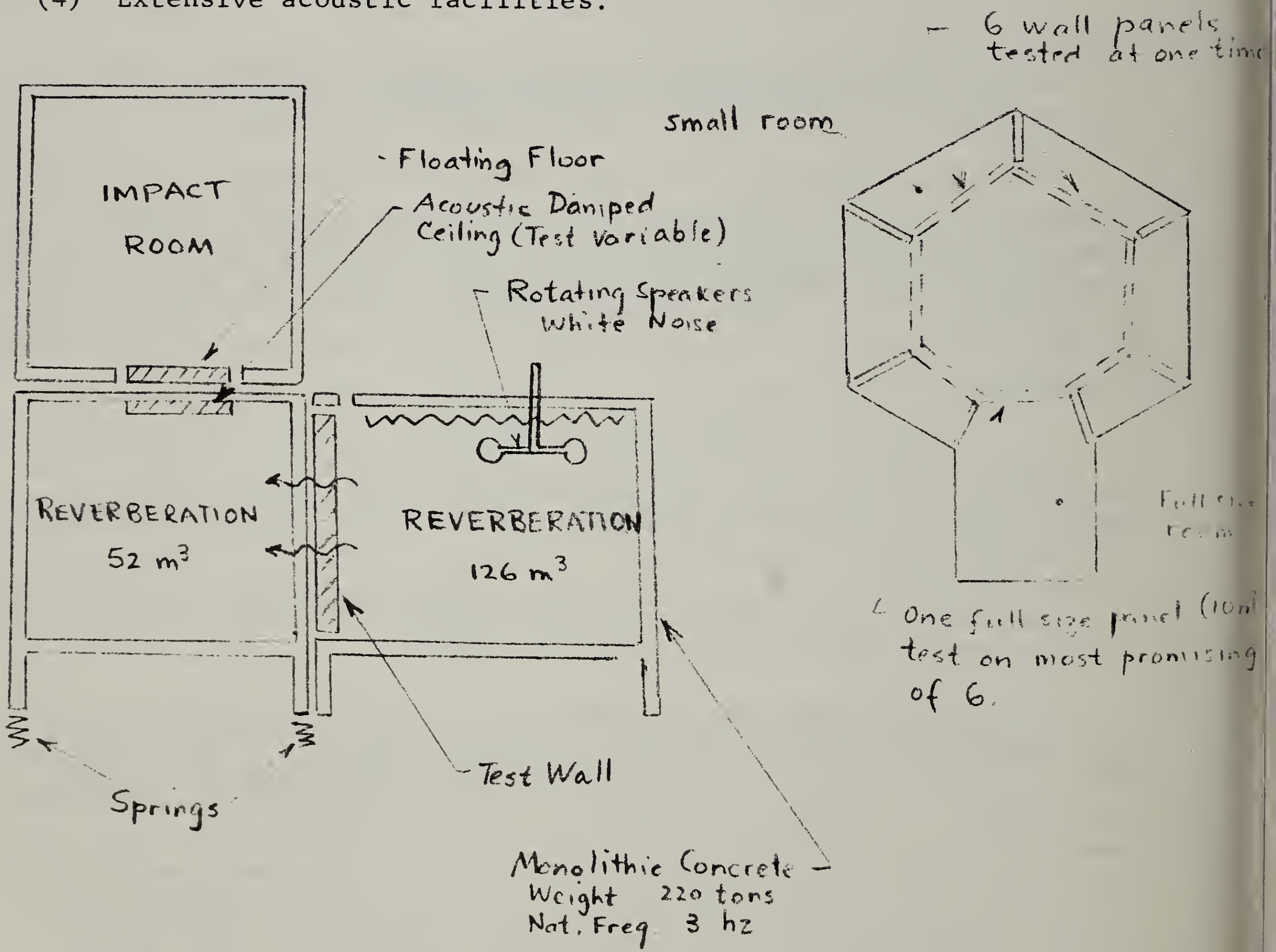
Next Meeting --- End of May, 1972
Tentative offer by Odeen for meeting in Stockholm.
Alternate proposal --- U.S.A.

Selection of Coordinator -- (CIB generally recommends rotating staff). J. F. Fry was nominated for another term.

A recent round robin study of fibrous insulation for EURISOL will be reported soon and forwarded to I.S.O.. Observations were made on description of sample after test and its position relative to the thermocouple. Comparisons were made with suggested criterion of Mr. Balzaretti (Italy), member of WG2; $P = \Delta\theta_{\epsilon} . d . 10^{-3} \geq 250°C$-sec; i.e. area = total temperature rise ($\Delta\theta\epsilon$) x duration above 800°C (d)



(4) Extensive acoustic facilities.

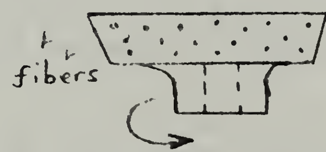


5. VISIT TO COMPAGNIE de ST. GOBAIN, RANTIGAY

The company was founded in 1901 and now produces a wide variety of products. At Rantigay where glass fiber is produced there are 700 employees. World-wide, St. Gobain and its 20 or more affiliates produce 30% of all glass fiber. Their only competition in France is one mineral wool manufacturer (which St. Gobain also produces).

The glass fiber production is 70 tons/day in each of two tanks. The heart of the system is the patented extrusion spinner which operates at 2300 rpm and 1050°C. The fine 5μ diameter fibers are sprayed with phenolic binder (also formaldehyde or melamine in small quantities) and cured at 200 to 220°C. The range in properties of the finished glass fiber batts are:

Thickness: 15mm to 200mm in 5mm steps
Density: 12 to 110 Kg/m^3
Binder: 3 to 12%



In addition to insulation batts, the plant produces rigid pipe insulation, blankets, roofing insulation, sintered glass (for battery separators), headliners for Citroen cars, etc.

In the Research Center, headed by Mr. Sauvage, there are 130 employees, including 20 research engineers and an annual budget of 10 million francs. Mr. Amy, who is a member of the French Stnadards Association and ISO TC/92 WG2, is a consultant to St. Gobain. Mr. Jumentier, who is on the corporate staff of the Glass Fiber Division, visited NBS in 1961 (Dr. Cook, Mr. Robinson, and Mr. Powell).

In the Physical Test Laboratory, the following test apparatus was noted:

(1) Dynatech Guarded Hot Plate (and NBS Standard materials).

(2) CSTB Croisset for combustibility of fibrous materials. Tests to begin later this month.

(3) ISO Noncombustibility Furnace. Furnace and stand now circular (previously square, but "shape unimportant"). Three separate windings and controls. Source of shielded thermocouple (and sample):

L'Equipement Thermique
31, Rue Louis Blanc
Alfortville (Seine), France

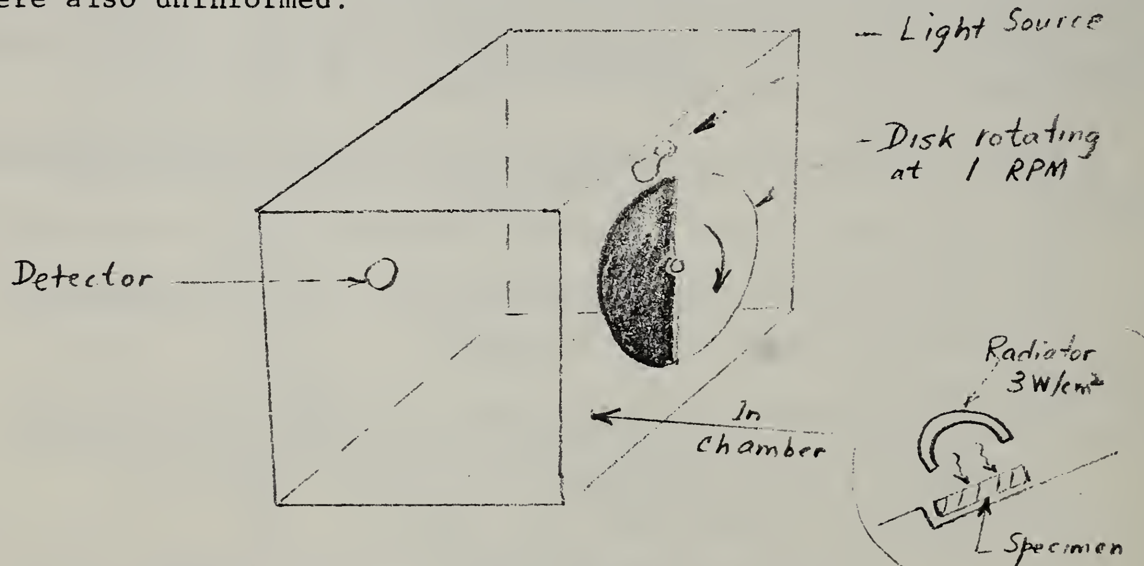
Thermocouple chemisés
2 ABAC 10 avec T.I. et <u>capuchon</u>
(largueur 10 mm, Ø 2.0 mm).
Larguer thermocouple: 2 metres.

6. VISIT TO C.S.T.B., CHAMPS-sur-MARNE

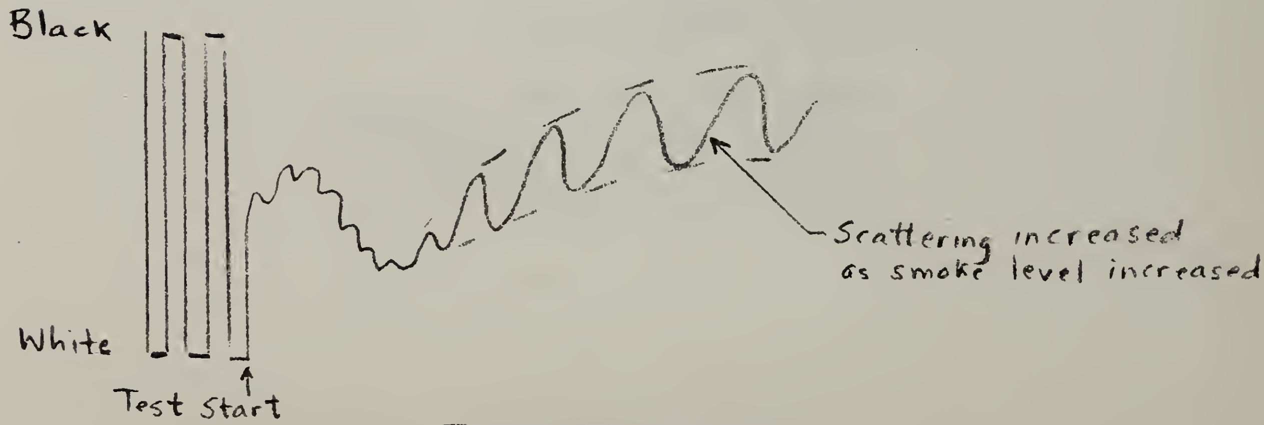
There are a wide variety of laboratory tests used for evaluating interior finish materials, wire insulation, etc. for combustibility, flammability, smoke, etc..

A test was recently developed for simultaneous measurement of smoke opacity and contrast. A specimen is exposed to 3 w/cm^2 radiation within a closed one meter cubical chamber. A disk with one half painted black and one half white rotates at 1 RPM on one side of the chamber facing a detector through a collimating lens. A lamp situated in another wall of the chamber provides uncollimated illumination so that only 90° scattered light will reach the detector. Air curtains are provided at the two walls where smoke leakage may otherwise be appreciable. A typical record is shown below.

The nine-story tower, which is used for research on plumbing (left side) and smoke movement (right side), was described in the recent CSTB Annual report (Laboratoire de Désenfumage). Smoke produced in one or more rooms leading to a corridor (5' wide x 8' high x 80' (?) long) can be measured and controlled by various means. We were shown the facilities at ground level and there was a discussion of the way in which the facility was being used but the explanation was largely in French and we failed to get a clear indication of the manner of use. It was clear though that Mr. Bellisson and others in the fire research group were also uninformed.



SMOKE OPACITY AND CONTRAST TEST



TYPICAL RECORD

7. VISIT TO FIRE RESEARCH STATION

7.1 Fire Growth

In discussions with Dr. Thomas, Mr. Heselden and Miss Margaret Law, the following information was gleaned:

A. Dr. Thomas is preparing a paper on the effect of wind on fire spread and has obtained correlation between Byram's data on wood cribs and JFRO data on grass fires. Can also correlate values for Japanese conflagrations following earthquakes (!).

R = spread rate, m/sec

ρ_f = fuel (bulk) density, Kg/m^3

V = velocity, m/sec

[Note: ρ_f is an independent variable, and should be placed on abscissa].

B. Dr. Thomas is working on a probabilistic approach to the distribution of (monetary) fire loss. The work is an extension of concepts presented by Benkert and Sternberg (Sweden) and Mandelbrot (MIT) as referenced in a paper by G. Ramachandran "The Poisson Process and Fire Loss Distribution".

At a staff meeting, Mr. Baldwin discussed a systems analysis approach to fire growth based on U.K. fire statistics. The cost of fire in the U.K. is estimated as follows:

Fire losses	£ 120 million
Fire Brigades	£ 90 million
Building Controls	£ 60 million
Sprinklers	£ 20 million
Detectors	£ 4 million.

"Large" fires (greater than £10,000) represent 1% by number but 50-60% of total monetary loss. Statistics show that 15% of all fires spread beyond the room of origin. As a typical example, taking the data for manufacturing industries (see table), the relationship between the total number of fires (N), the number which spread beyond the room of origin (n_s), and the number of "large" fires (n_ℓ) could be expressed

as: $n_\ell = 1.84\ n_s^{2.75}\ N^{-1.88}$

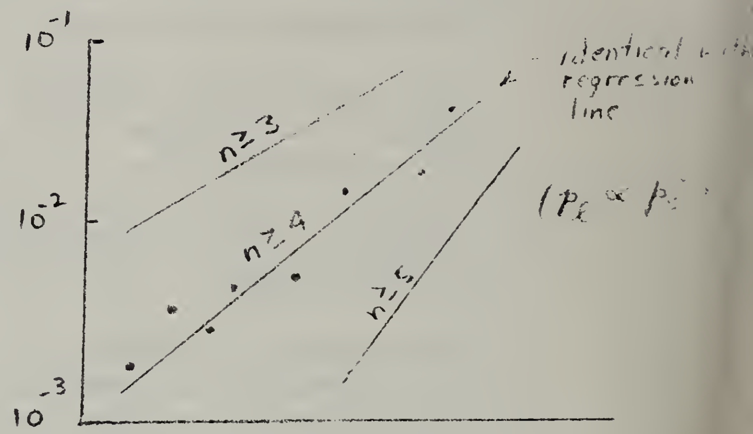
or $\frac{n_\ell}{N} = 1.84\ (\frac{n_s}{N})^{2.75}$ approximately. Therefore, the probability of a large fire developing, depends strongly on the probability of a fire spreading, and fire spread may be considered as a stochastic process, subject to chance. Since $n_\ell = f(n_s)$, we can study small fires to find out how and why they spread.

If s is a spread parameter which applies equally to any wall, the probability of spread can be expressed as $p_s = 1 - (1-s)^4 \dot{\approx} 4s$.

$$p_s = \underset{\text{avg. data value}}{\mu} + \underbrace{\underset{\text{age}}{A} + \underset{\text{height (stories)}}{S} + \underset{\text{risk}}{R} + \underset{\text{time of discovery}}{T}}_{\text{adjustment factors}}$$

The fit of data suggests that (n=) 4 rooms represents an average loss of £10,000.

Chance of Fire Becoming Large



Chance of Spread Beyond Room of Origin

One interesting conclusion drawn from the statistical data was that the fire size was practically unaffected by the attendance time (fire brigade response). A visiting team under Mr. Silcock is assigned to the scene of fires in London area to obtain additional first-hand data on actual fire growth.

In this analysis, spread between compartments only is considered and from a probabilistic point of view. Spread within and between compartments due to physical events is more complicated and not being considered at this time.

C. With regard to the ISO Flame Spread program, JFRO has not performed tests yet. They will probably use a commercial radiation pyrometer to measure blackbody temperature of panel. Thomas thinks 800°C is feasible provided a 2-stage regulator is used from propane tank and a regulator at the aspirator. His general philosophy is that if a material melts, expands, or otherwise produces a qualitatively different behavior in the (ceiling) position, then this position needs to be included, even though the wall and floor positions are more repeatable.

D. With regard to the ISO Ignition program, Dr. Thomas has provided three additional materials (Gypsum Board, Galbestos and Treated Hardboard) to participants, for tests at 5 W/cm^2, and will send NBS some. He feels that the color temperature of the Rohm & Haas radiator is exceptionally high and also that the gases are more turbulent due to the close spacing of radiators in the closed chamber. Mr. Becker agreed to repeat tests using the apparatus removed from the chamber. Mr. Keough has prepared a report on his test (mailed about two months ago).

E. Margaret Law has prepared (or is preparing) a report analyzing the model compartment data in terms of the equivalent fire endurance of a protected steel column of known thermal resistance and heat capacity. She is also working on the fire load survey of buildings and an analysis of escape time in aircraft due to an external fuel fire.

7.2 Codes

In discussions with Mr. Langdon-Thomas and Mr. Butcher, the following information was obtained:

In England and Wales (except for London), there are no Codes, only Codes of Practice. Legal power to regulate means of escape are expected shortly, although it is very difficult to translate technical information into detailed legal documents. The Standard Codes of Practice are published by the British Standards Institution, an independent organization, not subject to Government control. There are the following:

Standard Code of Practice CP3: Chapter IV

Part 1.	High Flats (>80 ft)	1962
Part 2.	Shops and Department Stores	1968
Part 3.	Offices	
	Hotels (in process, via Home Office)	

The Ministry of Housing is tending toward the Scottish mandatory code, e.g. totally enclosed staircases in department stores. Schools are under the control of the Ministry of Education. Reference: Bldg. Bulletin No. 7 "Fire and the Design of Schools" originally published in 1952, new edition, early 1960's.

There is a proposed Code "Fire Precautions in Flats and Maisonettes Over 80 Feet in Height" (see Appendix E).

The proposed code permits a greater distance of travel through smoke (10 meters vs 15 feet in current code). No degree of cross-ventilation would be required, but provision for 4 to 5 ft^2 of permanent opening plus 10 ft^2 of openable window. The WORTHING AAC system, incorporating a MINERVA ionization-type smoke detector to actuate vents on the exterior of the building, creates a circulation and "scouring action" (with a total area $\geq$ 14 ft^2) which is considered very good.

There are four areas of consideration for exit requirements: (a) within the apartment, (b) from apartment to corridor, (c) stairs, (d) exit to street. If the distances between the furthest bedroom door and the apartment entrance door is greater than 7.5 m(?), a secondary exit from the bedroom (e.g. balcony or pass door) is required. Apartment entrance doors are to be fire-resistant and self-closing.

There are no standards for "smoke-stop" doors, but wood doors are preferable. (Types 1, 2, 3). Total door assembly should be tested. SECO Mastic Intumescent strip (English version of SNITKOR) works very well as a smoke-stop in frame, not door.

With regard to spread of flame, BS 476 Class 1 had too large a range in performance ("good" to "bloody awful"). Therefore, there has been an addition of Class "O" to U.K. Standard Building Regulations (all buildings). See Fire Note No.9 for comprehensive data.

The Fire Propagation Test is expected to take the place of Class "O" of BS 476 (Part 6) in less than 12 months. Indes 12 (overall)/6 (First 3 minutes) was chosen to include plasterboard. Polystyrene foam has very low rating (less than 12/6), but may be excluded on basis of excessive smoke. The Fire Propagation Test in a room will be proposed as standard smoke test.

7.3 Detection

In discussions with Mr. Burry, JFRO performs a great many approval tests, and prepares test method standards. The only currently available specification is BS 3116 - Part 1 - Heat Sensitive (Point) Detectors. In process are (a) Line Heat Detectors, (b) Smoke Detectors, (c) Control Equipment. They use a "heat tunnel" to evaluate heat detectors and assorted fires (wood crib, petrol, etc); a "smoke tunnel" to evaluate smoke detectors. The laser is more sensitive to smoke than the ionization detector, and JFRO will continue its development. A research associate from PYRENE CO. worked at JFRO until recently and is now developing a commercial laser detector.

A recent study by Mr. Fry of the actuation of fire detection systems at actual fires (FR Note No. 810), showed that for every call due to fire, there were 10 to 15 false alarms. These were due to various environmental conditions, such as vibration, external smoke, external heat, etc. A program is now underway to determine the environmental conditions existing in various occupancies. A field instrumentation package will be developed to record: temperature, rate-of-rise, smoke, vibration, humidity, shock, impact, corrosion.

APPENDIX A

COMMISSION W.14 du C.I.B. (9ème Session)

du 1er au 5 juin 1970

au C.S.T.B.
(PARIS)

AFRIQUE DU SUD	M. H.T.H. DANNENFELDT C.S.I.R. National Building Research Institute
AUSTRALIE	M. J.J. KEOUGH Commonwealth Experimental Building Station
BELGIQUE	M. G.A. HERPOL Université de GAND
CANADA	M. G.W. SHORTER National Research Council
DANEMARK	M. J. HOLST Danish Building Research Institute
FRANCE	M. G. BELLISSON Centre Scientifique et Technique du Bâtiment
	M. A. CABRET Centre Scientifique et Technique du Bâtiment
	M. le Lt. Colonel HAURE Service National de la Protection Civile Ministère de l'Intérieur
	M. le Lt. Colonel LE PULOC'H Brigade des Sapeurs-Pompiers de la Ville de Paris

FRANCE (suite)	M. J.C. TOURRETTE Centre Scientifique et Technique du Bâtiment
	M. R. TRAVERSE Service National de la Protection Civile Ministère de l'Intérieur
NORVEGE	M. H.A. BAKKE Fire Research Laboratory Techn. University Norway
PAYS BAS	M. J.F. van ELTEREN Institut T.N.O. DELFT
	M. J. van KEULEN Institut T.N.O. DELFT
	M. J. WITTEVEEN Institut T.N.O. DELFT
	M. H. ZORGMAN Institut T.N.O. DELFT
R.F.A.	M. W. BECKER B.A.S.F. LUDWIGSHAFEN am Rh.
	M. P. SEEGER Forschungsstelle für Brandschutztechnik Universität KARLSRUHE (TH)
	M. K.Th. TEICHEN Forschungs und Material- prüfungsanstalt für das Bauwesen - STUTTGART
	M. STANKE B.A.M. - BERLIN -
	M. W. WESTHOFF M.P.A. Nordrhein Westfalen DORTMUND
SUEDE	M. S. BENGTSON Nat. Swedish Inst. for Mate- rial Testing
	M. K. ODEEN Nat. Swedish Inst. for Mate- rial Testing

UNITED KINGDOM	M. P.C. BOWES Joint Fire Research
	M. J.F. FRY, J.F.R.O.
	M. A.J.M. HESELDEN J.F.R.O.
	M. D.I. LAWSON J.F.R.O.
	M. H.L. MALHOTRA J.F.R.O.
	M. P.H. THOMAS J.F.R.O.
UNITED STATES OF AMERICA	M. R. FRIEDMAN Factory Mutual Research Corp.
	M. D. GROSS National Bureau of Standards
	M. A.F. ROBERTSON National Bureau of Standards
	M. J.B. SMITH Factory Mutual Research Corp.
	M. C.H. YUILL Southwest Research Instit.
U.R.S.S.	Mme A. OPOTCHINSKAIA Gosstroi - MOSCOU - State Committee for Building Moscow, K-1, str. Schuseva, 3 Union of Architects,

C.I.B. Commission W.14
Programme for 9th Meeting

Sunday, 31st May. Arrive in Paris.

---oOo---

Monday, 1st June. at C.S.T.B.

10.00 - 11.00
(a) Speeches of welcome, etc.
(b) Election of Chairman for the week's proceedings.
(c) Acceptance of record of 8th Meeting.
(d) Divide into three Groups.

11.00 - 12.30
14.00 - 17.00
Groups discuss progress since 8th meeting:-

Group 1 - Fire endurance.
Group 2 - Spread of smoke and toxic gases.
Group 3 - Fires in single compartments.

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Tuesday, 2nd June. at C.S.T.B.

09.30 - 12.30 Report back from Group 2 and discussion of papers:-

CIB/CTF 69/6(UK)
" " 70/7(USA)
* " " 70/26(CA)
* " " 70/34(USA)

14.00 - 17.00 Report back from Groups 1 and 3 and discussion of papers:-

*CIB/CTF 70/20(USA)
* " " 70/24(UK)
* " " 70/19(USA)

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Wednesday, 3rd June. at C.S.T.B.

09.30 - 12.30 Discussion of papers:-

CIB/CTF 69/2(I)
* " " 70/31(USA)
" " 70/12(F)

14.00 - 17.00 Discussion of papers:-

*CIB/CTF 70/39(UK)
" " 69/5(UK)
* " " 70/14(C)

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*Not yet distributed.

Thursday, 4th June.

Morning - Visit to Factory and Laboratories of Sînt Gobain at Rantigay, (Oise).

Afternoon - Visit to Laboratoire, du Feu, C.S.T.B., Champs sur Marne.

---oOo---

Friday, 5th June. at C.S.T.B.

09.30 - 12.30 Discussion of papers:-

*CIB/CTF 70/30(USA)
" " 68/39(UK)
" " 68/49(UK)

14.00 - 17.00 Future activities of Commission:-

(1) Proposal by Programmes Committee of C.I.B. for a Symposium on the security of structures in fire.

(2) Distribution of papers.

(3) Date and place of next meeting.

(4) Other business.

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APPENDIX C

CIB/CTF 70/41 (UK)

COMPLETE LIST OF PAPERS CIRCULATED TO DELEGATES SINCE SEPTEMBER 1968 MEETING

CIB/CTF 68/35(USA)	-	Research and Development Laboratories of the Portland Cement Association. Research Department Bulletin 164. Effect of restraint on fire resistance of prestressed concrete
CIB/CTF 68/36(J)	-	Study on smoke generation from building materials
CIB/CTF 68/37(S)	-	Fire resistance of prestressed concrete double-T units
CIB/CTF 68/38(S)	-	Structural fire engineering research. Today and Tomorrow
*CIB/CTF 68/39(UK)	-	The contribution of flames under ceilings to fire spread in compartments. Part 1. Incombustible ceilings
CIB/CTF 68/40(J)	-	Calculation of smoke movement in buildings
CIB/CTF 68/41(J)	-	Estimation of fire temperature curves in rooms
CIB/CTF 68/42(J)	-	Research on the fire resistance of steel beams
CIB/CTF 68/43(J)	-	Behaviour of end restrained concrete member in fire
CIB/CTF 68/44(D)	-	The toxicity of combustion products of organic materials
CIB/CTF 68/45(F)	-	Cahiers du Centre Scientifique et Technique du Batiment No. 93. Essais de Résistance Au Feu (20e série)
CIB/CTF 68/46(J)	-	Experimental study on explosive spalling of artificial lightweight aggregate concrete in fire
CIB/CTF 68/47(J)	-	An elementary study of capacities of water supply points
CIB/CTF 68/48(UK)	-	F.R. Note No. 718. Fully-developed fires with furniture in a compartment
CIB/CTF 68/27(UK) ADDENDUM	-	Complete list of papers circulated to delegates since May 1966 Meeting (Addendum)
Up-to-date Membership	-	1968/69 C.I.B. Distribution Membership list
*CIB/CTF 68/49(UK)	-	F.R. Note No. 729. Spread of fire in buildings - effect of source of ignition
CIB/CTF 68/50(C)	-	National Research Council of Canada, NRC Paper 9867. Smoke movement in buildings
CIB/CTF 68/51(C)	-	National Research Council of Canada, NRC 9984. Control of smoke in buildings
CIB/CTF 68/52(C)	-	National Research Council of Canada, NRC 9467. Pressure differences for a nine-story building as a result of chimney effect and ventilation system operation

CIB/CTF 68/53(C)	- National Research Council of Canada, NRC 9950. Pressure differences caused by chimney effect in three high buildings and building pressures caused by chimney action and mechanical ventilation
CIB/CTF 68/54(UK)	- F.R. Note No. 728. The rate of burning of cribs of wood
CIB/CTF 69/1(F)	- Cahiers du Centre Scientifique et Technique du Batiment No. 94. Essais de Résistance Au Feu (21e série)
*CIB/CTF 69/2(I)	- Sulla resistenza al fuoco dei continui elastoplastici
CIB/CTF 69/3(F)	- Cahiers du Centre Scientifique et Technique du Batiment No. 95. Essais de Résistance Au Feu (22e série)
CIB/CTF 69/4(UK)	- F.R. Note No. 745. The chance of an outbreak of fire and the likelihood of large fires in various occupancies
*CIB/CTF 69/5(UK)	- F.R. Note No. 736. The critical distance for ignition from some items of furniture
*CIB/CTF 69/6(UK)	- F.R. Note No. 749. The assessment of smoke production by building materials in fires. 2. Test method based on smoke accumulation in a compartment
CIB/CTF 69/7(C)	- National Research Council of Canada, NRC 10523. Effect of deck on failure temperature of steel beams
CIB/CTF 69/8(F)	- Centre Scientifique et Technique du Batiment. Essais de Résistance Au Feu (23e série)
CIB/CTF 69/9(F)	- Centre Scientifique et Technique du Batiment. Tableau récapitulatif des classements relatifs a la résistance au feu
CIB/CTF 69/10(D)	- Vortrage und Aufsatze aus dem Stahlbau. Theoretische Uberlegungen zum brandverhalten von stahlkonstruktionen
CIB/CTF 69/11(D)	- Institut fur Baustoffkunde und stahlbetonbau der Technischen Hochschule Braunschweig
CIB/CTF 69/12(D)	- Sonderdruck aus dem Mitteilungsblatt Brandverhutung und Brandbekampfung Nr. 4/68. Das verhalten von abwasserrohren aus Kunststoffen im Feuer
CIB/CTF 69/13(D)	- Sonderdruck aus der VFDB-Zeitschrift, Uber die Normung und Zulassung von Feuerschutzturen
CIB/CTF 69/14(D)	- Institut fur Baustoffkunde und Stahlbetonbau der Technischen Universitat Braunschweig. Brandverhalten verschiedener Bauplatten aus Baustoffen der Klassen A und B, insbesonde aus Baustoffen der Klasse A2
CIB/CTF 69/15(D)	- Westdeutsche Spritzputz GMBH. Brandversuche an ummantelten Stahlträgern

CIB/CTF 69/16(D) - Centre Scientifique et Technique du Batiment. Tableau des Classements de la 23 ème série d'essais de résistance au feu, qui vient de paraître

CIB/CTF 69/17(UK) - F.R. Note No. 767. Investigation into the processes governing the operation and discharge of fire extinguishers

*CIB/CTF 69/18(UK) - F.R. Note No. 769. A study and toxic evaluation of the products from the thermal decomposition of PVC in air and nitrogen

CIB/CTF 69/19(F) - Centre Scientifique et Technique du Bâtiment. Essais de résistance au feu (24e série)

CIB/CTF 69/20(CA) - Steel properties for fire resistance. MRL 6/1.

CIB/CTF 69/21(CA) - Prediction of creep equation of state from isothermal tests. MRL 18/1

CIB/CTF 69/22(F) - Centre Scientifique et Technique du Bâtiment. Essais de résistance au feu (25e série)

CIB/CTF 69/23(CA) - Technical Record BS 52/75/389 Department of Works Commonwealth Experimental Building Station. Fire-resistance test on a 10-in non-loadbearing cavity wall consisting of a 4 5/16-in external leaf of burnt-clay bricks and a $3\frac{5}{8}$-in internal leaf of concrete hollow blocks

CIB/CTF 69/24(C) - National Research Council of Canada, NRC 10773. Lethal effects of mattress fires

CIB/CTF 69/25(C) - National Research Council of Canada, NRC 10854. Simultaneous moisture and heat transfer in porous systems with particular reference to drying

CIB/CTF 69/26(C) - National Research Council of Canada, F.R. Note 8. Time of evacuation by stairs in high buildings

*CIB/CTF 69/27(UK) - F.R. Note No. 776. Studies of phosgene production during the thermal decomposition of PVC in air

*CIB/CTF 69/28(C) - National Research Council of Canada, NRC 10965. Design of fire test furnaces

CIB/CTF 70/1(F) - Centre Scientifique et Technique du Bâtiment. Essais de résistance au feu (26e série)

CIB/CTF 70/2(F) - Centre Scientifique et Technique du Bâtiment. Essais de résistance au feu (27e série)

CIB/CTF 70/3(C) - National Research Council of Canada, NRC 11080. Limited safe surface temperatures for combustible materials

CIB/CTF 70/4(UK)	- F.R. Note No. 795. Experimental and theoretical studies of the dehydrochlorination of PVC in air and nitrogen
CIB/CTF 70/5(F)	- Centre Scientifique et Technique du Bâtiment. Essais de résistance au feu (28é serie)
*CIB/CTF 70/6(D)	- Bundesanstalt fur Materialprufung (BAM) Laboratory for Fire Protection. Correlation tests on furnaces for separating elements
*CIB/CTF 70/7(USA)	- Southwest Research Institute. Hazards of smoke and toxic gases produced in urban fires, September, 1969
CIB/CTF 70/8(USA)	- NFPA reprint from Fire Journal, March, 1969. Full-scale fire tests on interior wall finish assemblies
CIB/CTF 70/9(UK)	- United Kingdom Fire Statistics 1967
CIB/CTF 70/10(UK)	- Report of the Eighth Meeting of C.I.B. Commission held at Boreham Wood, England, 23rd - 27th September, 1968
*CIB/CTF 70/11(F)	- Centre Scientifique et Technique du Bâtiment. Tableau Recapitulatif des classements relatifs a la resistance au feu
*CIB/CTF 70/12(F)	- Centre Scientifique et Technique du Bâtiment. Tenue au feu des Batiments
*CIB/CTF 70/13(C)	- National Research Council of Canada, NRC 11161. Thermal performance of concrete masonry walls in fire
*CIB/CTF 70/14(C)	- National Research Council of Canada, NRC 11162. Fire test standard in the light of fire research
*CIB/CTF 70/15(C)	- National Research Council of Canada, NRC 11163. Elevated-temperature tensile and creep properties of some structural and prestressing steels
CIB/CTF 70/16(D)	- Informationsdienst Holz A49 - Brandverhalten von Holzkonstruktionen
CIB/CTF 70/17(D)	- Wasserkühlung von Stahlstützen im Feuer
CIB/CTF 70/18(D)	- Über Definition und Prüfung nichtbrennbarer Baustoffe
*CIB/CTF 70/19(USA)	- Design of liquid-filled structural members for fire resistance
*CIB/CTF 70/20(USA)	- Fire test of an exterior exposed steel spandrel girder
CIB/CTF 70/21(USA)	- The projection of flames from burning buildings
CIB/CTF 70/22(UK)	- F.R. Note No. 808. Survey of fire-loads in modern office buildings - some preliminary results

CIB/CTF 70/23(D)	-	Beschreibung und Diskussion des Gegenheizverfahrens zur näherungsweisen Bestimmung der Feuerwiderstandsdauer bekleideter Stahlstützen
*CIB/CTF 70/24(UK)	-	Fire Research Memorandum No. 2. Criteria of failure in fire resistance tests
*CIB/CTF 70/25(UK)	-	Fire Research Memorandum No. 1. Effect of age on the fire resistance of reinforced concrete columns
*CIB/CTF 70/26(CA)	-	Technical Record 44/153/391. Department of Works, Commonwealth Experimental Building Station. Smoke produced by burning materials in oxygen-deficient atmospheres
*CIB/CTF 70/27(USA)	-	Smoke and gases produced by burning aircraft interior materials
CIB/CTF 70/28(USA)	-	Techniques for the survey and evaluation of live floor loads and fire loads in modern office buildings
*CIB/CTF 70/29(USA)	-	A system for continuously monitoring hydrogen chloride concentrations in gaseous mixtures using a chloride ion-selective electrode
*CIB/CTF 70/30(USA)	-	Interlaboratory comparison of the potential heat test method
*CIB/CTF 70/31(USA)	-	Fire load, fire severity and fire endurance
*CIB/CTF 70/32(USA)	-	Experimental fires in model enclosures - CIB test results
CIB/CTF 70/33(USA)	-	A proposed national fire research program Committee on Fire Research, NRC-NAS, 1969
*CIB/CTF 70/34(USA)	-	Generation of lethal environments in building fires
CIB/CTF 70/35(USA)	-	Burning of well-ventilated wood cribs
CIB/CTF 70/36(USA)	-	An application of the water-gas reaction to improve the combustion of # 2 diesel fuel oil
CIB/CTF 70/37(USA)	-	Experiments on natural convection in enclosures with localized heating from below
CIB/CTF 70/38(USA)	-	Numerical study of natural convection in an enclosure with localized heating from below - creeping flow to the onset of laminar instability
*CIB/CTF 70/39(UK)	-	I.N. Note No. 374. C.I.B. International Co-operative Programme on fully-developed fires in single compartments: comprehensive analysis of results
CIB/CTF 70/40(UK)	-	I.N. Note No. 375. Co-operative Research Programme on fire spread. Preliminary analysis from 6 laboratories
CIB/CTF 70/41(UK)	-	Complete list of papers circulated to delegates since September 1968 Meeting
CIB/CTF 70/42		Research Summary

*Papers marked with an asterisk will be required for discussion at the Meeting.

APPENDIX D

CIB/CTF 70/49(UK)

NINTH MEETING C.I.B. COMMISSION W.14
SUMMARY OF DECISIONS ON WHICH ACTION IS REQUIRED

Among the decisions at the Meeting were several which call for some action and these are listed below:-

(1) To assess the role of new and traditional building and furnishing materials and new methods of construction in the loss of life by fire, it is necessary to have better information than exists at present on the causes of deaths by fire. Without this the various hazards (heat, smoke, toxic and noxious products of combustion) cannot be properly evaluated.

This problem has been discussed by representatives of thirteen nations present at a meeting of the Fire Commission (Commission W.14) of the Conseil International du Bâtiment which is a world-wide organization of institutions responsible for building research and documentation. The Commission resolved that, in the various member countries, an approach should be made to the government, medical or other organizations responsible for determining the causes of death to obtain more complete pathological information from autopsies.

(2) Mr. Bowes of the United Kingdom delegation is asked to draft a questionnaire, with a short explanatory note, for circulation to member countries so that uniform reporting can be achieved on fire deaths.

(3) In view of the lack of information on the causes of explosive spalling of concrete Commission W.14 resolved to ask member countries to report on the materials and circumstances in which explosive spalling is observed during fire tests.

Mr. Malhotra of the United Kingdom delegation is asked to prepare a reporting form for circulation to member countries so that uniform reporting can be achieved.

(4) Commission W.14 should continue its study of fires in single compartments and in particular the second series of co-operative experiments which has already been started. The Commission should also consider questions related to the application of its results to design problems and should study papers on such matters prepared by member organizations. If necessary Group 3 of the Commission (Fires in single compartments) should meet before the next full meeting of Commission W.14 to prepare summaries of information to be considered by the Commission.

It was decided to publish the results of the first co-operative programme on the study of fully developed fires and paper No. CIB/CTF 70/39(UK), (already circulated), was prepared as a draft document. Comment and suggestions for additional information to be included in the final document are to be sent to The Co-ordinator to arrive <u>not later than 31st December, 1970</u>. The final document will then be prepared by the United Kingdom delegation for publication as a C.I.B. paper.

(5) Commission W.14 of CIB considers that for the design of buildings to minimize the life hazard and the likelihood of loss by fire, it is essential to have a comprehensive collection of statistical information on fires. It was agreed that all Members of the Commission should exert what influence they can in their own countries to improve the collection and collation of fire statistics so that these may be used to assess the influence of building design and materials on casualties and losses.

APPENDIX E

Proposed Code "Fire Precautions in Flats and Maisonettes

Over 80 Feet in Height"

The Code Drafting Committee (Sub-Committee on Smoke Control) of the Ministry of Housing presented prposals for smoke control in horizontal circulation spaces. Butcher and Langdon - Thomas are members of the subcommittee. The Code being written is founded on the principle of smoke dispersal (rather than smoke containment) in order to allow greater travel distance.

The sketched plans are based on various arrangements of dwellings, without alternative exits, wholly independent of the normal approach route.

Design A would be acceptable with a maximum travel distance of 40m (~130 ft) from a dwelling entrance door to a door in a staircase enclosure or protection lobby, if the following alternatives were made:

(a) the smoke stop doors in the center of the corridor were omitted

(b) the windows at either end were permanently open or automatically controlled to open on the detection of smoke, thus encouraging cross-ventilation.

Designs B1 and B2 would be acceptable with maximum travel distances of 40m (~33 ft) from a dwelling entrance door to a door in a staircase enclosure or protection lobby where there is escape in one direction only, if the following alterations were made:

(a) the smoke stop doors in the corridor were omitted

(b) the windows at either end were automatically controlled to open on detection of smoke, thus encouraging cross ventilation.

Designs C1 and C2 would be acceptable .... 10m (~33 ft) ... to the door in the staircase protection lobby where there is escape in only one direction, if the following alterations were made:

(a) the dead end lobbies were provided with automatically controlled cross ventilation (through high level ducting).

(b) the staircase protection lobby itself was adequately ventilated.

Design D would be acceptable with a max. travel distance of 10m (~33 ft) from a dwelling entrance door to the staircase protection lobby door if permanent or automatically controlled cross-ventilation were provided. The implications of this in planning terms would require investigation.

Additional Criteria:

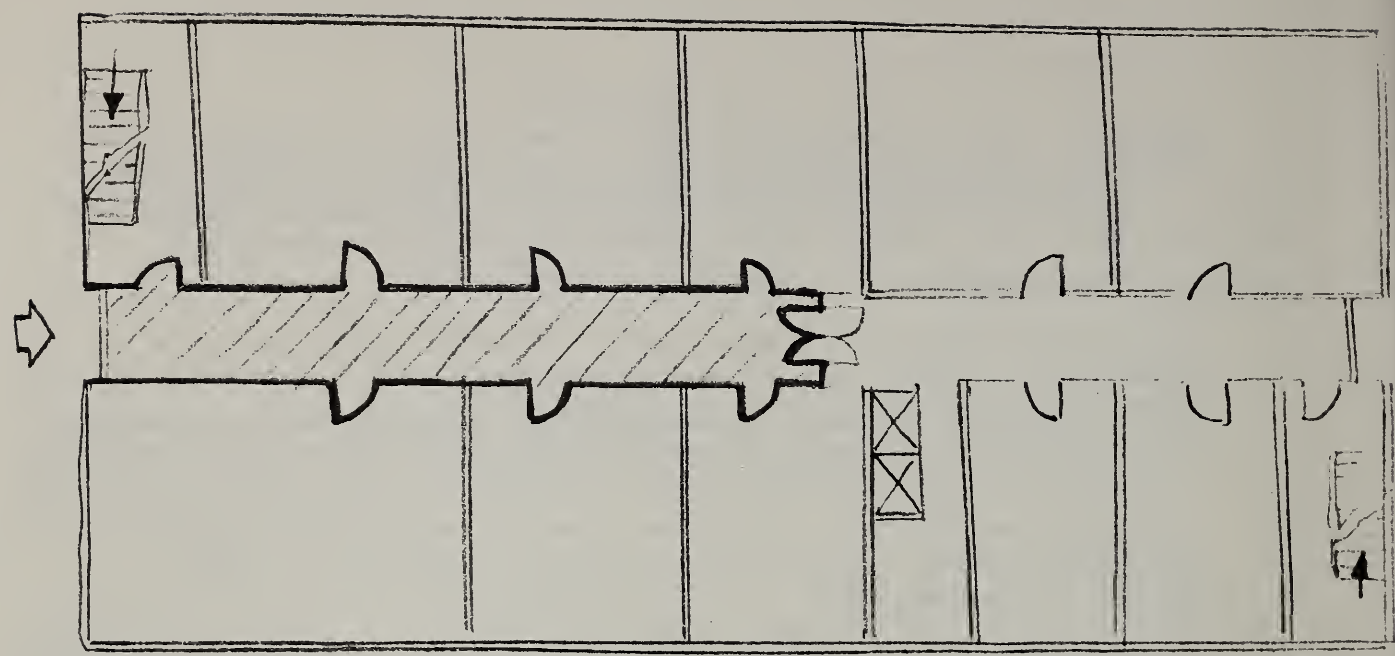
(a) The maximum distance between direct connections to external walls in cross ventilated corridors should be 60m (approx. 200 ft).

(b) The possibility of using the scouring effect of specially designed windows on one side or end of a corridor or lobby, should be investigated.

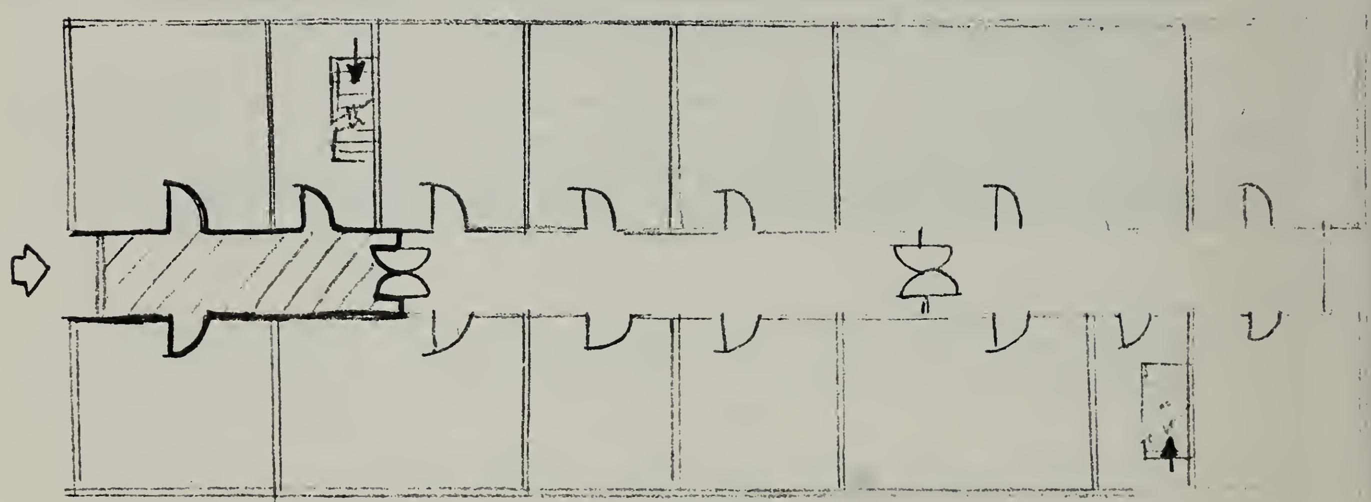
(c) The need for staircase protection lobbies in multi-staircase buildings should be considered further in relation to cross ventilated access corridors.

(d) The implications of recommending that cross ventilation openings should be at high levels should be investigated.

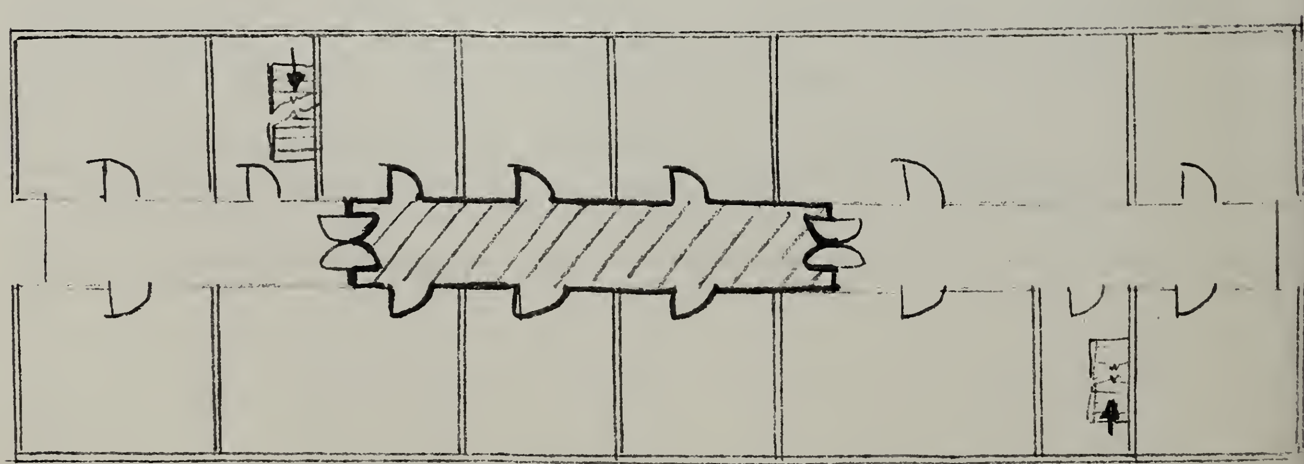
(JFRO to prepare a report on probable effect on smoke dispersal of ventilation openings of different types and sizes; not now feasible to include details about mechanical ventilation; however mechanical ventilation could be used for smoke control in suitable circumstances).



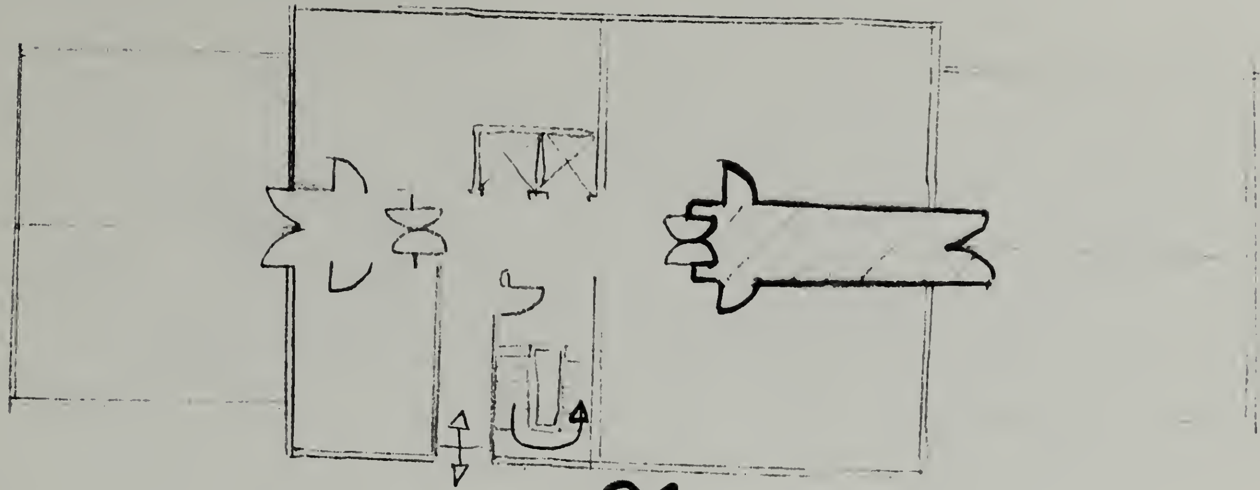
A



B1



B2



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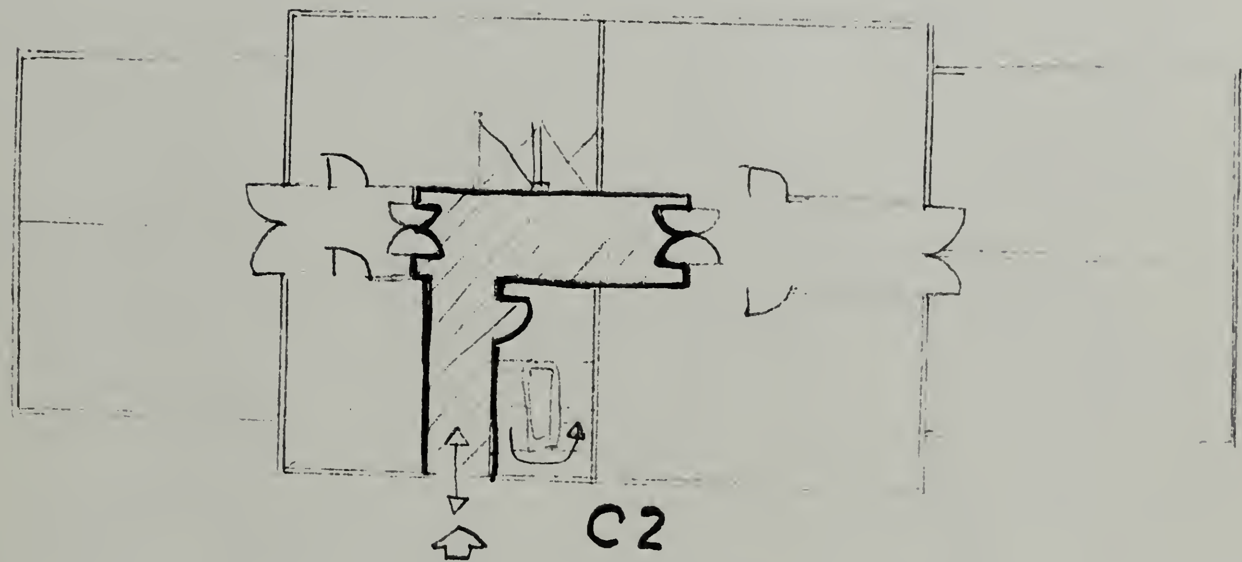

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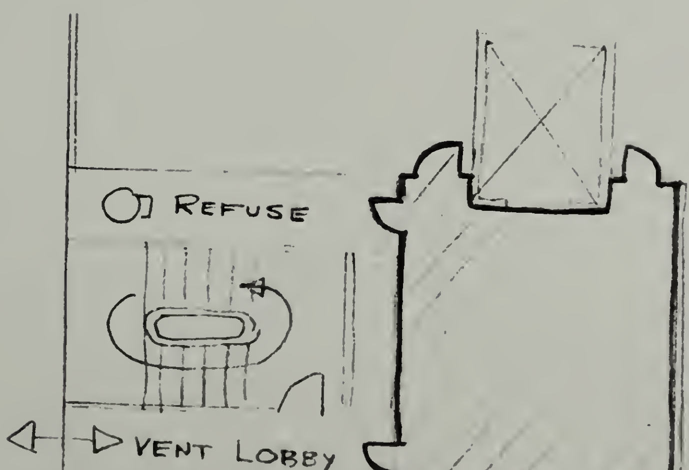
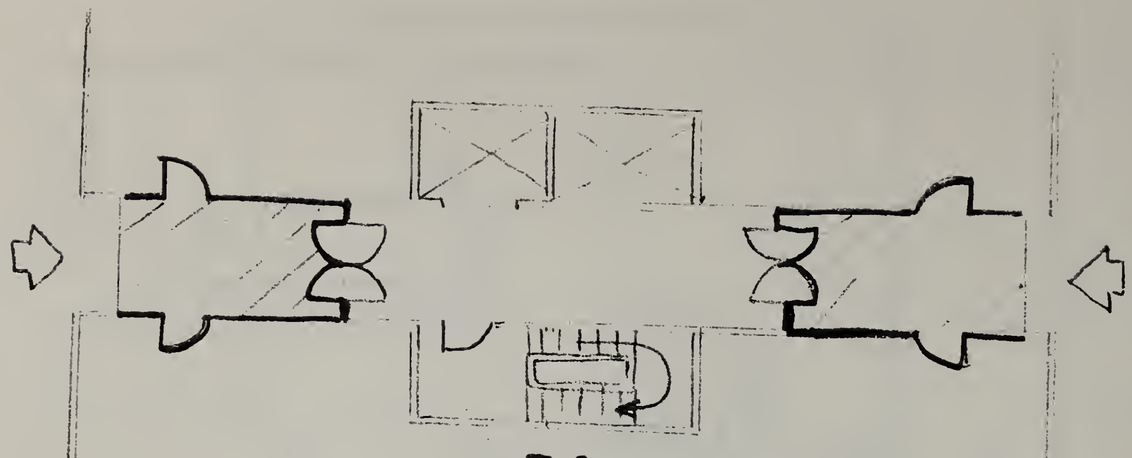


D



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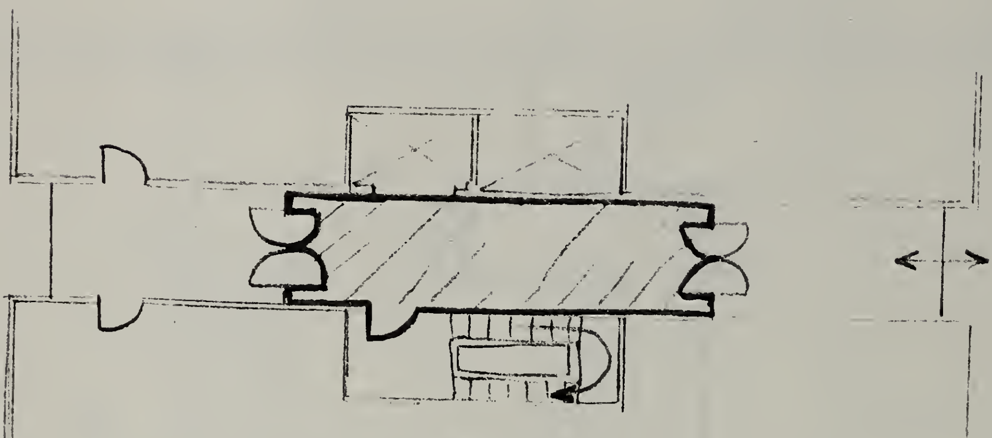
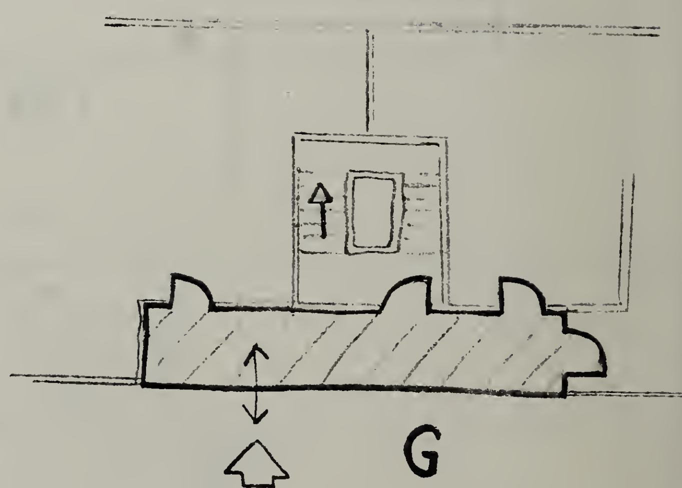


E2

F



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DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS